DOE–EM/GJTAC3011

Office of Environmental Management – Grand Junction

UMTRA Project

Moab UMTRA Project Groundwater and Surface Water Monitoring Report July through December 2018

Revision 0

April 2019

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contractor under contract number DE-EM0005014
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

DOE-EM/GJTAC3011

Moab UMTRA Project
Groundwater and Surface Water Monitoring Report July through December 2018

Revision 0

Review and Approval

5/2/2019

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Revision History

Revision	Date	Reason for Revision
0	May 2019	Initial issue.

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Figures

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Tables

Appendices

Acronyms and Abbreviations

bgs	below ground surface
CCB	continuing calibration blank
CCV	continuing calibration verification
CF	Configuration
CFR	Code of Federal Regulations
cm	centimeter
COC	chain-of-custody
CRI	reporting limit verification
DOE	U.S. Department of Energy
EB	equipment blank
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 ohms
MB	method blank
MDL	method detection limit
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
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 summarize the results 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 second half of 2018. The results of the data validation process are also presented.

Three sampling events were completed during this time frame. The first event included the collection of samples from the suitable habitat that developed to the east of the side channel adjacent to the CF4 injection wells and with the Configuration (CF) 5 extraction wells in September/October 2018. All of the habitat area and CF5 sampling locations are shown on Figures 1 and 2, respectively.

The second event was associated with the Crescent Junction well 0205 (Figure 3) sampling in October 2018 as part of the quarterly monitoring for the fourth quarter of 2018.

The third event started in November and was completed in December 2018, in which samples were collected from a variety of site-wide groundwater and surface water locations. However, due to site conditions inside the Contamination Area, it was not possible to safely collect samples from all locations by the end of December.

The remaining four locations were sampled in the middle of January 2019, and these results supplemented the data set to provide a more complete report. Groundwater and surface water sampling locations are shown on Figures 4 and 5, 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 upstream and downstream 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).

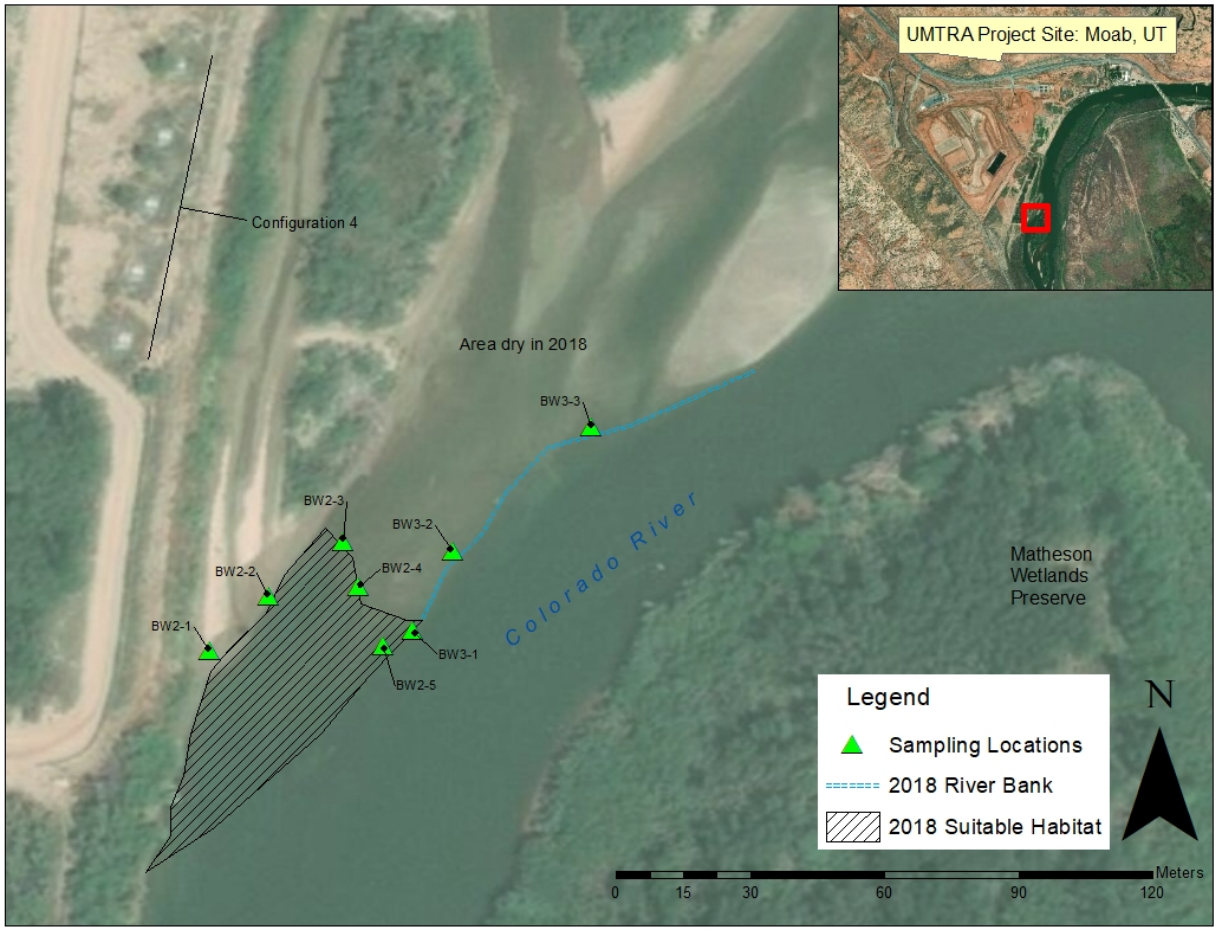

Figure 1. October 2018 Habitat Area Sampling Locations

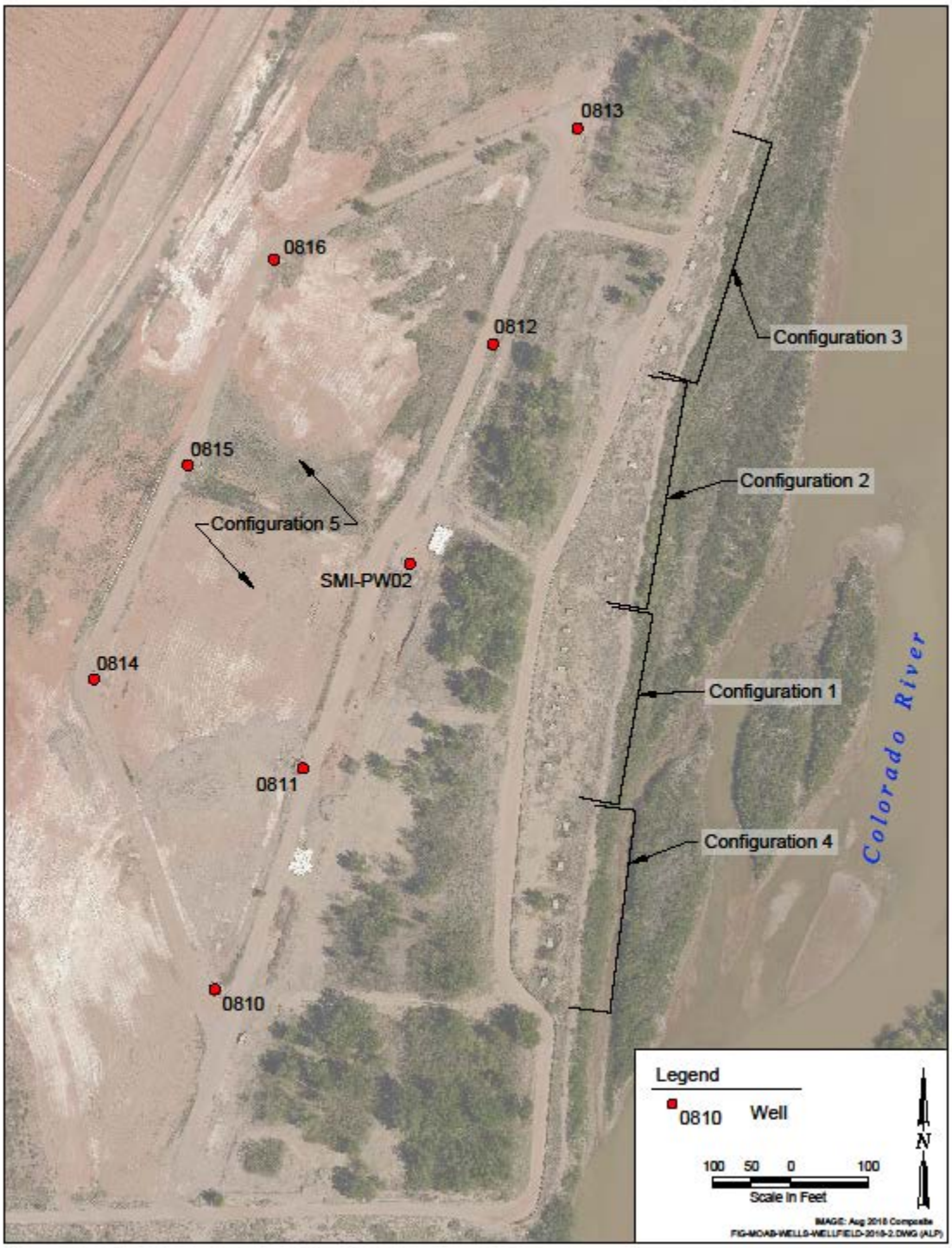

Figure 2. Second Half 2018 CF5 Groundwater Sampling Locations

Figure 3. Crescent Junction Well 0205 Sampling Location

Appendix A includes the Water Sampling Field Activities Verification, Minimums and Maximums Report, Water Quality Data, Water Level Data, and the trip report associated with the September/October 2018 Habitat Area/CF5 sampling event. Appendices B and C provide similar information for the October 2018 Crescent Junction and the November/December 2018 site-wide sampling events, respectively.

Appendices A and C also include the data associated with the trip blanks collected during the September/October 2018 Habitat Area and November/December 2018 Site-wide events. 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.

The Minimums and Maximums Reports were generated (by the Sample Management System and the SEEPro 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.

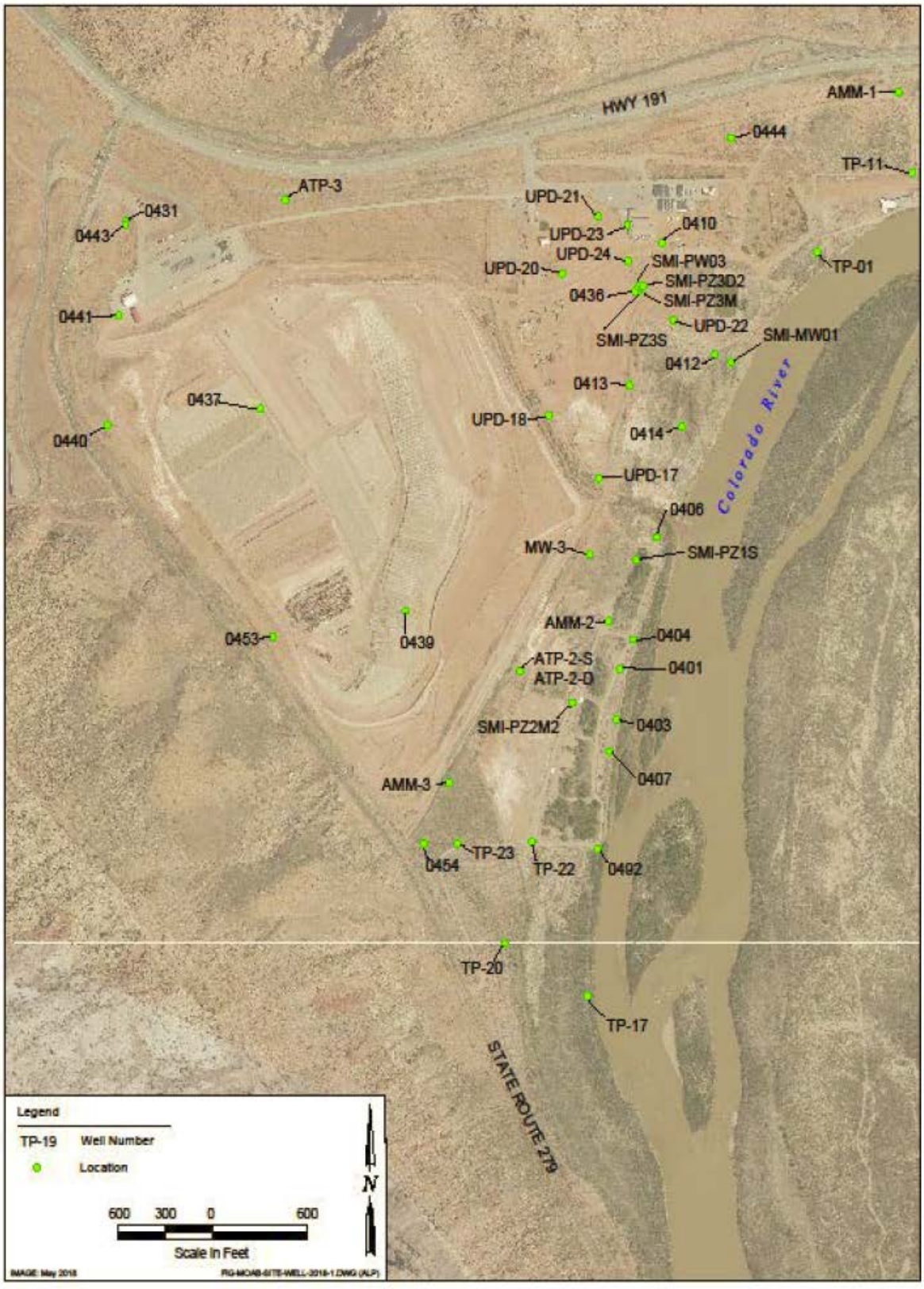

Figure 4. November/December 2018 Site-wide Groundwater Sampling Locations

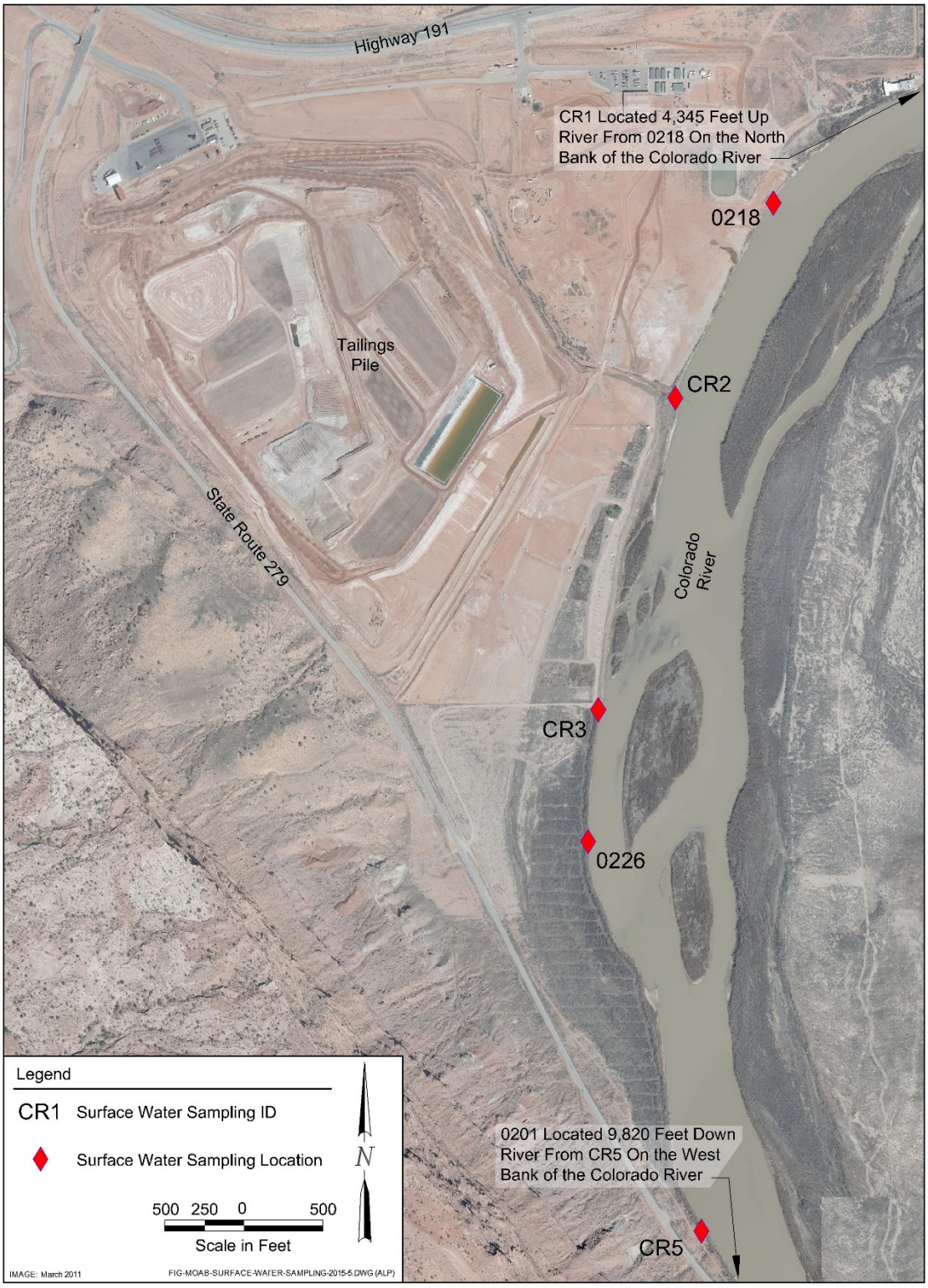

Figure 5. November/December 2018 Surface Water Sampling Locations

2.0 Summary of Sampling Events

2.1 September/October 2018 Habitat Area and CF5 Sampling Event

Eight surface water samples were collected from the suitable habitat that developed in August 2018. Because of exceptionally low Colorado River flows, the side channel off the CF4 injection wells (which has historically developed into a suitable habitat) was dry, but a suitable habitat did develop just to the east (Figure 6). Once it was confirmed as a suitable habitat for endangered fish species by a Utah Division of Natural Resources representative, the surface water diversion system was implemented to reduce the ammonia concentrations associated with groundwater discharge that potentially impacted this area.

Figure 6. Photo of Suitable Habitat, August 2018

The habitat sampling results were collected to confirm the surface water diversion system was effective in lowering the ammonia concentrations below the acute and chronic concentrations. The CF5 samples were collected to determine the effectiveness of the groundwater extraction system, with the concentrations measured at each of the CF5 wells used to update the ammonia and uranium mass removal calculations and contaminant concentration trends.

2.2 October 2018 Crescent Junction Sampling Event

A groundwater sample was collected from well 0205 as part of the quarterly monitoring at the Crescent Junction site. If water is present in any of the four monitoring wells during a quarterly monitoring event, a sample is typically collected.

2.3 November/December 2018 Site-wide Sampling Event

Fifty groundwater and surface water samples were collected as part of the site-wide event. This event corresponds to the time frame when the Colorado River is generally experiencing base flow conditions. The 43 groundwater samples were collected from a variety of upgradient, downgradient, and cross-gradient locations at various depths. The locations in the vicinity of the northeastern uranium plume were also included. The seven surface water samples were collected upstream, downstream, and adjacent to the site during this event. All samples were submitted to ALS Global Laboratory for ammonia and uranium analysis.

3.0 Data Assessment

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.

In addition, for inductively coupled plasma (ICP) analytes (uranium), reporting limit verifications (CRIs) verify the linearity of the calibration curve near the reporting limit (RL). For ICP-mass spectrometry analytes (uranium), instrument tuning and performance criteria are checked for mass calibration and resolution verifications. For ICP-mass spectrometry analyte uranium, internal standards are also analyzed to indicate stability of the instruments.

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) were qualified "J" when the detections were less than five times the blank concentration. Non-detects were 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
Matrix spike (MS) samples may not be generated due to a limited sample volume. Instead, laboratory control sample (LCS) duplicates **(**LCSDs) are performed. LCSDs that contain known concentrations of the analyte of interest are prepared in the laboratory. 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 NELAC Institute, an 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.

3.1 September/October 2018 Habitat Area and CF5 Sampling Event

3.1.1 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

Report Identification Number (RIN)	1809105
Laboratory:	ALS Global, Fort Collins, Colorado
Sample Data Group (SDG) Numbers:	1810184
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	27 March 2019

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

Table 1. September/October 2018 Habitat Area 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 2. Refer to Table 3 for an explanation of the data qualifiers applied.

Table 2. September/October 2018 Habitat Area and CF5 Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1810184-10 through 1810184-17	BW2-1, BW2-2, BW2-3, BW2-4, BW2-5, BW3-1, BW3-2, BW3-3	Ammonia	J	EB-1
1810184-10 through 1810184-17	BW2-1, BW2-2, BW2-3, BW2-4, BW2-5, BW3-1, BW3-2, BW3-3	Ammonia	J	CB-1, CCB-1
All	All in SDG 1810184	Uranium	J	MS-1, MSD-1
All	All in SDG 1810184	Uranium	J	SD-1

"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Table 3. September/October 2018 Habitat Area and CF5 Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
EB-1	J	N/A	The EB from the equipment that was used to collect the samples had an ammonia concentration that was higher than some of actual sample results. This could possibly lead to sample contamination.
CB-1	J	N/A	The slope intercept was an absolute value that is more than three times the MDL, so all results that are less than three times the MDL are flagged.
CCB-1	J	N/A	A calibration blank was 0.075 mg/L, and the MDL is 0.03 mg/L. Therefore, all samples less than five times the highest calibration blank are flagged.
MS-1	J	UJ	The MS sample for the sample group was from another client.
MSD-1	J	UJ	No MSD data were included in the narrative.
SD-1	J	N/A	No SD was run with the sample group.

MDL = method detection limit; mg/L = milligrams per liter.
"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving
ALS Global received a total of 18 samples for RIN 1809105 in one shipment, which arrived on October 15, 2018 (UPS tracking number 1Z5W1Y510196372514). The SDG was accompanied by a chain-of-custody (COC) form.

The COC form was checked to confirm all 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 1810184 was received with a temperature of 0.6°C. All samples were received in the correct container types, and all samples were analyzed within the applicable holding times.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium
The initial calibrations were all performed using five 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 three 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. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL. The CRI verifications were within the acceptance criteria range.

Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. Internal standard recoveries were stable and within acceptable ranges.

Method 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; however, the slope intercept was more than three times the MDL. The samples that have a concentration less than three times the y-intercept are flagged "J" for reason CB-1. This applies to samples 1810184-10 through 1810184-17. Nondetects are not qualified.

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

Method and Calibration Blanks
Two of the CCBs for the ammonia analysis were slightly above the MDL, and eight of the sample results were less than five times the highest CCB; therefore locations 1810184-10 through -17 were flagged "J" for reason CCB-1.

One of the CCBs on uranium SDG was slightly above the MDL, however no sample concentrations were less than five times the highest CCB, so no locations had to be flagged.

Equipment Blanks
One EB (location 2001, 1810184-9) was collected after the surface water tubing was decontaminated. The ammonia result was 0.44 milligrams per liter (mg/L), which is greater than any of the surface water sample results. The source of ammonia in the EB is unknown, but the groundwater technicians will look at switching out the bottle of de-ionized water that was used to collect the sample. The surface water samples (1810184-10 through -17) are flagged "J" for reason EB-1.

Matrix Spike Analysis
The ammonia MS met the requirements for frequency and percent recovery, so no data had to be qualified.

For the uranium SDG, the MS sample selected for quality control (QC) analysis was from another client and the information was not included in the analysis. Therefore, all of the uranium data were flagged "J" for reason MS-1.

Laboratory Replicate Analysis
The uranium SDGs did not contain an MS or MSD sample. Therefore, all of the uranium data were flagged "J" for reason MSD-1.

Field Duplicate Analysis
Duplicate samples were collected from location 0813 (1810184-4). The duplicate results met the EPA-recommended laboratory duplicate criteria of less than 20 percent relative difference (RPD) for results that are greater than five times the RL.

Laboratory Control Samples
LCSs were not reported for uranium. Per national environmental laboratory accreditation requirements provided by the NELAC Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution
Since no SD samples were run on the uranium samples in any of the SDGs, the uranium 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 November 17, 2018. The contents of the EDD were manually examined to ensure all and only the requested data were delivered in compliance with requirements and sample results accurately reflected the data contained in the sample data package.

3.1.2 Minimums and Maximums Report and Anomalous Data Review

The Minimums and Maximums Report for this sampling event is located in Appendix A. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.2 October 2018 Crescent Junction Sampling Event

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 1810106
Laboratory: ALS Global, Fort Collins, Colorado
SDG Numbers: 1810183
Analysis: Metals, Inorganics, Isotopic Uranium
Validator: Elizabeth Moran
Review Date: 1 April 2019

The samples were prepared and analyzed using accepted procedures as shown in Table 4.

Table 4. October 2018 Crescent Junction Sampling Event, Analytes and Methods

Analyte	Preparation Method	Analytical Method
Ammonia as N, NH_3-N	EPA 350.1	EPA 350.1
Alkalinity	EPA 310.1	EPA 310.1
Bicarbonate	EPA 310.1	EPA 310.1
Carbonate	EPA 310.1	EPA 310.1
Nitrate/Nitrite as N	EPA 353.2	EPA 353.2
Bromide	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Chloride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Fluoride	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Sulfate	EPA 300.0 Rev 2.1	300.0 Rev 2.1
Arsenic, Barium, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Potassium, Selenium, Silver, Sodium	SW-6010B	EPA 6010B
Uranium	SW-846- 3005A	SW-846 6020A
Total Dissolved Solids	EPA 160.1	540 C
Isotopic Uranium	SOP 776/778	SOP 714

Data Qualifier Summary

Analytical results were qualified as listed in Table 5. Refer to Table 6 for an explanation of the data qualifiers applied.

Table 5. October 2018 Crescent Junction Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1810183-1	0205	All Metals	J	MS-1, MSD-1
1810183-1	0205	All Metals	J	SD-1
1810183-1	0205	Chloride, Sulfate	J	MS-2, MSD-2

"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Table 6. October 2018 Crescent Junction Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
MS-1, MSD-1, SD-1	J	UJ	Per method requirements, matrix QC was performed for this analysis, however, a sample from this order number was not the selected QC sample. Therefore, the data was not included in the narrative.
SD-1	J	N/A	Serial dilution analysis was not conducted on the metals.
MS-2, MSD-2	J	UJ	The chloride and sulfate concentrations in the native sample were above the analytical range and therefore, accurate quantitation of MS/MSD recoveries were not possible.

"J" indicates results are estimated; it becomes "UJ" for analytical results lower than the detection limit.

Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado, received one sample for RIN 1810106 in a shipment of one cooler. The shipment (SDG 1810183) contained one groundwater sample from Crescent Junction well 0205. The temperature of the cooler was 0.6°C, and it arrived on October 8, 2018 (Tracking number 1Z5W1Y510196372514).

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. The 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 except for the following.

Matrix Spike and Replicate Analysis

For the metals analysis, the selected quality control sample was from another client and not included in the narrative. As a result, there was not a MSD or a SD sample analysis. Therefore, all of the metal data are flagged "J" for reasons MS-1, MSD-1, and SD-1.

For SDG 1810183, an MS was performed for the ammonia as N, nitrate/nitrite as N, total dissolved solids, alkalinity, bicarbonate, carbonate, bromide, chloride, fluoride, and sulfate analyses. The chloride and sulfate MS samples failed because the native concentration was too high. Therefore, these samples were flagged "J" for reasons MS-2 and MSD-2. For the remaining analytes, the selected QC sample was from another client and not included in the narrative, so all of the metal data were flagged "J" for reason MS-1.

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

Electronic Data Deliverable Files
The EDD files arrived on November 28, 2018. 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
Appendix B contains the Minimums and Maximums Report for this sampling event. Based on the results, all concentrations were within the acceptable ranges, and there were no anomalous data values associated with this sampling event.

3.3 November/December 2018 Site-wide Sampling Event

3.3.1 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	1811107
Laboratory:	ALS Global, Fort Collins, Colorado
SDG Numbers:	1812136, 1812342
Analysis:	Metals and Inorganics
Validator:	Elizabeth Moran
Review Date:	26 March 2019

The samples were prepared and analyzed using accepted procedures as shown in Table 7. Analytical results were qualified as listed in Table 8. Refer to Table 9 for an explanation of the data qualifiers applied.

Table 7. November/December 2018 Site-wide Sampling Event, Analytes and Methods

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

Table 8. November/December 2018 Site-wide Sampling Event, Data Qualifiers

Sample Number	Location	Analyte	Flag	Reason
1812136-8, 1812136-10, 1812136-14, 1812342-24	AMM-1, TP-01, UPD-20, CR3	Ammonia	J	CB-1
1812342-24 / 1812342-7	0431 / CR3	Ammonia	J	CCB-1
All	All in SDG 1812136 All in SDG 1812342	Uranium	J	MS-1, MSD-1
All	All in SDG 1812136 All in SDG 1812342	Uranium	J	SD-1
1812136-8, 1812136-10, 1812136-14, 1812342-24	AMM-1, TP-01, UPD-20, CR3	Ammonia	J	CB-1

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

Table 9. November/December 2018 Site-wide Sampling Event, Reason Codes for Data Flags

Reason Code	Qualifier (Detects)	Qualifier (Non-detects)	Explanation
CB-1	J	N/A	The slope intercept was an absolute value that is >3x the MDL, so all results that are <3x MDL are flagged.
CCB-1	J	N/A	A calibration blank was 0.044 mgl and the MDL is 0.03 mg/L. Therefore all samples <5x the highest calibration blank are flagged.
MS-1	J	UJ	The MS sample for the sample group was from another client.
MSD-1	J	UJ	No MSD data were included in the narrative.
SD-1	J	N/A	No SD was run with the sample group.

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

Sample Shipping/Receiving

ALS Analytics in Fort Collins, Colorado, received a total of 54 samples for RIN 1811107 in two shipments (Table 10).

Table 10. November/December 2018 Site-wide Sampling Event, Sample Shipping/Receiving

SDG	Number of Samples	Arrival Date	UPS Tracking Number
1812136	14	12/11/18	1Z5W1Y510190829087
1812342	40	12/21/18	1Z5W1Y510196682957 1Z5W1Y510195217747

The two SDGs were accompanied by a 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. Sample 1812136-5 (0413) had an incorrect sample time on the COC, but it was corrected at the laboratory.

Preservation and Holding Times

All of the SDGs were received intact. SDG 1812136 was received with a temperature of 3.5°C, SDG 1812342 was received in a two cooler shipment with temperatures of 3.8°C and 4.4°C. All samples were received in the correct container types and all samples were analyzed within the applicable holding times.

Laboratory Instrument Calibration

Method SW-846 6020A, Uranium

The initial calibrations were all performed using five 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 three times the IDL.

ICV and CCV checks were made at the required frequency. All calibration checks met the acceptance criteria. CRIs were made at the required frequency to verify the linearity of the calibration curve near the RL. The CRI verifications were within the acceptance criteria range for all SDGs.

Mass calibration and resolution verifications were performed at the beginning of each analytical run in accordance with the analytical procedure. 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 an r^2 value greater than 0.995; however, for both SDGs, the slope intercept was more than three times the MDL. The samples that have a concentration less than three times the y-intercept are flagged "J." This applies to samples 1812136-8 (AMM-1), 1812136-10 (TP-01), 1812136-14 (UPD-20), and 1812342-24 (CR3). Nondetects are not qualified.

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

One of the CCBs on the ammonia SDG 1812342 was slightly above the MDL, and two of the sample results were less than the highest CCB; therefore, locations 1812342-7 (0431) and 1812342-24 (CR3) were flagged "J" for reason CCB-1.

One of the CCBs on uranium SDG 1812136 was slightly above the MDL, however no sample results were less than five times the highest CCB, so no locations had to be flagged.

Equipment Blanks

One EB (location 2003, 1812342-16) was collected after the surface water tubing was decontaminated. No data had to be qualified.

Matrix Spike Analysis

All of the ammonia MSs met the requirements for frequency and percent recovery, so no data had to be qualified.

For all of the uranium 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 uranium data were flagged "J" for reason MS-1.

Laboratory Replicate Analysis
The uranium SDGs did not contain an MS or MSD sample. Therefore all of the uranium data were flagged "J" for reason MSD-1.

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 UPD-22 (1812342-38), SMI-PW03 (1812342-27), and AMM-2 (1812342-17), The duplicate results met the EPA-recommended laboratory duplicate criteria of less than 20 percent relative difference (RPD) for results that are greater than five times the RL. However, it should be noted that the laboratory miscalculated the dilution factor for the SMI-PW03 duplicate (sample location 2002). The error was corrected and a re-submission of the Inorganics Case Narrative was submitted in April 2018.

Laboratory Control Samples
LCSs were not reported for uranium. Per national environmental laboratory accreditation requirements provided by the NELAC Institute, an MS may be used in place of an LCS provided the acceptance criteria are as stringent.

Metals Serial Dilution
Since no serial dilution (SD) samples were run on the uranium samples in any of the SDGs, the uranium 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 EDD files arrived on January 15 and 17, 2018, for SDGs 1812136 and 1812342, respectively. 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.

3.3.2 Minimums and Maximums Report and Anomalous Data Review
The Minimums and Maximums Report for this sampling event is located in Appendix C. There were four anomalous data points, all based on the ammonia results. Two of the data points were associated with surface water samples (from locations 0201 and CR-5), and two were associated with groundwater samples (locations 0406 and ATP-3). With the exception of the result from the groundwater sample collected from location 0406, all were considered anomalous because higher detection limits were used during the analysis of these samples. The ammonia concentration in the sample collected from 0406 was significantly lower than the historic minimum, as shown in Table 11.

Table 11. Anomalous Data Associated with the November/December 2018 Site-wide Sampling Event

Location	Sample Date	Analyte	Concentration (mg/L)	Historical Minimum (mg/L)	Historical Maximum (mg/L)	Disposition
0201	12/12/2018	Ammonia Total as N	1	0.066	0.26	Higher detection limit used for analysis compared to historical detection limits.
0406	12/17/2018	Ammonia Total as N	14	110	510	Sample collected from location just off Moab Wash, flows in wash may have impacted groundwater chemistry.
ATP-3	12/20/2018	Ammonia Total as N	1	0.026	0.25	Higher detection limit used for analysis compared to historical detection limits.
CR-5	12/12/2018	Ammonia Total as N	1	0.07	0.495	Higher detection limit used for analysis compared to historical detection limits.

mg/L = milligrams per liter

4.0 Results

4.1 September/October 2018 Habitat Area and CF5 Sampling Event Results

The eight surface water samples were collected from the suitable habitat area on October 1, 2018. Due to low Colorado River flows a suitable habitat developed to the east, off the main river channel. Once it was confirmed as suitable habitat, the surface water diversion system was started on August 8 and ran continuously through October 1. The habitat sampling results were collected to confirm the surface water diversion system was effective in lowering the ammonia concentrations below the acute and chronic concentrations.

As displayed in Figure 1, the BW2 locations were collected around the water's edge of the suitable habitat, while the BW3 samples were collected off the main river channel. These BW3 results are therefore considered representative of background conditions. The results are summarized in Table 12 along with the EPA acute and chronic criteria. The pH values measured on October 1 were not indicative of those measured during the four other sampling events completed between August 28 and September 24 and were considered suspect. To determine the acute and chronic criteria, it was necessary to have a representative pH for each sample, and the average pH measured during the previous four events was used.

As shown in Table 12, the BW2 results ranged from below the 0.1 mg/L detection limit to 0.35 mg/L ammonia, and the results from the sampling of the three BW3 locations were all below the detection limit. All results were below both the acute and chronic criteria.

The groundwater extraction system had operated on a regular basis since mid-March 2018 (approximately 6 months) when the CF5 extraction well samples were collected for the September/October 2018 event. The ammonia and uranium results are displayed on Figure 7. Time versus concentration plots (Figures 8 through 11) were also generated to display trends of the CF5 extraction wells during the past 8 years, which represent the approximate lifespan of the CF5 well field (extraction was started in April 2010).

Table 12. October 2018 Habitat Area Surface Water Ammonia Concentrations and Comparisons to EPA Acute and Chronic Criteria

Location	Date	Temp (ºC)	pH[1]	Ammonia as N (mg/L)	EPA - Acute Total as N (mg/L)[2]	EPA - Chronic Total as N (mg/L)[3]
BW2-1	10/1/18	18.7	7.5	0.14	21	1.5
BW2-2	10/1/18	19.4	7.7	<0.1	15	1.2
BW2-3	10/1/18	19.9	7.8	0.17	13	1.0
BW2-4	10/1/18	19.5	8.0	0.35	8.8	0.78
BW2-5	10/1/18	18.9	8.0	0.18	8.8	0.83
BW3-1	10/1/18	18.3	8.1	<0.1	7.3	0.76
BW3-2	10/1/18	18.2	8.2	<0.1	6.0	0.65
BW3-3	10/1/18	18.2	8.2	<0.1	6.0	0.65

1 = Average pH measured the previous month prior to when the October 1 samples were collected.
2 = 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).
3 = 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).

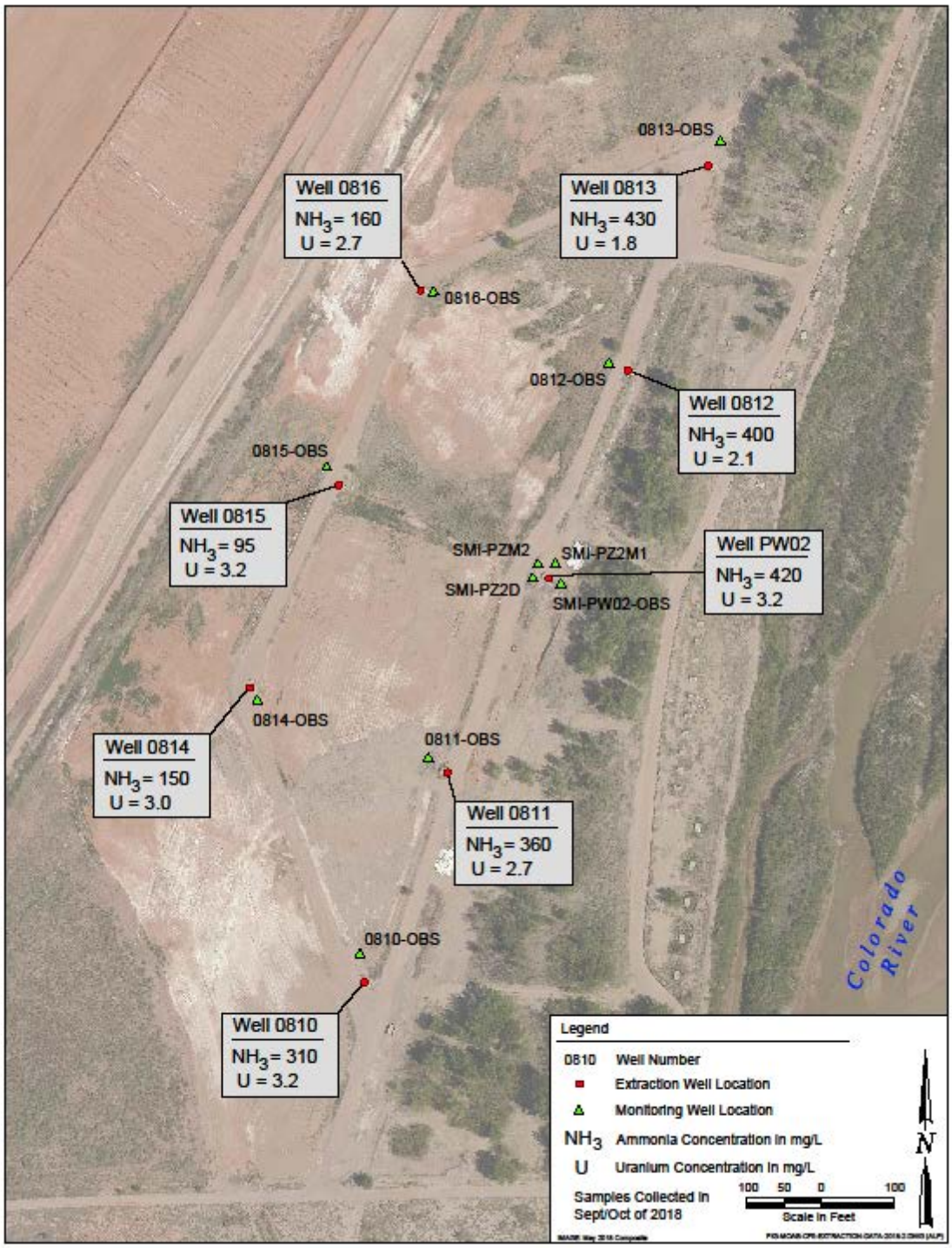

Figure 7. September/October 2018 CF5 Ammonia and Uranium Groundwater Concentrations

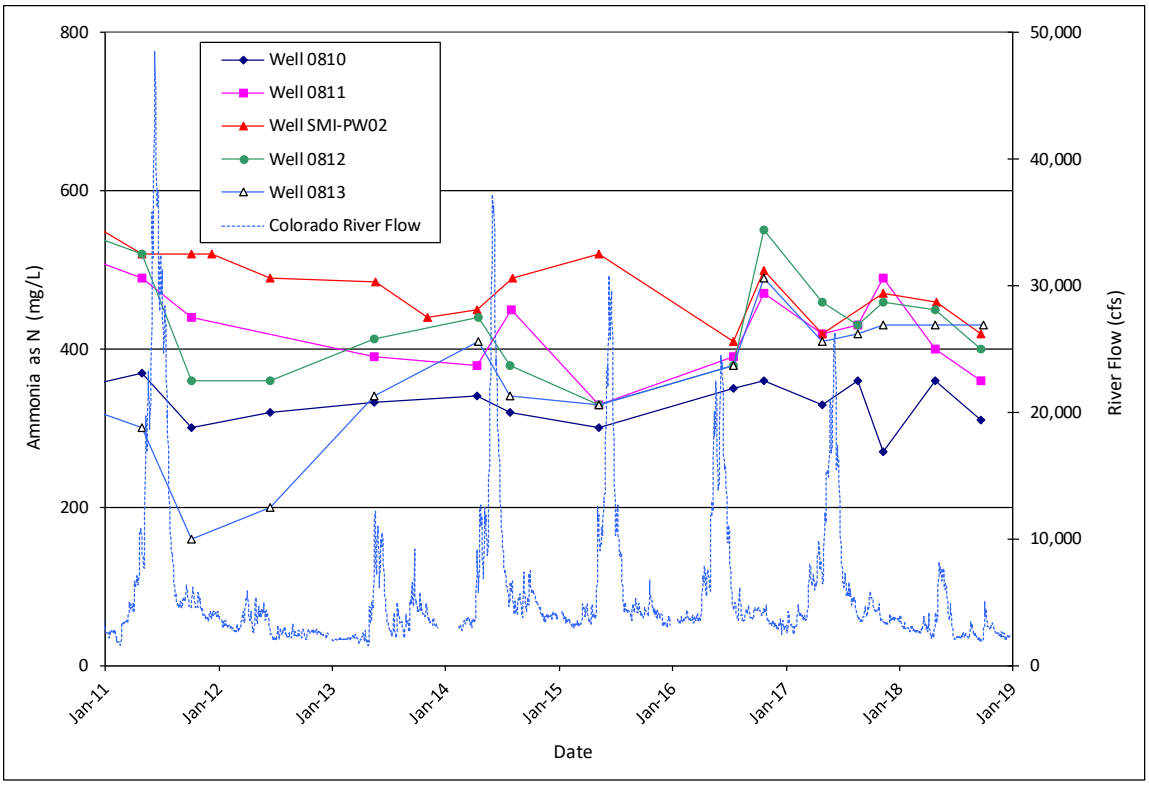

Figure 8. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Ammonia Concentration Plot

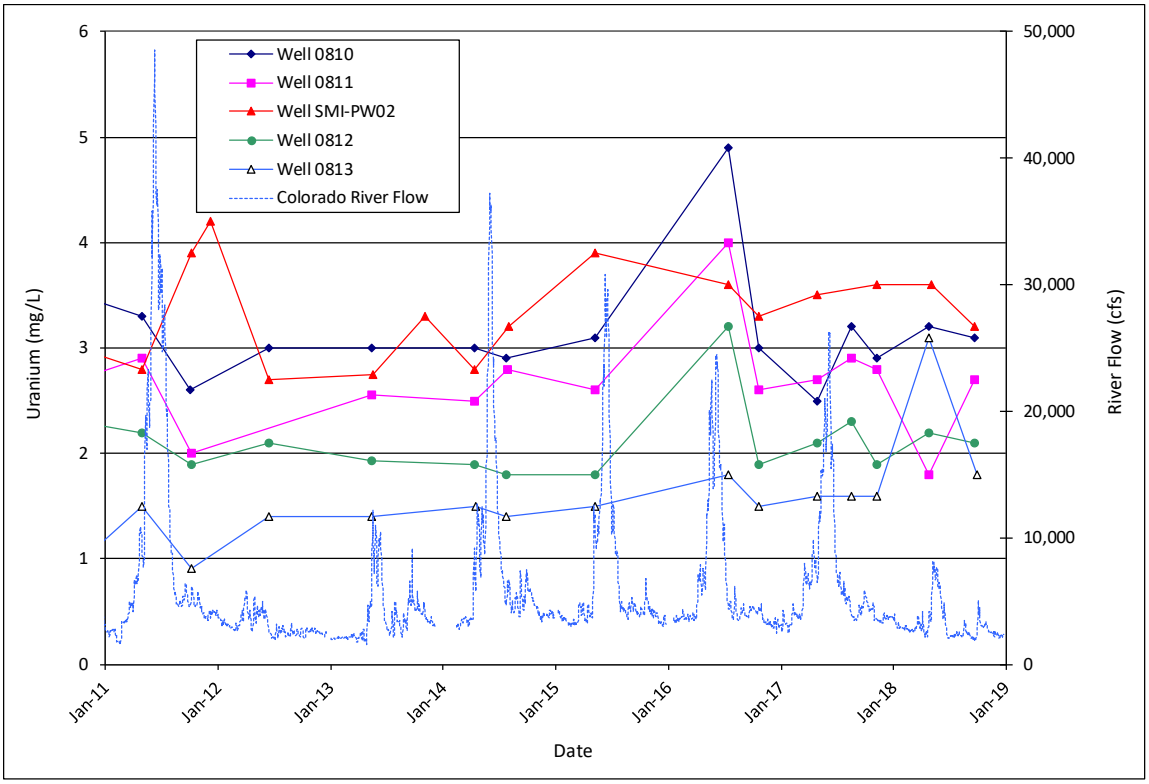

Figure 9. CF5 Extraction Wells 0810, 0811, 0812, 0813, and SMI-PW02 Time versus Uranium Concentration Plot

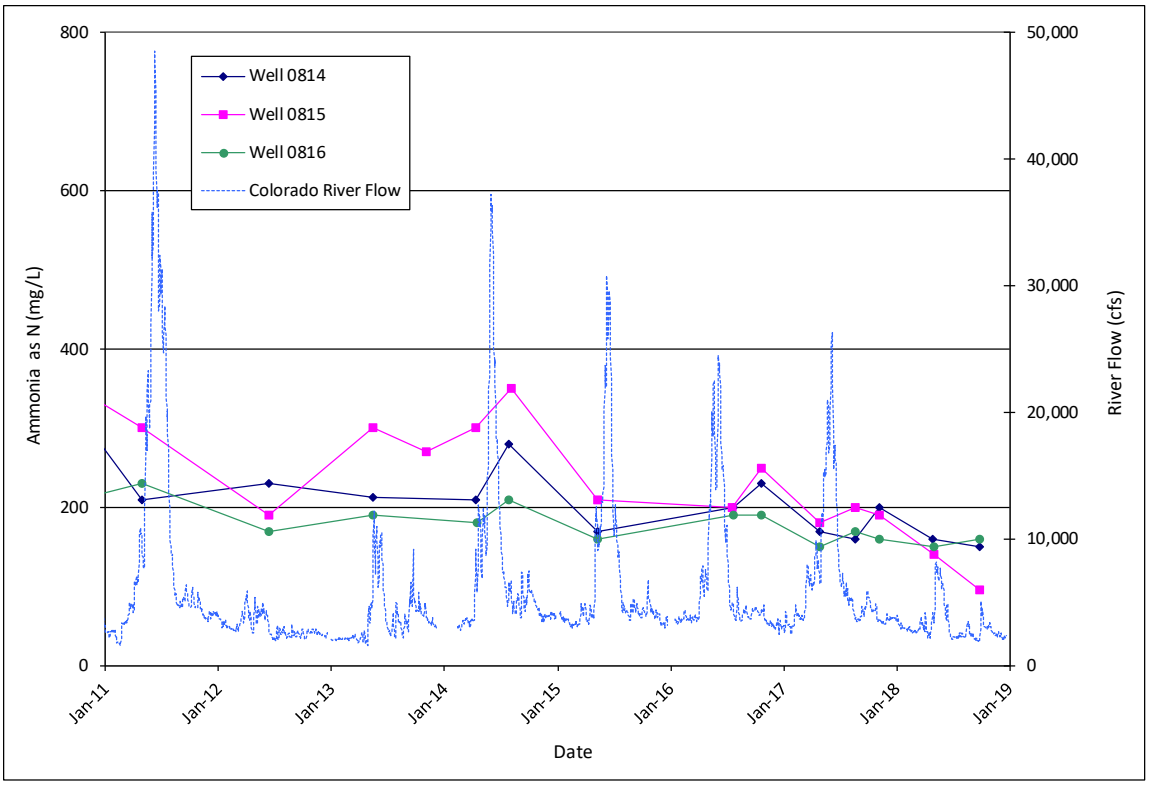

Figure 10. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Ammonia Concentration Plot

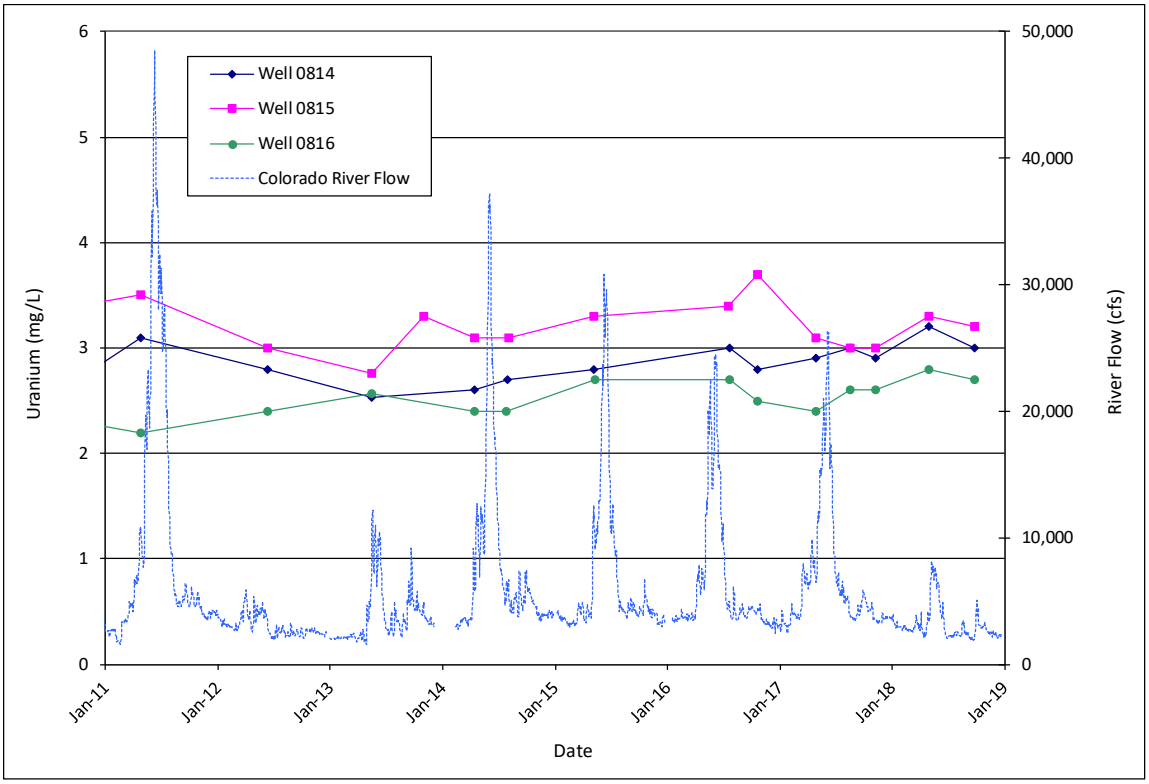

Figure 11. CF5 Extraction Wells 0814, 0815, and 0816 Time versus Uranium Concentration Plot

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).

As the plots exhibit, the ammonia concentrations along the CF5 southeastern boundary have ranged from 160 to 550 mg/L since 2011, with the lowest concentrations generally occurring after the well field was flooded from May to August 2011. Well SMI-PW02, which is located at the center of this line of wells (and near the center of the groundwater contaminant plume), has generally had the highest concentration. During the September/October 2018 sampling event, all of these wells had ammonia concentrations between 360 and 430 mg/L (Figure 8).

Uranium concentrations (Figure 9) in samples from this same set of wells have, in general, been less consistent. Since October 2016, the concentrations have ranged from 1.5 to 3.6 mg/L.

As shown in Figure 10, ammonia concentrations in the wells located closer to the base of the tailings have been gradually declining since August 2014. During the September/October 2018 event, the ammonia concentrations in the samples collected from each of these three locations ranged from 95 to 160 mg/L. The uranium concentrations (Figure 11) have been more consistent, between 2.4 and 3.7 mg/L since June 2012. During the September/October 2018 event, the concentrations were similar, ranging from 2.7 to 3.2 mg/L.

Taking into account all eight extraction wells, the contaminant concentrations have been higher in the samples collected from wells located along the CF5 southeastern boundary compared to the wells located along the toe of the tailings pile.

4.2 October 2018 Crescent Junction Sampling Event Results

Table 13 displays the analytical results of the October 2018 samples collected from well 0205, along with the results from the three previous sampling events in June 2017 and February and June 2018. These results indicate the well 0205 analyte concentrations of the samples collected from well 0205 have generally not significantly changed in 2018, and the well continues to be recharged from the same water source.

4.3 November/December 2018 Site-wide Sampling Event Results

All samples collected during this event were analyzed for both ammonia and uranium. There is no groundwater standard for ammonia; however, Table 14 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 13. Crescent Junction Well 0205 Analyte Concentrations, June 2017 through October 2018

Analyte	Analyte Concentration on 6/20/17	Analyte Concentration on 2/6/18	Analyte Concentration on 6/27/18	Analyte Concentration on 10/03/18
Ammonia as N	13	14	13	22
Arsenic	0.0039#	0.039#	0.039#	0.0039#
Barium	0.012	NA	NA	NA
Bicarbonate as $CaCO_3$	950	1,000	1,100	1,100
Boron	1.2	1.3	1.4	1.1
Bromide	10#	20#	40#	20#
Cadmium	0.00033#	0.0033#	0.0033#	0.00033#
Calcium	260	330	370	300
Carbonate as $CaCO_3$	100#	50#	20#	100#
Chloride	3,700	3,500	3,400	3,900
Chromium	0.00051#	0.0051#	0.0051#	0.012
Copper	0.0016	0.0097#	0.0097#	0.0047
Fluoride	5#	10#	20#	10#
Iron	7	0.049#	0.049#	0.026
Lead	0.0013#	0.013#	0.013#	0.0013#
Magnesium	820	850	1,000	1,000
Manganese	0.3	0.38	0.44	0.33
Molybdenum	0.0022	0.011#	0.011#	0.013
Nitrate/ Nitrite as N	830	600	940	860
Potassium	58	50	54	71
Selenium	4.4	4.1	4.4	4.1
Sodium	9,700	10,000	10,000	9,700
Sulfate	24,000	23,000	23,000	24,000
Total Alkalinity as $CaCO_3$	950	1,000	1,100	1,100
Total Dissolved Solids	40,000	35,000	46,000	41,000
Uranium $_{234}$	27.1 +/- 4.6 pCi/L	29.7 +/- 5.4 pCi/L	31.9 +/- 5.7 pCi/L	30.1 +/- 5 pCi/L
Uranium $_{235}$	0.34 +/- 0.2 pCi/L	0.32 +/- 0.27 pCi/L	0.64 +/- 0.37 pCi/L	0.56 +/- 0.19 pCi/L
Uranium $_{238}$	9.2 +/- 1.7 pCi/L	9.3 +/- 2 pCi/L	11.9 +/- 2.4 pCi/L	9.7 +/- 1.7 pCi/L
Uranium	0.026	0.028	0.037	0.029

= Concentration at or below the detection limit, NA = Sample not analyzed for this analyte
Note: All concentrations in mg/L, except where noted

Table 14 also includes the locations from the other sampling events from July to December 2018 that exceeded this concentration.

To 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 uranium plume (which includes the PW03 cluster), the southeastern base of the tailings pile, along the southwestern boundary, along the Colorado River bank, and south of the site. All results are also plotted against the Colorado River flow to determine if the river stage may impact the concentrations.

Table 14. July through December 2018 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L Uranium Groundwater Standard

Well Number	Date	Location	Sample Depth (ft bgs)	Uranium Concentration (mg/L)
0401	12/4/2018	CF2	18	1.9
0403	12/4/2018	CF1	18	1.3
0404	12/17/2018	CF3	18	1.6
0406	12/17/2018	CF1	18	0.92
0407	12/4/2018	CF1	18	1.7
0410	12/19/2018	NE Uranium Plume Area	23.5	0.36
0412	11/29/2018	NE Uranium Plume Area	10	3.1
0413	11/29/2018	NE Uranium Plume Area	10	2.9
0414	11/29/2018	NE Uranium Plume Area	7.5	3.6
0437	1/23/2019	On Tailings Pile	NA	2.6
0439	1/23/2019	On Tailings Pile	118	1.3
0441	12/20/2018	Support Area	53	0.05
0453	1/15/2019	Along SW Site Boundary	80	2.5
0454	12/10/2018	Along SW Site Boundary	13	1.6
0492	12/4/2018	Along S Site Boundary	18	2
0810	9/27/2018	CF5 Extraction Well	10 to 40	3.1
0811	9/27/2018	CF5 Extraction Well	9 to 39	2.7
0812	9/27/2018	CF5 Extraction Well	14 to 44	2.1
0813	10/3/2018	CF5 Extraction Well	14 to 44	1.8
0814	10/3/2018	CF5 Extraction Well	12 to 42	3
0815	10/3/2018	CF5 Extraction Well	22 to 52	3.2
0816	10/3/2018	CF5 Extraction Well	21 to 51	2.7
AMM-2	12/11/2018	Near CF5	48	2.1
AMM-3	12/11/2018	CF5 Vicinity	48	1.4
MW-3	12/11/2018	Near CF5	44	3
SMI-MW01	11/28/2018	NE Uranium Plume Area	16	3.1
SMI-PW02	9/27/2018	CF5 Extraction Well	20 to 60	3.2
SMI-PW03	12/19/2018	NE Uranium Plume Area	60	0.28
SMI-PZ1S	12/11/2018	CF5 Vicinity	18	1.3
SMI-PZ2M2	12/11/2018	CF5 Vicinity	56	2.4
SMI-PZ3D2	12/19/2018	NE Uranium Plume Area	78	0.72
SMI-PZ3M	12/18/2018	NE Uranium Plume Area	59	0.3
SMI-PZ3S	12/18/2018	NE Uranium Plume Area	25	0.76
TP-01	11/28/2018	E boundary of site	22	0.053
TP-22	12/11/2018	NE Uranium Plume Area	17	0.28
TP-23	12/10/2018	NE Uranium Plume Area	25	2.4

Table 14. July through December 2018 Sampling Events, Groundwater Locations Exceeding the 0.044 mg/L Uranium Groundwater Standard (continued)

Well Number	Date	Location	Sample Depth (ft bgs)	Uranium Concentration (mg/L)
UPD-17	11/27/2018	NE Uranium Plume Area	14	1.4
UPD-18	11/27/2018	NE Uranium Plume Area	13	0.68
UPD-20	11/27/2018	NE Uranium Plume Area	17	0.056
UPD-21	12/18/2018	NE Uranium Plume Area	25	5.2
UPD-22	12/13/2018	NE Uranium Plume Area	9	2.3
UPD-23	12/13/2018	NE Uranium Plume Area	26	0.8
UPD-24	12/18/2018	NE Uranium Plume Area	27	5.2

E = eastern; ft bgs = foot bags; NE = northeastern; SW = southwestern;

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. Historically, ammonia concentrations have displayed a general trend of higher ammonia concentrations during river base flows and, conversely, lower concentrations during the spring runoff or higher flows. Due to below average river flows, the concentrations in the samples collected from UPD-17 and UPD-18 did not significantly change in 2018. The same is true for the uranium concentrations, which changed only 0.1 mg/L compared to the samples collected in December 2017.

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.

4.3.3 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 0413, 0414, and UPD-20. Well 0411 has not contained sufficient volume to collect a sample during the last three sampling events.

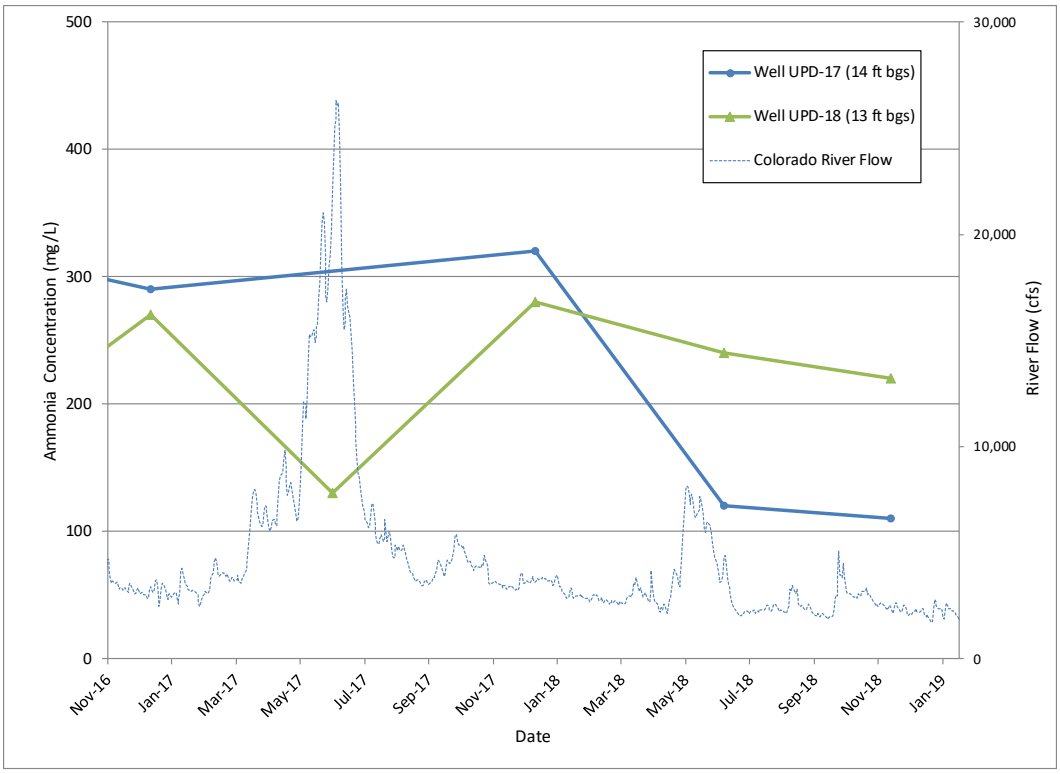

Figure 12. Wells UPD-17 and UPD-18 Time versus Ammonia Concentration Plot

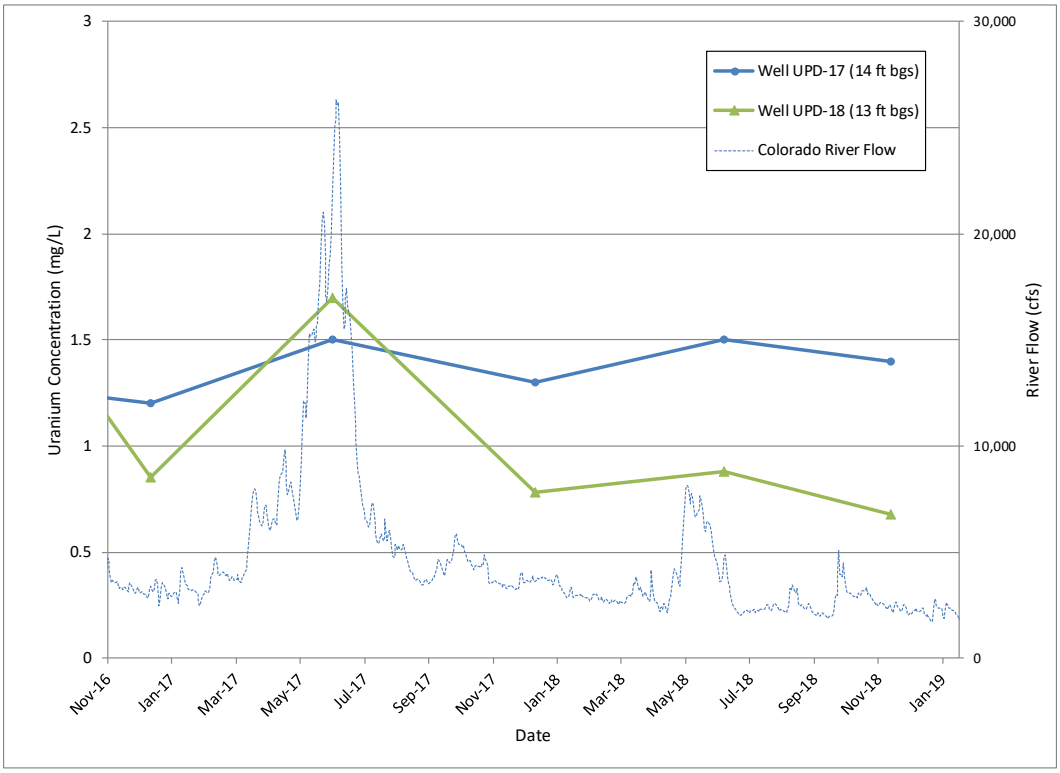

Figure 13. Wells UPD-17 and UPD-18 Time versus Uranium Concentration Plot

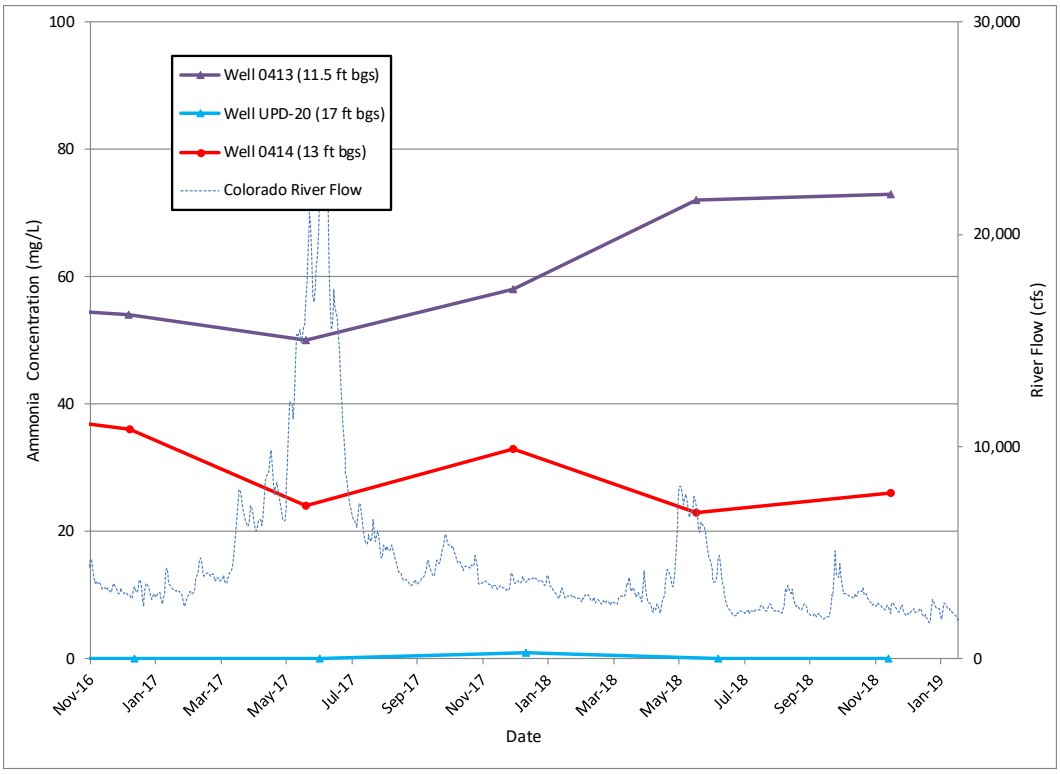

Figure 14. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Ammonia Concentration Plot

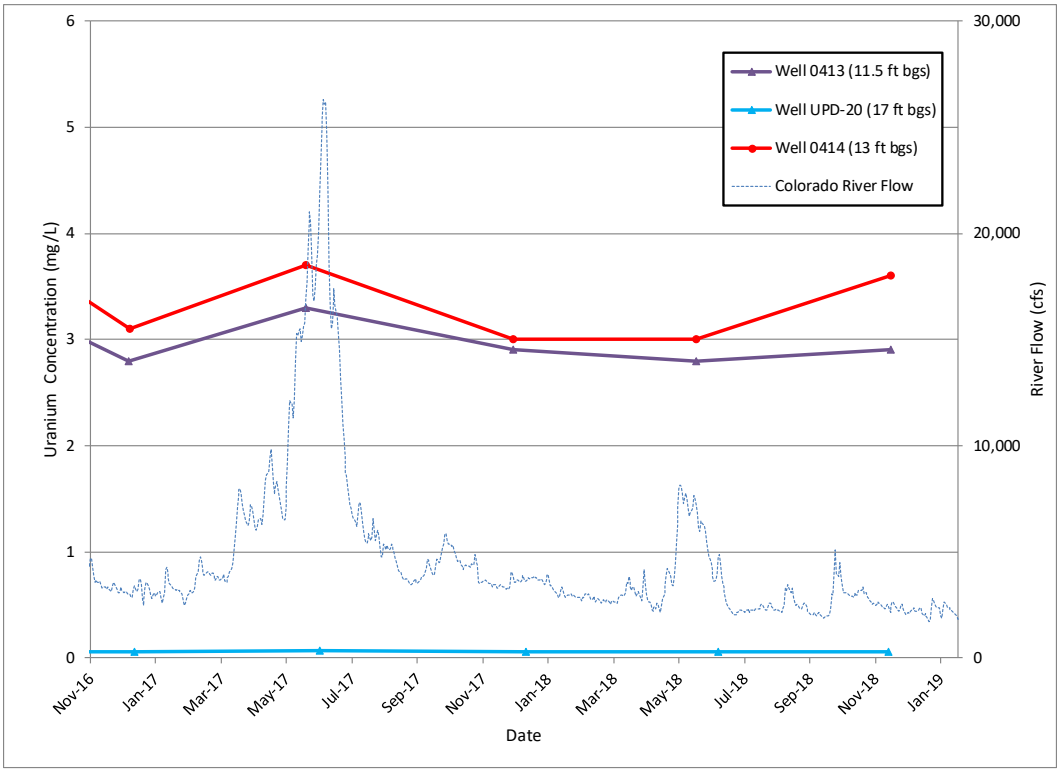

Figure 15. Center of Northeastern Uranium Plume Area Observation Wells 0411, 0413, 0414, and UPD-20 Time versus Uranium Concentration Plot

As displayed in Figure 14, the ammonia concentrations remained below the detection limit in the samples collected from well UPD-20. Ammonia concentrations in the samples collected from locations 0413 and 0414 have not significantly changed compared to the previous event (concentrations are within 3 mg/L).

The uranium concentrations in samples collected from well 0413 did not change significantly compared to the previous sample, and the concentration in the sample from 0414 increased from 3 to 3.6 mg/L (Figure 15). The uranium concentration in the sample collected from well UPD-20 was just above the 0.044 mg/L standard, with a concentration of 0.056 mg/L. In the past 2 years, the concentration has ranged from 0.067 to 0.056 mg/L.

4.3.4 Atlas Building Vicinity

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.

As shown in Figure 16, the ammonia concentrations in the samples collected from these locations did not significantly change. Ammonia concentrations in this area of the plume have remained below 10 mg/L since 2012.

Figure 17 displays the uranium concentrations in samples collected from wells 0410 and UPD-23 remain lower than 1.0 mg/L and have not changed within the past 2 years. The uranium concentrations in the sample from location UPD-24 historically displayed a definitive seasonal fluctuation, but this trend was not followed during 2018, again mostly due to the below average river stages. The uranium concentrations in the sample collected from UPD-21 did not change compared to the previous event.

4.3.5 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 (wells 0412, UPD-22, SMI-MW01, and SMI-PZ3S).

As Figure 18 exhibits, the ammonia concentrations associated with the sampling of wells UPD-22, SMI-PZ3S, and 0412 just slightly decreased since the previous event. The sample collected from SMI-MW01 contained an ammonia concentration that was within the historical range. The increase of the well 0412 ammonia concentration in the past year is a function of a change in the detection limit (1.0 as opposed to 0.1 mg/L). Similar to the samples collected in the vicinity of the Atlas Building, all the concentrations in this area of the plume are below 10 mg/L ammonia.

The uranium concentrations in the samples collected from wells 0412 and SMI-MW01 slightly increased compared to the previous event, while the concentrations in the samples from UPD-22 and SMI-PZ3S decreased by a similar percentage (Figure 19). Uranium concentrations in the samples from 0412 and SMI-MW01 have displayed typical seasonal fluctuation as a result of their proximity to the riverbank; however, with the 2018 low peak river flows, the decreases were not as significant. The concentration in the sample collected from SMI-PZ3S has remained at or below 1.0 mg/L since June 2016.

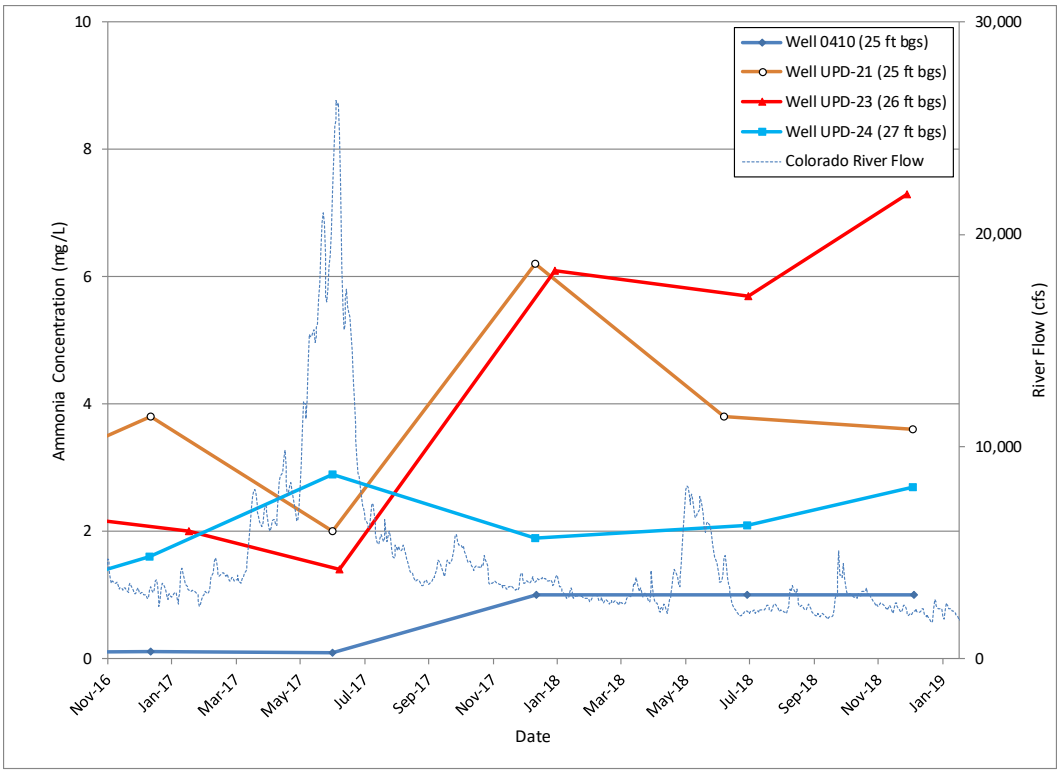

Figure 16. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Ammonia Concentration Plot

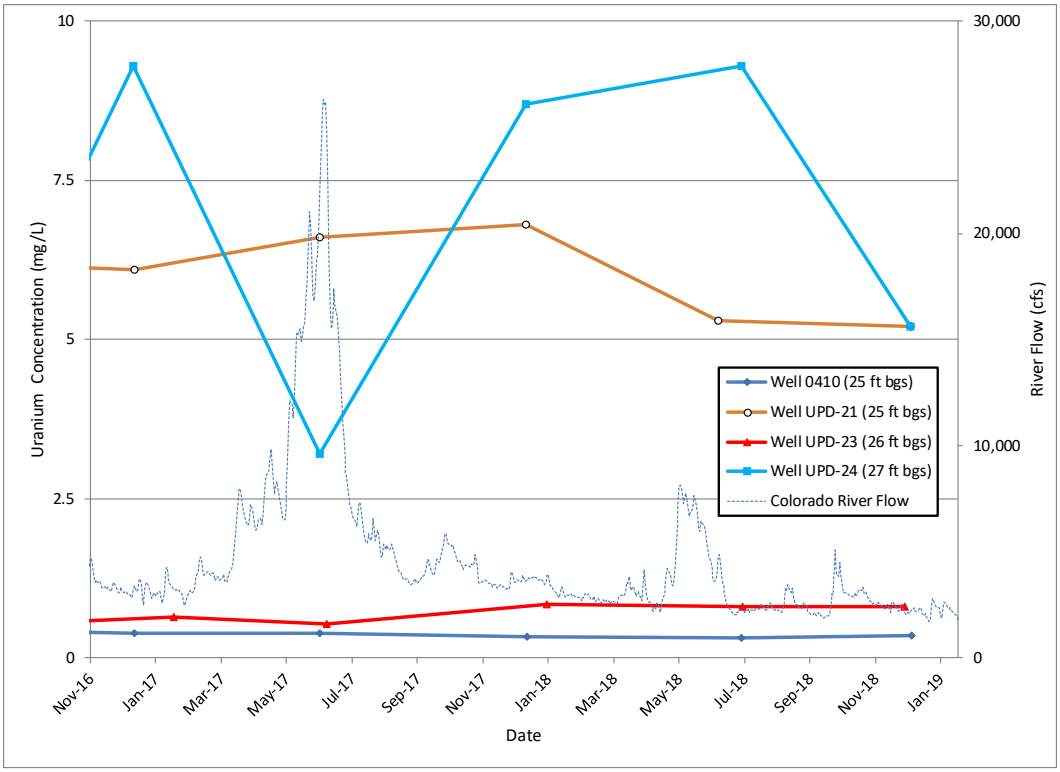

Figure 17. Vicinity of Atlas Building Observation Wells 0410, UPD-21, UPD-23, and UPD-24 Time versus Uranium Concentration Plot

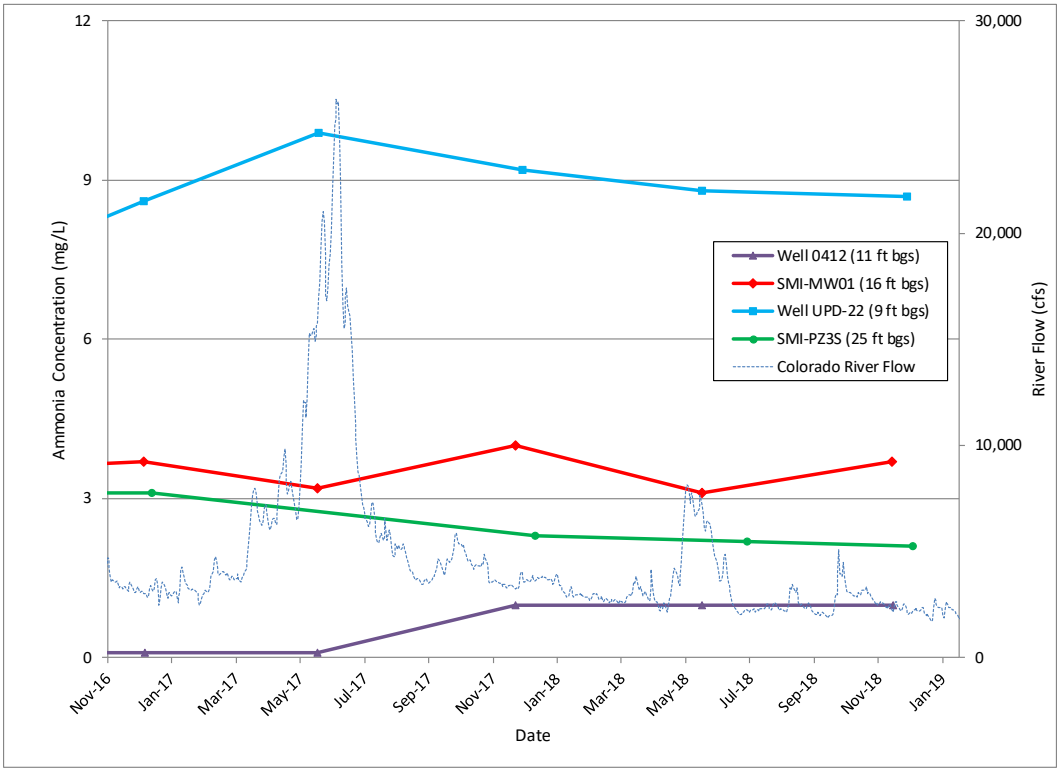

Figure 18. Northeastern Edge of Uranium Plume Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Ammonia Concentration Plot

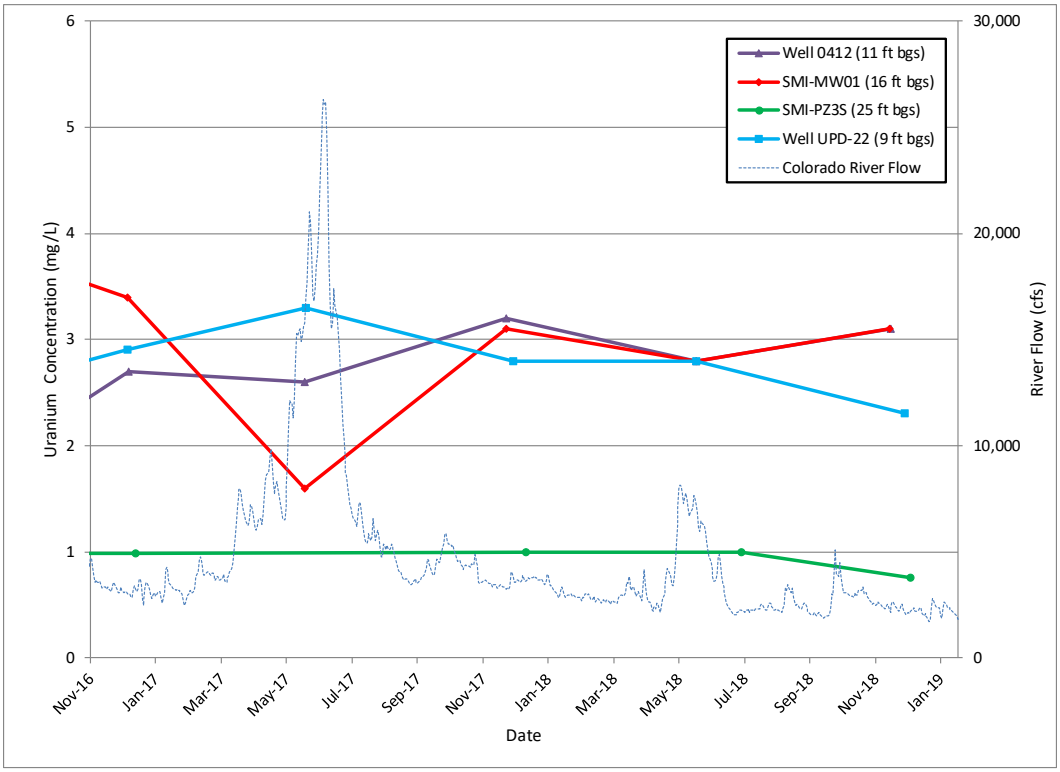

Figure 19. Northeastern Edge of Uranium Plume Area Observation Wells 0412, SMI-MW01, SMI-PZ3S, and UPD-22 Time versus Uranium Concentration Plot

4.3.6 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 AMM-3, ATP-2-S, ATP-2-D, and MW-3 (listed from south to north). This most recent sampling event represents the first time well AMM-3 had been sampled since May 2017. As Figure 20 exhibits, the ammonia concentrations measured from these locations during the most recent sampling event display a slight gradual increase since May 2017.

Uranium concentrations in wells ATP-2-S, with a sample depth 25 foot bags (ft bgs), and ATP-2-D (sample depth 88 ft bgs) have been less than 0.015 mg/L since 2010. Figure 21 suggests the uranium concentrations associated with the samples collected from well MW-3 has gradually increased from 2.6 to 3.0 mg/L since December 2016, and the concentration measured in the sample from AMM-3 has decreased from 2.8 to 1.4 since May 2017.

4.3.7 Southwestern 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 or from upgradient to downgradient groundwater flow direction) along the southwestern site boundary.

Both wells 0453 and 0454 ammonia concentrations (Figure 22) have seasonally fluctuated, and that trend continued during this most recent sampling event to a lesser degree (due to less than average river flows). Concentrations in the samples collected from wells 0440 and 0441 (the upgradient locations) have been at or below the 0.1 mg/L detection limit since 2010.

Wells 0453 and 0454 uranium concentrations (Figure 23) display a similar trend to the ammonia concentrations, with a limited seasonal fluctuation. The sample collected from well 0440 (0.03 mg/L) is below the 0.044 mg/L uranium UMTRA standard. The concentration associated with well 0441 (0.05 mg/L) has consistently been just above the standard since December 2013.

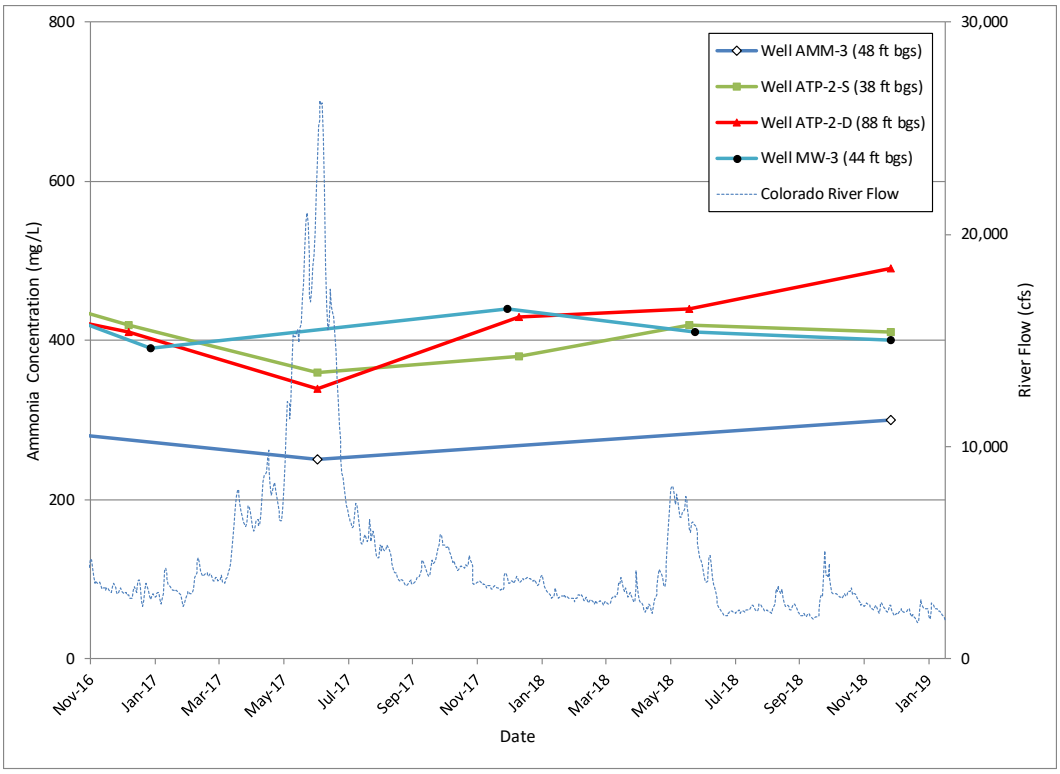

Figure 20. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Ammonia Concentration Plot

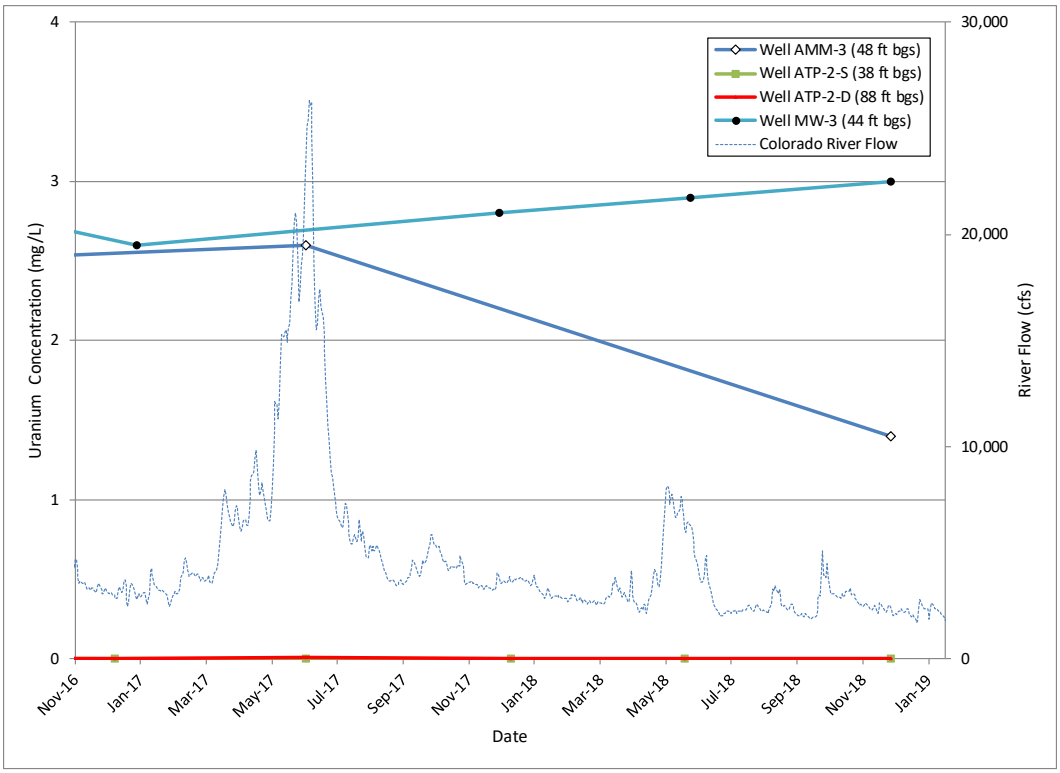

Figure 21. Base of Tailings Pile Observation Wells AMM-3, ATP-2-S, ATP-2-D, and MW-3 Time versus Uranium Concentration Plot

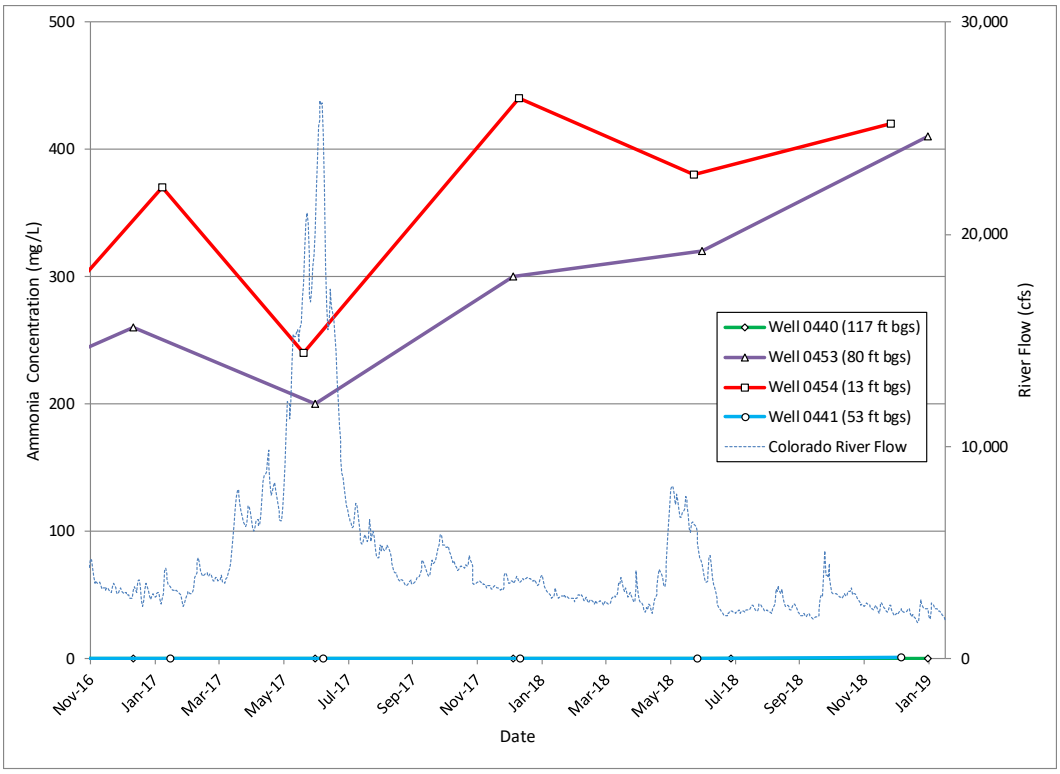

Figure 22. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Ammonia Concentration Plot

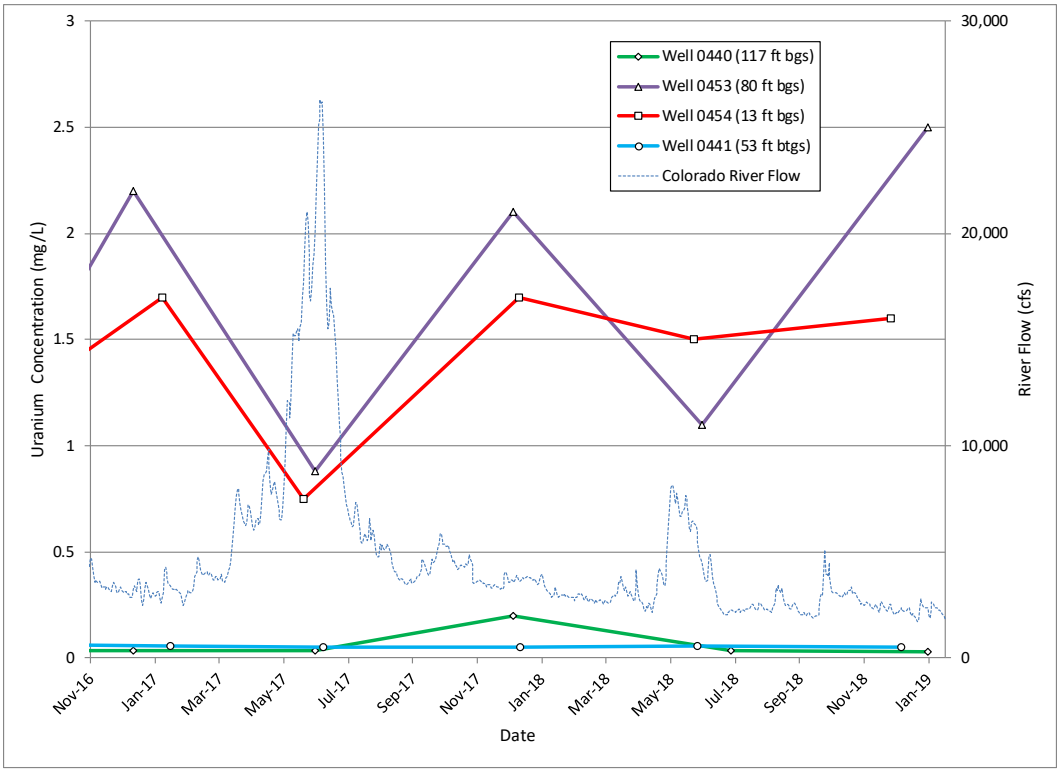

Figure 23. Southwestern Boundary Observation Wells 0453, 0454, and 0440 Time versus Uranium Concentration Plot

4.3.8 Riverbank Area

Figures 24 and 25 are the time versus ammonia and uranium concentration plots, respectively, for the locations sampled along the riverbank, presented from the south to the north (wells TP-17, 0492, 0407, 0401, 0404, and TP-01). Because these wells are located along the riverbank, their water chemistry has historically been heavily influenced by the seasonal changes of the Colorado River stage.

From May 2017 to June 2018, the ammonia concentration associated with well 0407 increased from 12 to 300 mg/L, and during this most recent event, the concentration decreased to 160 mg/L (Figure 24). The ammonia concentration measured in the sample from well 0404 has increased from 210 mg/L to 670 mg/L since May 2017. Since January 2018, the concentration associated with location 0492 has increased from 16 to 250 mg/L. The lowest ammonia concentrations were associated with the samples collected from the wells farthest to the north (well TP-01, below the 0.1 mg/L detection limit) and to the south along the site (well TP-17, 2.0 mg/L). While drought conditions may be a factor, the reason for this significant change in this particular portion of the groundwater system is not apparent at this time.

As displayed in Figure 25, the uranium concentrations associated with the samples collected from each of these wells has increased a similar percentage compared to the previous sampling event. The uranium concentration in the sample collected from well 0492 has gradually increased since May 2017 from 0.22 to 2.0 mg/L. As displayed in the ammonia plot, the most southern and northern wells have the lowest concentrations.

4.3.9 Southern and Off-site Areas

Figures 26 and 27 are the plots for the two locations sampled south of the site, wells TP-17 and TP-20. Well TP-17 is located along the riverbank, and TP-20 is located approximately 500 ft off the riverbank. Typically, contaminant concentrations are low in samples collected from these wells because they are located along the southern edge of the contaminant plumes.

Ammonia concentrations (Figure 26) in both wells did not significantly change in 2018. Typically, wells located along the riverbank display a well-defined impact of changes in the river stage (lower concentrations during higher runoff flows and higher concentrations during base flows). However, both wells TP-17 and TP-20 are located in the area of the site where the brine unit is very shallow, as evidenced by a specific conductance above 105,000 micro ohms per centimeter (µmhos/cm) at a depth of just 28 ft bgs and more than 120,000 µmhos/cm at a depth 32 ft bgs for wells TP-17 and -20, respectively.

The combination of the shallow brine (contaminants in general do not migrate into these areas due to groundwater density differences) and the wells located near the edge of the plume result in very low ammonia concentrations. Despite a slight increase since the previous event, the uranium concentrations (Figure 27) associated with the samples collected from these locations continue to remain below the 0.044 mg/L UMTRA standard since 2008.

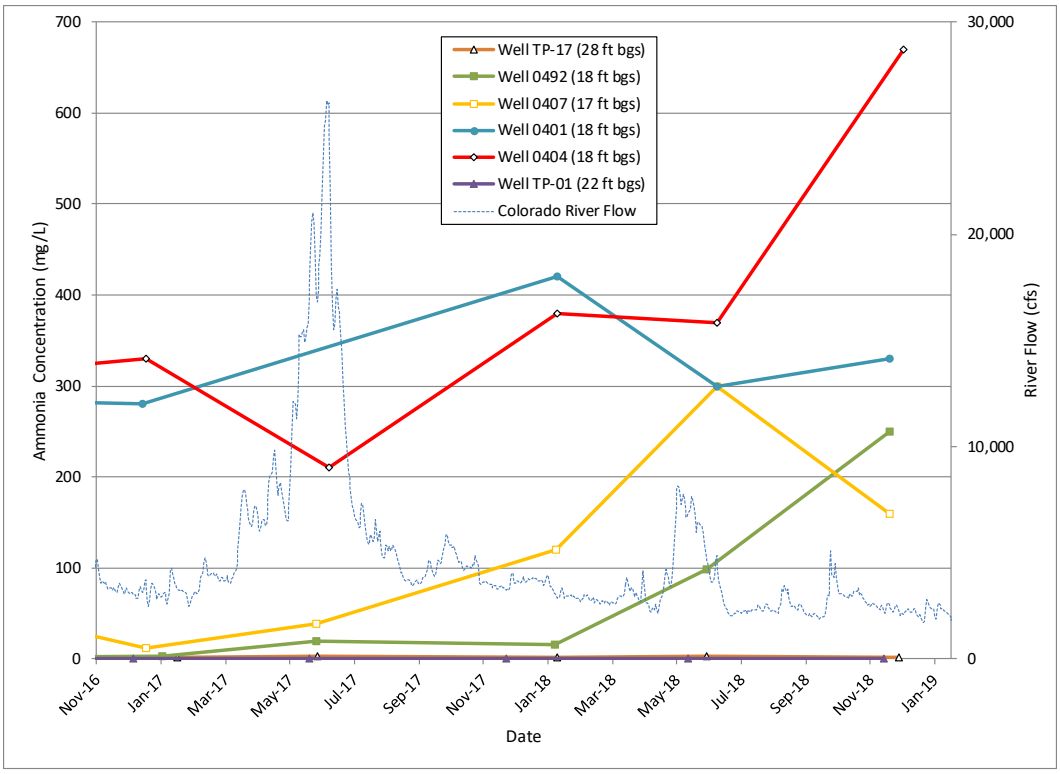

Figure 24. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, and TP-01 Time versus Ammonia Concentration Plot

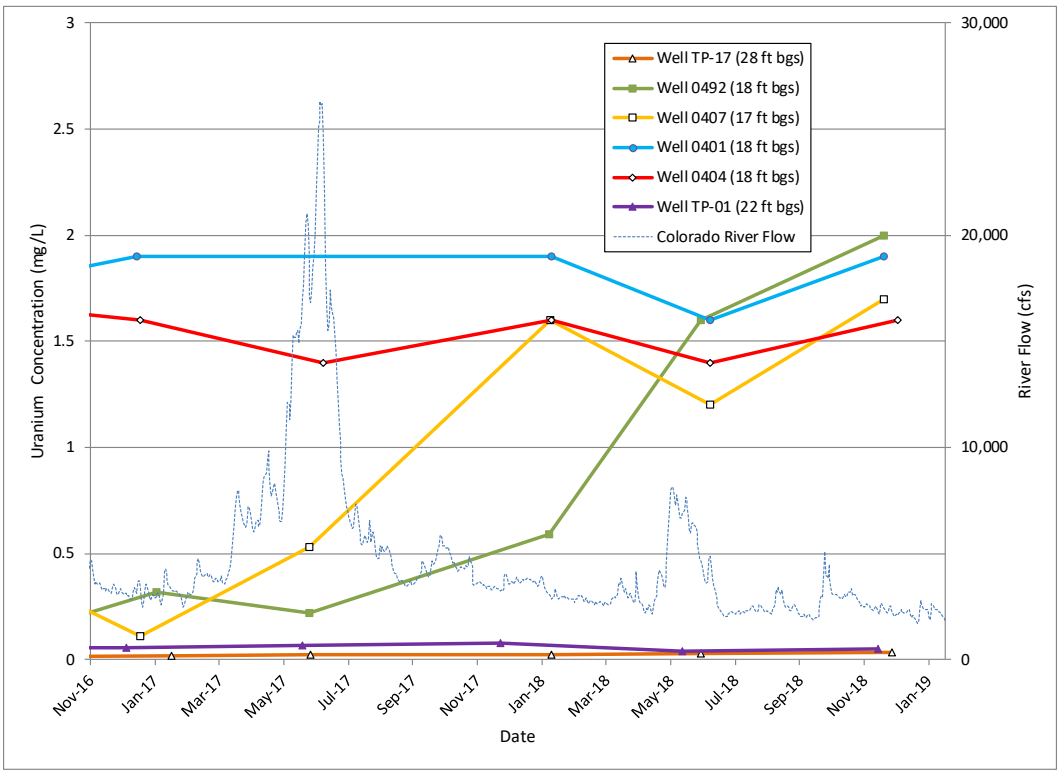

Figure 25. Riverbank Observation Wells TP-17, 0492, 0407, 0401, 0404, and TP-01 Time versus Uranium Concentration Plot

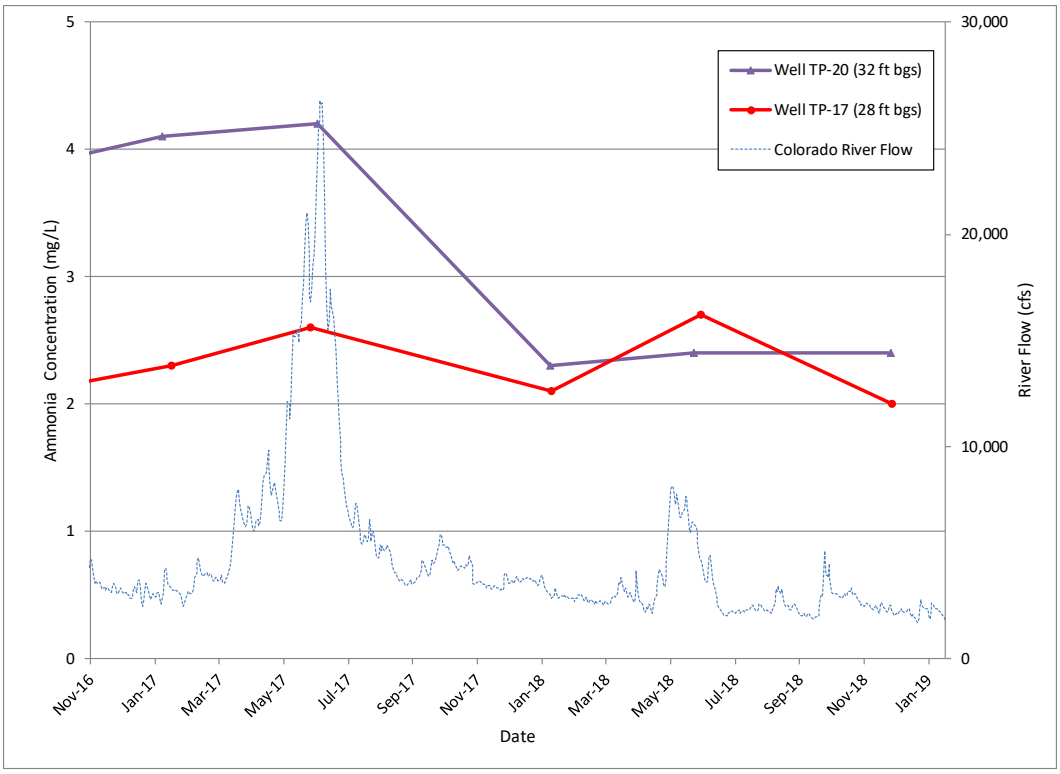

Figure 26. South of Site Observation Wells TP-17 and TP-20 Time versus Ammonia Concentration Plot

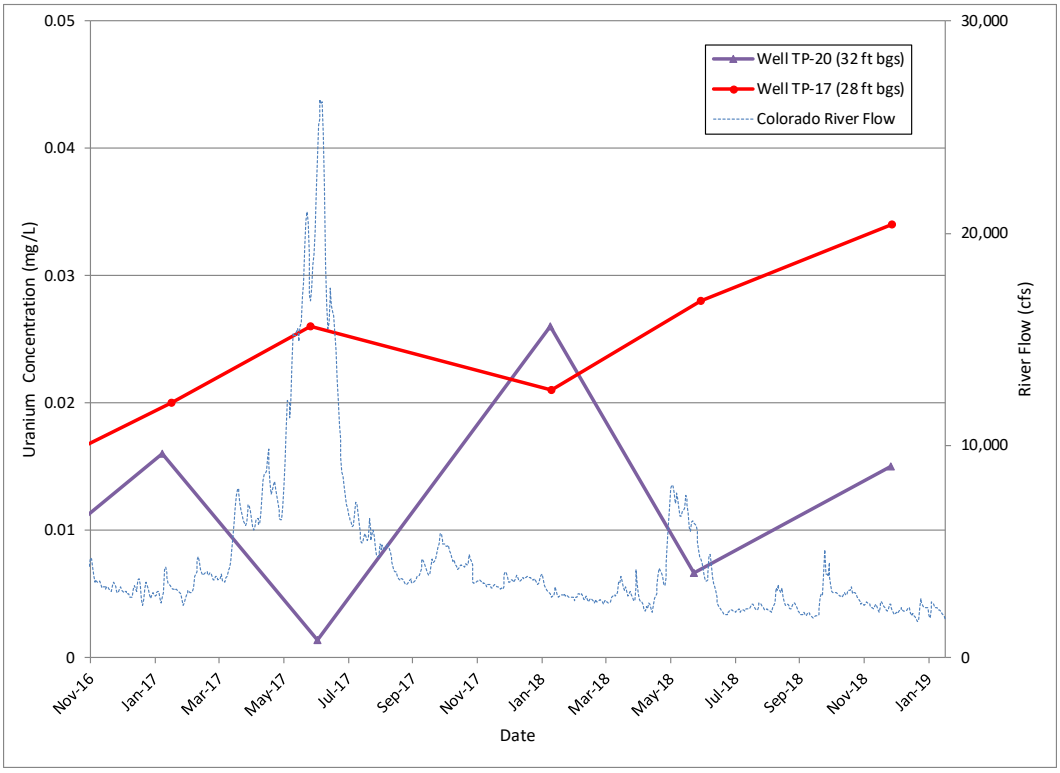

Figure 27. South of Site Observation Wells TP-17 and TP-20 Time versus Uranium Concentration Plot

4.3.10 Surface Water Sampling Results

Table 15 presents the ammonia results from the surface water sampling as part of this sampling event, with the samples collected in mid-December 2018 from locations 0201, 0218, 0226, CR1, CR2, CR3, and CR5 (as shown in Figure 3). The ammonia concentrations and comparisons to the applicable EPA criteria for both acute and chronic concentrations (along with the temperature and pH data used to calculate these concentrations) are shown in Table 15.

Table 15. November/December 2018 Site-wide Surface Water Ammonia Concentrations and Comparisons to EPA Acute and Chronic Criteria

Location	Date	Temp (ºC)	pH	Ammonia as N (mg/L)	EPA - Acute Total as N (mg/L)*	EPA - Chronic Total as N (mg/L)**
0201	12/12/18	2.9	7.45	<1.0	21	3.2
0218	12/12/18	3.2	7.25	<1.0	27	3.8
0226	12/12/18	3.2	8.01	<1.0	8.8	1.8
CR1	12/12/18	2.7	7.84	<1.0	13	2.3
CR2	12/12/18	3.0	7.21	<1.0	31	4.0
CR3	12/12/18	3.5	7.61	<0.1	18	2.9
CR5	12/12/18	2.8	7.59	<1.0	18	2.9

*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)

The ammonia concentrations measured during this event were below the 1.0 mg/L detection limit (with the exception of the 0.1 mg/L detection limit for CR3). All surface water ammonia concentrations are below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

4.4 Groundwater Surface Elevation

Water level data to generate the groundwater surface contour map were collected between October 31 and November 5, 2018, when the Colorado River mean daily flows ranged from 3,030 to 3,350 cubic feet per second, and the river stage at the southern end of the site only ranged from 3,953.5 to 3,953.6 feet above mean sea level.

Because river elevations fluctuated less than 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 28. This contour map displays how the site groundwater system responds to the river during primarily losing conditions. Groundwater flow direction and 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 29 and 30 are maps showing shallow groundwater ammonia and uranium plumes, respectively, using data collected during the November/December 2018 site-wide events. Contaminant distribution is generally comparable to previous plume maps generated using data collected during the past 2 years.

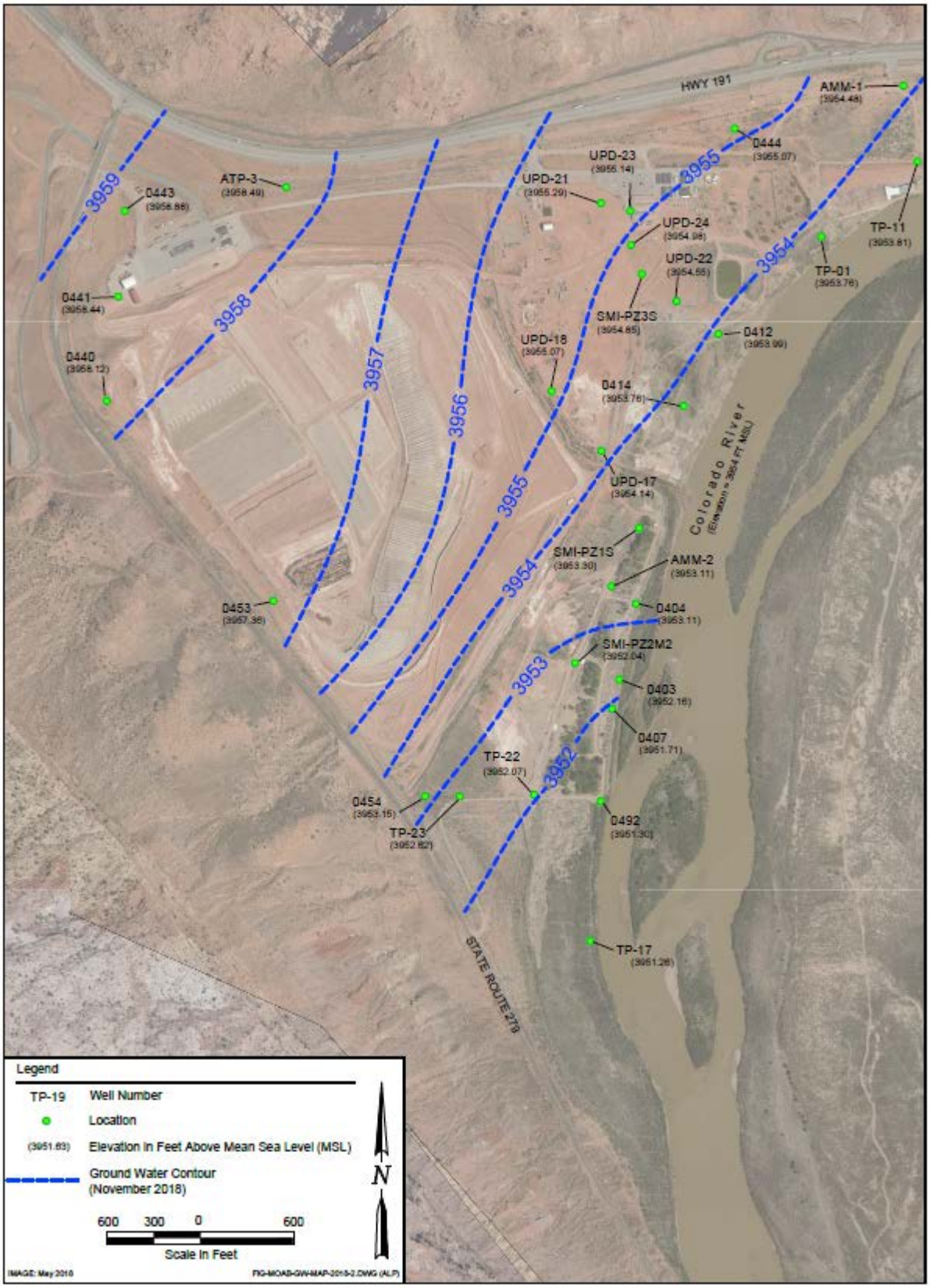

Figure 28. Site-wide Groundwater Elevations, October 31 through November 1, 2018

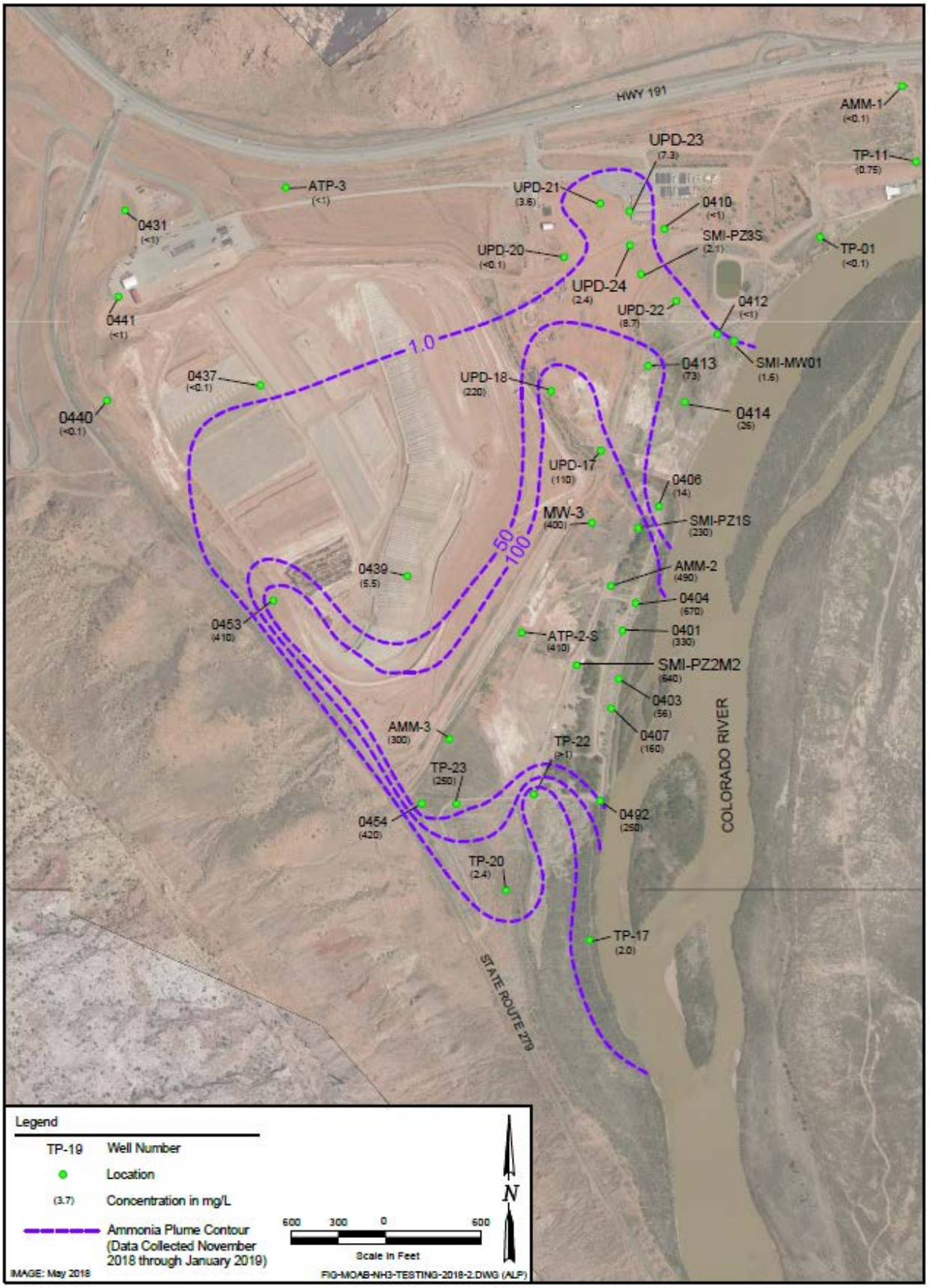

Figure 29. Ammonia Plume in Shallow Groundwater, November/December 2018

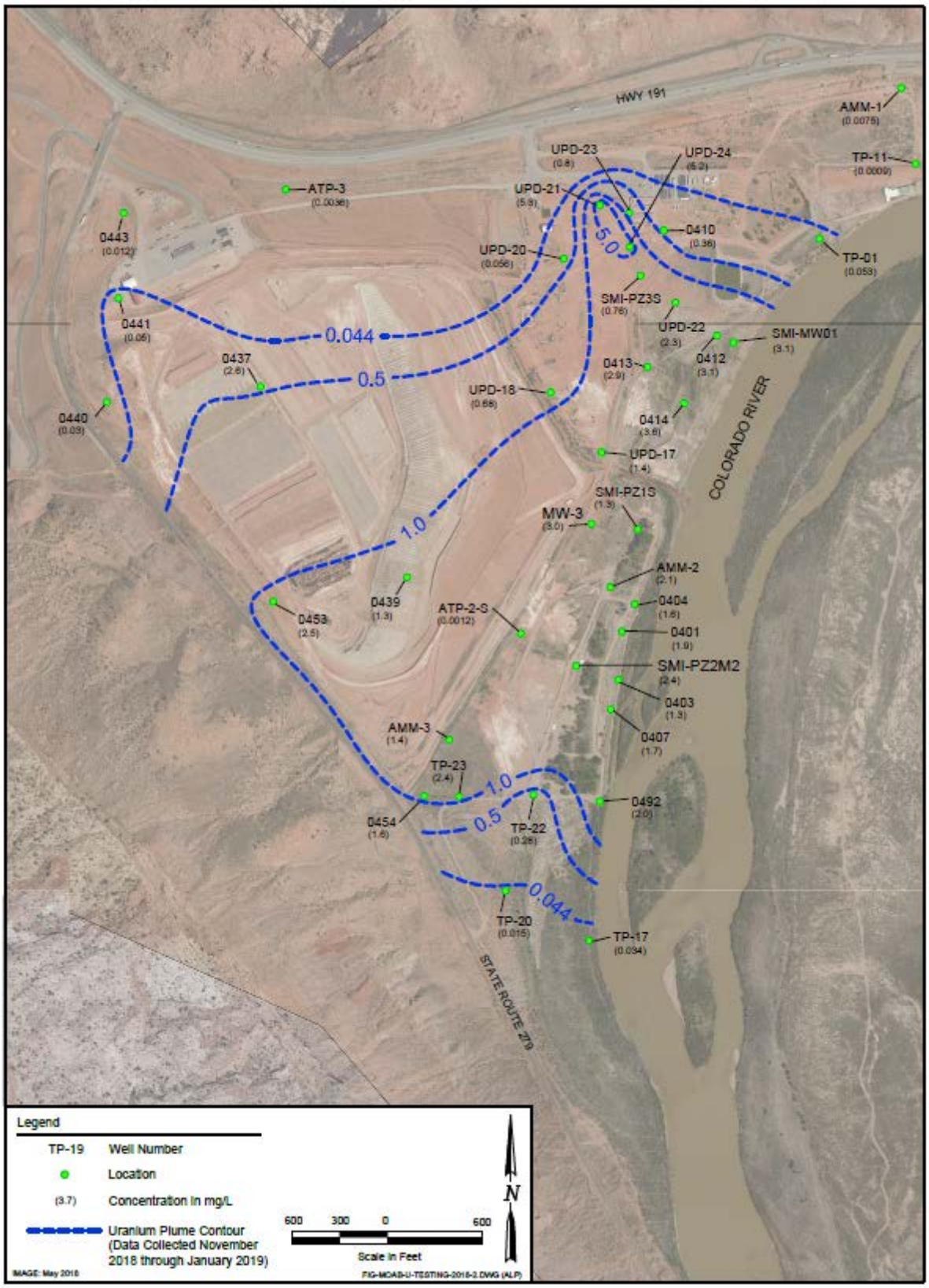

Figure 30. Uranium Plume in Shallow Groundwater, November/December 2018

5.0 Conclusions

This report presents the results of sampling conducted at the Moab and Crescent Junction sites between July and December 2018. The primary contaminants of interest are ammonia and uranium, and, while there is no EPA drinking water standard maximum concentration level for ammonia, the UMTRA groundwater standard for uranium is 0.044 mg/L. This uranium standard was exceeded in at least one location for each of the Moab site sampling events. Refer to Table 14 for a complete list of the Moab site locations and associated uranium concentrations that exceeded the 0.044 mg/L uranium standard.

There were four anomalous data points associated with any of these sampling events, three of which were the result of higher detection limits being used during the analysis of the samples. The fourth anomalous data point was the result of an ammonia concentration significantly below the historic minimum.

5.1 September/October 2018 Habitat Area and CF5 Sampling Event

Surface water samples were collected from a suitable habitat area that developed in August 2018. These samples were collected from eight locations and submitted to the analytical laboratory; the results indicated the ammonia concentrations were below both the acute and chronic criteria.

All eight CF5 wells were sampled to monitor contaminant concentration trends over time and to update the contaminant concentrations used for the mass removal calculations. In general, ammonia and uranium concentrations have not significantly changed over the past 2 years. The data indicate the samples collected from the extraction wells located along CF5 southeastern boundary have higher ammonia concentrations compared to the samples collected from the wells near the base of the tailings pile. No trends are apparent based on the uranium concentrations.

5.2 October 2018 Crescent Junction Sampling Event

The rationale for collecting the groundwater samples from Crescent Junction monitoring well 0205 was to help identify any changes associated with the source of the water present in well 0205. Samples were collected in October (as part of the quarterly monitoring for the fourth quarter of 2018). In addition to the standard analytes, the samples were also analyzed for bicarbonate as $CaCO_3$, carbonate as $CaCO_3$, total alkalinity as $CaCO_3$, uranium-234, uranium-235, and uranium-238. The analyte concentrations measured in this sample indicate that well 0205 continues to be recharged from the same water source that was identified during previous sampling events.

5.3 November/December 2018 Site-wide Sampling Event

The rationale for conducting the November/December 2018 site-wide sampling event was to collect data from the site during Colorado River base flows and to assess any changes or trends in the groundwater system water chemistry. The river flows were well below average due to regional drought conditions. Surface water sampling was also conducted to assess surface water quality adjacent to the site compared to upstream and downstream water quality.

In general, with the exception of the locations in the vicinity of the Colorado River bank, the ammonia and uranium concentrations did not significantly change since the previous site-wide sampling event in November/December 2017. Ammonia concentrations from the seven surface water samples collected during this sampling event were below the 0.1 mg/L ammonia laboratory detection limit and below the applicable EPA criteria (for a suitable habitat) for both acute and chronic concentrations.

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), *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).