Appendix A

Supplemental Groundwater Information

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Appendix A presents groundwater data and analysis in support of Chapter 3. This appendix consists of the following five attachments:

- Attachment A.1 provides operational data for the South Field Module, the South Plume Module, and the Waste Storage Area Module.
- Attachment A.2 provides total uranium data (including summary statistics) and plume maps for the first and second halves.
- Attachment A.3 provides groundwater elevation data and quarterly water level maps.
- Attachment A.4 provides an analysis of the non-uranium final remediation level exceedances both inside and outside the Waste Storage Area (Phase II) design remediation footprint.
- Attachment A.5 presents leak detection and leachate monitoring results associated with the On-Site Disposal Facility monitoring program.

Groundwater analytical data are available through the Department of Energy Office of Legacy Management's Geospatial Environmental Mapping System (http://www.lm.doe.gov/Fernald/Sites.aspx).

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Attachment A.1

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Abbreviations

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EW	extraction wells
FRL	final remediation level
GMA	Great Miami Aquifer
PRRS	Paddys Run Road Site
RW	recovery wells
UCL	upper confidence level
VFD	variable frequency drive
WSA	Waste Storage Area

Measurement Abbreviations

gpm	gallons per minute
lb	pounds
μg/L	micrograms per liter
M gal	million gallons

A.1.0 Operational Assessment

This attachment presents operational data for each extraction well pumping in 2013, and estimates on when uranium concentrations at each extraction well will reach the aquifer cleanup standard for uranium of 30 micrograms per liter (µg/L). The groundwater remediation is currently operating to the Waste Storage Area (WSA) Phase II Design, which was established in 2005. The WSA Phase II Design calls for the operation of 23 extraction wells at a target pumping rate of 4,775 gallons per minute (gpm).

During 2013, 23 extraction wells were operational. Figure A.1-1 depicts the locations of extraction and former re-injection wells and identifies surrounding monitoring wells. Table A.1-1 provides summaries of gallons pumped, total uranium removed, and uranium removal indices for 2013 and for August 1993 through December 2013.

Information in this attachment is organized into the following subsections:

- South Field Module (Section A.1.1)
- South Plume Module (Section A.1.2)
- Waste Storage Area Module (Section A.1.3)
- Total Uranium Data (Section A.1.4)
- Pumping Rates (Section A.1.5)

A.1.1 South Field Module

Thirteen extraction wells were operational in the South Field Module in 2013. The 13 active extraction wells (EW) are 31550 (EW-18), 31560 (EW-19), 31561 (EW-20), 33326 (EW-17a), 32276 (EW-22), 32446 (EW-24), 32447 (EW-23), 33061 (EW-25), 33262 (EW-15a), 33264 (EW-30), 33265 (EW-31), 33266 (EW-32), and 33298 (EW-21a).

The target combined pumping rate for the South Field Module wells in 2013 was 2,575 gpm. The combined performance data for the South Field Module are presented in Table A.1-1. This target rate is consistent with pumping rates defined for the WSA (Phase II) Model Design. Tables A.1-2 through A.1-14 provide individual extraction well performance data for 2013. The footnotes explain individual extraction well outages of greater than 24 hours.

During 2013, 1,306.99 million gallons (M gal) of groundwater were pumped by the active extraction wells in the South Field Module, resulting in the removal of 291.66 pounds (lb) of uranium from the Great Miami Aquifer (GMA). Since startup of the South Field Module in July 1998, the module has removed 17.42 billion gallons of water and 7,113 lb of uranium from the GMA.

A.1.2 South Plume Module

Six extraction wells were operational in the South Plume Module in 2013. The six active recovery wells (RW) are 3924 (RW-1), 3925 (RW-2), 3926 (RW-3), 3927 (RW-4), 32308 (RW-6), and 32309 (RW-7). These wells are located south of Willey Road and north of New Haven Road.

The target combined pumping rate for the South Plume Module in 2013 was 1,200 gpm. Tables A.1-15 through A.1-20 provide individual extraction well performance data for the South Plume Module extraction wells in 2013. The footnotes explain individual extraction well outages of greater than 24 hours. The combined performance data for the South Plume Module are presented in Table A.1-1.

The extraction wells in the South Plume Module experienced excessive down time in the summer of 2013 beginning on July 18 with a power surge from the site's energy supplier (RW 3925 was turned off 1 day earlier [July 17] to address a variable frequency drive [VFD] issue). The power surge damaged capacitors in the VFDs, and damaged fuses. Although the fuses were damaged, some fuses did not disengage, resulting in a phase imbalance in the electric supply. As shown below, the majority of the South Plume Module wells were down for 32 days or more to safely implement repairs.

Well	Date Well Turned Off		Date Well Turned On		Approximate Time Off
	Date	Time[a]	Date	Time	(Days)
3924	July 18	14:00	August 19	15:50	32
3925	July 17	09:30	August 19	15:50	33
3926	July 18	14:00	August 19	15:50	32
3927	July 18	14:00	August 19	15:50	32
32308	June 26	NR	August 20	09:15	54
32309	June 26	NR	July 11	15:00	14

[a] NR = not recorded

During 2013, 563.39 M gal of groundwater were pumped by the six wells in the South Plume Module, resulting in the removal of 88.40 lb of uranium from the GMA. Since startup of the South Plume Module in August 1993, the module has removed 14.22 billion gallons of groundwater and 2,868.66 lb of uranium from the GMA.

During 2013, the South Plume Module continued to meet the primary objectives of:

- Preventing further southward movement of the total uranium plume while capturing the main lobe of the South Plume without adversely affecting the Paddys Run Road Site (PRRS) plume (3924 [RW-1], 3925 [RW-2], 3926 [RW-3], and 3927 [RW-4]).
- Actively remediating the higher concentration region of the off-property plume (32308 [RW-6] and 32309 [RW-7]).

Attachment A.3 presents additional details concerning capture, along with supporting data.

In 2013, as in previous years, PRRS constituents of concern (arsenic, phosphorus, potassium, sodium, and volatile organic compounds) were monitored at 11 monitoring well locations immediately south of the South Plume Module to ensure that the operation of the system does not adversely impact the PRRS plume. The 11 wells monitored were 2128, 2625, 2636, 2898, 2899, 2900, 3128, 3636, 3898, 3899, and 3900 (refer to Figure A.1-1).

The Mann-Kendall test for trend was run on PRRS data collected from these wells. As indicated in Table A.1-21, four parameters at five different wells monitored for PRRS constituents of concern had "up, significant" trends:

- Arsenic in monitoring wells 2898, 2899, 3636, 3898, and 3899
- Phosphorous in monitoring well 2625
- Potassium in monitoring wells 2898, 2899, 3898, and 3899
- Sodium in monitoring wells 3898 and 3899

Concentration versus time plots for these constituents and wells are provided in Figures A.1-2 through A.1-13. Groundwater flow directions are reported in Attachment A.3 in the form of water table maps. The water table maps for 2013 indicate that flow to monitoring wells 2898, 3898, 2899, and 3899 was from the northeast to the southwest. This indicates that the increasing concentrations at these locations were moving toward the PRRS plume, not away from it. The water table maps also indicate that flow from monitoring wells 2625 and 3636 was away from the South Plume, not toward it.

The monitoring activity for PRRS constituents of concern also included sampling for volatile organic compounds. These compounds are monitored because they were present in the PRRS plume, which is not of Fernald origin (ERM Midwest, Inc. 1994). No volatile organic compounds were detected in 2013.

Monitoring water levels appears to be more conclusive for determining if pumping in the South Plume is pulling the PRRS plume toward the South Plume recovery wells then monitoring for water quality changes. The U.S. Department of Energy (DOE) plans to take a look at potentially cutting back on the water quality sampling conducted for the PRRS wells and rely more heavily on water elevations to show that the South Plume wells are not pulling PRRS contamination toward the South Plume. Any future recommendation to make a monitoring change would be discussed with the U.S. Environmental Protection Agency (EPA) and Ohio EPA, and would only be implemented with their concurrence.

A.1.3 Waste Storage Area Module

Four extraction wells were operational in the former WSA in 2012. The four extraction wells are 32761 (EW-26), 33062 (EW-27), 33334 (EW-28a), and 33347 (EW-33a).

The target combined pumping rate for the WSA Module wells in 2013 was 1,000 gpm. This target pumping rate is consistent with the WSA (Phase II) Model Design. Tables A.1-22 through A.1-25 provide individual extraction well performance data for the WSA Module wells. The combined performance data for the WSA Module are presented in Table A.1-1.

During 2013, 504.45 M gal of groundwater were pumped from extraction wells in the WSA Module, resulting in the removal of 90.73 lb of uranium from the GMA. Since startup of the WSA Module in May 2002, 5,276 billion gallons of water and 1,879 lb of uranium have been removed from the GMA.

A.1.4 Total Uranium Data

Water samples were collected monthly in 2013 from the extraction wells and analyzed for total uranium. The total uranium concentrations were used to calculate the mass of uranium removed by the well in 2013. The total uranium concentrations can also be used to determine if a well needs to be routed to treatment or to bypass treatment. Since 2005, the percentage of treatment needed to achieve uranium discharge limits has decreased. Data collected since 2010 indicates that the aquifer remedy can now achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 µg/L, and 600 lb annually) established in the Operable Unit 5 Record of Decision (DOE 1996) without groundwater treatment. In 2013, 2.37 billion gallons of water were pumped from the GMA, and 1.379,655 M gal of groundwater were treated. This equates to approximately 0.05 percent.

Uranium concentration data collected from the extraction wells are also tracked graphically to predict when the extraction-well-specific uranium concentrations will reach the groundwater remediation goal of 30 µg/L. The data are tracked by plotting uranium concentrations over time and then fitting a regression line to the data set.

Figures A.1-14 through A.1-36 are uranium concentration versus time plots for each extraction well. Each graph displays three different data sets (operational data, 95 percent upper confidence level [UCL] of the operational data, and model predictions). Trend lines for the operational data set and the 95 percent UCL of the operational data set were fitted using the regression analysis function in Microsoft Excel software.

As pumping continues, the uranium concentration of the pumped groundwater will decrease. The slope of a fitted regression curve through the uranium concentration data set collected at each extraction well provides a prediction of when pumping concentrations will decrease below 30 µg/L at each well. However, the slope of a fitted regression curve through the pumped uranium concentration data set is an insufficient statistical measure by itself because future measured concentrations could vary about the trend curve. EPA guidelines in *General Methods for Remedial Operation Performance Evaluations* (EPA 1992) suggest that a 95 percent UCL of the measured uranium concentration data set can be used to help evaluate the uncertainty of the predicted data trend. From this perspective, the concentration trend of the measured data set presents a less conservative prediction of when pumping concentrations will decrease below 30 µg/L, and the 95 percent UCL data trend presents a more conservative trend prediction (i.e., longer predicted cleanup times).

The graphs in Figures A.1-14 through A.1-36 predict for each extraction well when the actual measured concentrations and the 95 percent UCL calculated concentrations will reach the 30 µg/L final remediation level (FRL) for total uranium. For example, the concentration trend of pumped water from extraction well 31562 (refer to Figure A.1-25) reached 30 µg/L in August of 2013 (trend for the measured data set) or beyond 2024 (trend for the 95 percent UCL data).

Figures A.1-14 through A.1-36 also compare modeled uranium concentration predictions to the measured and 95 percent UCL data trends. The Variable Saturated Model in 3 Dimensions groundwater model uranium concentration predictions are based on modeling results for the WSA (Phase II) Design (DOE 2005). Groundwater model predictions are based on the assumption that an equilibrium linear isotherm adequately describes the partitioning of total uranium between the sorbed and dissolved phases.

The Fernald groundwater model predicts the future average pounds of uranium that will be removed from the aquifer for each year of the modeled remedy. This prediction (broken down by year) is used to judge how closely the remediation is tracking the model predictions. The average annual pounds of uranium actually removed from the aquifer are compared to the model predictions to assess how reasonable the model predictions were. Concentration regression equations based on measured concentration data collected at the extraction wells are used to provide a prediction of the number of pounds of uranium that will be removed from the aquifer in future years. Regression equations based on uranium concentration data collected at extraction wells through December 31, 2013, are summarized in Table A.1-26.

At the end of December 2013, approximately 11,784 net lb of uranium had been removed from the GMA by the pump-and-treat remedy. The WSA Phase II Design predicts that cleanup objectives could be achieved as early as 2024. Model predictions indicate that through 2024 an additional 2,449 lb of uranium will be removed from the GMA by operating the system according to the WSA (Phase II) Design. The concentration data set indicates that an additional 2,504 lb of uranium will be removed from the GMA based on regression analyses of the individual well data. The 95 percent UCL measured concentration data set indicates that an additional 10,284 lb of uranium will be removed from the GMA based on regression analyses of the individual well data. A summary of the predictions are provided below.

Net pounds of uranium extracted through December 2013	11,784		
	Data	**Model**	**95% UCL**
Predicted pounds of uranium to be extracted between 2014 and the end of the pump and treat stage of the aquifer remedy (per the WSA Phase II Design)	2,504	2,449	10,284
Total predicted pounds of uranium to be removed	**14,288**	**14,233**	**22,068**
Estimated Percent Complete (based on pounds of uranium to be removed)	**83%**	**83%**	**53%**

Table A.1-27 provides a yearly breakdown for the three predictions. Figure A.1-37 illustrates the relationship between the three estimates. Tracking mass removal trends against groundwater modeling predictions provides an indirect status on progress being made to attain uranium FRLs. A more direct method is presented in Attachment A.2 in the form of maximum uranium plume maps.

Results indicate that as of January 1, 2014, the uranium concentration data trend predicts that the estimated mass completeness of the pump-and-treat stage of the aquifer remedy is approximately 83 percent. The groundwater model predicted an estimated mass completeness of 83 percent. The estimated mass completeness of the pump-and-treat stage based on the 95 percent UCL is approximately 53 percent. Following the EPA guidelines mentioned earlier, the estimated mass completeness can be estimated as being between 53 percent and 83 percent complete.

As shown in Table A.1-27, 2011 marks the first year that the estimated mass completeness metric based on concentration data is lower than the estimate mass completeness metric based on model predictions (i.e., 76 percent compared to 77 percent, respectively). This relationship indicates that the modeled cleanup predictions started becoming more optimistic than the actual measured concentration data trend indicates. This trend was repeated in 2012. In 2013, the estimated mass completeness based on concentration data equaled the estimate based on model predictions (i.e., 83 percent). The uranium decreases plotted at each extraction well illustrate that the concentration curves are trending asymptotic. Actual uranium decreases measured in the field are decreasing each year. This trend is a characteristic of pump-and-treat remediations in general. DOE will continue to track this trend and may recommend operational changes in efforts to improve uranium removal efficiencies as the remedy continues.

As reported above, estimated mass completeness based on both the actual concentrations measured in the extraction wells, and the model predicted concentrations predicted for the extraction wells were in very close agreement (i.e., both equated to 83 percent). A more detailed look at the model predicted concentration versus the actual measured concentration is provided in Table A.1-28. This table shows that the average actual concentration is higher than the model predicted average concentration and the range of actual concentrations is also larger than the range of model predictions.

An additional analysis was conducted for this year's Site Environmental Report. As Table A.1-28 shows, 6 of the 23 extraction wells had uranium concentrations at the end of 2013 that were very near or above the 30 µg/L uranium cleanup value (i.e., 32308, 31550, 33298, 32447, 32446, and 33264). Figure A.1-38 shows the locations of the six wells.

It should be noted that even if the uranium concentration measured in an extraction well is less than 30 µg/L that does not indicate that the well has achieved remediation objectives. Achievement of remediation objectives is predicted by groundwater modeling if the extraction wells are operated according to the pumping schedule that was modeled. Continued operation of the extraction well remediates uranium contamination in the area of the aquifer impacted by the extraction well. It should also be noted that partial penetration effects of the extraction wells also serve to dilute uranium concentrations at the extraction wells.

As mentioned above, 6 of the 23 extraction wells had uranium concentrations at the end of 2013 that were very near or above the 30 µg/L uranium FRL: extraction wells 32308, 31550, 33298, 32447, 32446, and 33264. The more recent data from these wells indicates that the trends of the data sets are becoming asymptotic over time. This indicates that it will take longer for the concentrations to trend below 30 µg/L at these wells than would be predicted if the entire data set was used in the trend regression. Additional analysis was conducted on the data sets from these six wells to quantify the impact of the decreasing concentration trends. Figures A.1-39 to A.1-44 are uranium concentration versus time plots for the six wells based on the more recent data from each well (as noted on the X axis of each plot). Use of just the more recent data gives a better trend prediction of how the data is currently trending. Table A.1-29 provides a summary of the regression equations and type of regressions that were conducted on each data set for the six subject wells. Selection of a regression method was based on the best R^2 fit.

Regressions using the more recent data resulted in trends with decreased slopes, resulting in longer predicted time estimates for reaching a uranium concentration of 30 µg/L. The decreased slopes also resulted in predictions that more pounds of uranium would be removed from the aquifer over time than originally estimated. As reported below, the predicted date for reaching a uranium concentration of 30 µg/L was extended at all six extraction wells.

Well Number	30 µg/L Prediction Based on Entire Data Set	30 µg/L Prediction Based on More Recent Data Set
32308 (RW-6)	June 30, 2011	February 3, 2013
31550 (EW-18)	May 21, 2013	January 3, 2024
33298 (EW-21a)	August 22, 2013	December 7, 2016
32447 (EW-23)	July 3, 2014	December 6, 2017
32446 (EW-24)	May 28, 2015	August 5, 2017
33264 (EW-30)	June 10, 2013	April 18, 2014

Table A.1-30 provides the new estimates. Results indicate that as of January 1, 2014, the extraction well concentration trend-based estimated percent complete for the pump and treat stage of the aquifer remedy is approximately 81 percent (based on the uranium concentration data set) or 83 percent (based on the model predictions). The pump-and-treat stage of the aquifer remedy is approximately 51 percent complete based on the 95 percent UCL data set. This exercise shows that use of the more recent data at the subject six extraction wells reduced the estimated percent mass complete based on the data by approximately 2 percent. The conclusion is that the groundwater remediation is becoming less efficient over time, as shown by the asymptotic trends being observed in some of the extraction well uranium concentration data sets.

A proposal was sent to the Ohio EPA in the fall of 2013 to initiate some pumping changes to the groundwater remediation design in an attempt to improve the efficiency of the ongoing pump-and-treat operation. In the proposal, the target pumping rate would be increased at five of the six subject extraction wells. The proposal is currently undergoing review.

A.1.5 Pumping Rates

Target extraction well pumping rates for 2013 are provided in Table A.1-31. The footnotes in the well-specific operational tables explain individual well outages of greater than 24 hours. The total target pumping rate of 4,775 gpm is consistent with the rate defined by the WSA (Phase II) Model Design. As additional operational experience is gained, pumping rates may change as efforts are made to maximize the effectiveness of each module.

In September of 2012, with concurrence from EPA and Ohio EPA, a pulse pumping exercise was initiated at Extraction Wells 31550 (EW-18), 31560 (EW-19), 31561 (EW-20), and 33061 (EW-25). All four of these wells are equipped with pumps and motors that operate most efficiently at rates of approximately 300 gpm. The WSA (Phase II) Model Design calls for a target pumping rate of 100 gpm for each of these wells. The 100 gpm rate was being achieved by throttling back on the flow from each of the wells; however, this type of operation was not energy efficient.

To become more energy efficient, when conditions allow, the wells are being pumped at a higher rate for a shorter period of time each day in order to remove the daily volume of water prescribed by the WSA (Phase II) Design (DOE 2005). Specifically, the wells are being pumped for 300 gpm for 8 hours a day (a total of 144,000 gallons per day) rather than 100 gpm for 24 hours a day (a total of 144,000 gallons per day). Flow and particle path monitoring predictions indicate that capture of the 30 µg/L uranium plume will be maintained by the new pumping schedule.

A.1.6 References

DOE (U.S. Department of Energy), 1996. *Record of Decision for Remedial Actions at Operable Unit 5*, 7478 U 007 501.4, Final, Fluor Fernald, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2005. *Waste Storage Area Phase II Design Report*, 52424-RP-0004, Revision A, Draft Final, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, June.

EPA (U.S. Environmental Protection Agency), 1992. *General Methods for Remedial Operation Performance Evaluations*, Environmental Research Laboratory, Ada, Oklahoma, January.

ERM Midwest, Inc., 1994. "Remedial Investigation and Risk Assessment, Paddys Run Road Site," Revision 1, Volumes 1 through 5, Crosby Township, Hamilton, Ohio.

Table A.1-1. Aquifer Restoration System Operational Summary

	Reporting Period					
	January 2013 through December 2013			August 1993 through December 2013		
	Gallons Pumped/ Re-injected (M gal)	**Total Uranium Removed/ Re-injected (lb)**	**Uranium Removal Index[a] (lb/M gal)**	**Gallons Pumped/ Re-injected (M gal)**	**Total Uranium Removed/ Re-injected (lb)**	**Uranium Removal Index[a] (lb/M gal)**
South Field Module	1,306.996	291.66	0.22	17,418.72	7,112.74	0.41
Waste Storage Area Module	504.45	90.73	0.18	5275.65	1,879.05	0.36
South Plume Module	563.39	88.40	0.16	14,214.78	2,868.66	0.20
Re-injection Module[b]	0	0	NA	1,936.478	76.27	NA
Aquifer Restoration Systems Totals						
Extraction Wells	2,374.83	470.79	0.20	36,909.15	11,860.45	0.32
(Re-injection Wells[b])	0	0	NA	(1,936.478)	(76.27)	NA
Net	2,374.83	470.79	NA	34,972.67	11,784.18	NA

[a] NA = not applicable.
[b] Re-injection module was shut down in September 2004.

Table A.1-2. Extraction Well 31550 (EW-18) Operational Summary for 2013

Reference Elevation (feet [ft] amsl) – 572.11 (top of well)
Northing Coordinate ('83) – 477,018.5
Easting Coordinate ('83) – 1,348,979.8

Hours in reporting period – 8,760
Hours not pumped – 990

Hours pumped – 7,770
Operational percent – 88.69
Adjusted operational percent[a] – 98.10

Target pumping rate – 100 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	122.1	5.451	36.7	0.31
Feb	107.2	4.322	37.0	0.31
Mar	129.5	5.779	34.8	0.29
Apr	128.0	5.528	35.6	0.30
May	51.9	2.316	38.5	0.32
Jun	71.4	3.084	36.8	0.31
Jul	127.8	5.704	35.7	0.30
Aug	136.4	6.091	34.8	0.29
Sep	112.6	4.864	34.2	0.29
Oct	135.7	6.059	33.8	0.28
Nov	135.5	5.851	35.0	0.29
Dec	120.3	5.371	33.2	0.28
	Average 114.9	Total 60.420	Average 35.5	Average 0.29

[a] Adjusted for planned annual well field shutdowns.
[b] Well 18 was down from May 13 to June 17 for annual wellfield shutdown.
Well 18 was down from September 14 to September 18 due to a ground fault error and replacement of variable frequency drive.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-3. Extraction Well 31560 (EW-19) Operational Summary for 2013

Reference Elevation (ft amsl) – 574.93 (top of well)
Northing Coordinate ('83) – 477,403.1
Easting Coordinate ('83) – 1,349,028.9

Hours in reporting period – 8,760
Hours not pumped – 911

Hours pumped – 7,849
Operational percent – 89.60
Adjusted operational percent[a] – 99.10

Target pumping rate – 100 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (μg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		126.0		5.623		16.4		0.14
Feb		108.3		4.365		15.9		0.13
Mar		130.0		5.802		15.4		0.13
Apr		142.4		6.150		16.7		0.14
May		52.0		2.321		18.6		0.16
Jun		71.3		3.078		19.5		0.16
Jul		128.6		5.742		19.5		0.16
Aug		134.8		6.018		17.7		0.15
Sep		128.3		5.541		15.8		0.13
Oct		133.0		5.938		13.9		0.12
Nov		135.1		5.835		13.2		0.11
Dec		120.4		5.376		14.8		0.12
	Average	117.5	Total	61.789	Average	16.5	Average	0.14

[a] Adjusted for planned annual well field shutdowns.
[b] Well 19 was down from May 13 to June 17 for annual wellfield shutdown.
Well 19 was down from July 31 to August 1 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-4. Extraction Well 31561 (EW-20) Operational Summary for 2013

Reference Elevation (ft amsl) – 578.77 (top of well)
Northing Coordinate ('83) – 477,660.8
Easting Coordinate ('83) – 1,349,254.5

Hours in reporting period – 8,760
Hours not pumped – 1,032

Hours pumped – 7,728
Operational percent – 88.22
Adjusted operational percent[a] – 97.58

Target pumping rate – 100 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		121.8		5.437		29.0		0.24
Feb		107.0		4.316		29.2		0.24
Mar		137.8		6.153		27.2		0.23
Apr		125.8		5.432		26.7		0.22
May		51.9		2.318		28.5		0.24
Jun		71.6		3.091		27.7		0.23
Jul		132.4		5.911		27.5		0.23
Aug		132.0		5.894		27.1		0.23
Sep		133.0		5.745		27.9		0.23
Oct		132.2		5.904		29.8		0.25
Nov		128.9		5.571		31.0		0.26
Dec		112.8		5.038		26.8		0.22
	Average	115.6	Total	60.809	Average	28.2	Average	0.24

[a] Adjusted for planned annual well field shutdowns.
[b] Well 20 was down from May 13 to June 17 for annual wellfield shutdown.
Well 20 was down from July 31 to August 1 for chemical treatment.
Well 20 was down from November 20 to November 21 for chemical treatment.
Well 20 was down from December 16 to December 17 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-5. Extraction Well 33326 (EW-17a) Operational Summary for 2013

Reference Elevation (ft amsl) – 574.84 (top of well)
Northing Coordinate ('83) – 477,905.5
Easting Coordinate ('83) – 1,348,854.1

Hours in reporting period – 8,760 Hours pumped – 6,826 Target pumping rate – 175 gpm
Hours not pumped – 1,934 Operational percent – 77.92
Adjusted operational percent[a] – 86.18

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	167.8	7.490	15.8	0.13
Feb	173.6	7.000	17.6	0.15
Mar	199.2	8.891	15.1	0.13
Apr	189.8	8.200	16.5	0.14
May	72.3	3.228	18.2	0.15
Jun	0.0	0.000	18.2	0.00
Jul	191.5	8.546	21.9	0.18
Aug	193.8	8.649	15.7	0.13
Sep	192.0	8.293	16.4	0.14
Oct	196.7	8.780	15.6	0.13
Nov	123.2	5.322	16.9	0.14
Dec	88.2	3.935	16.5	0.14
	Average 149.0	Total 78.334	Average 17.0	Average 0.13

[a] Adjusted for planned annual well field shutdowns.
[b] Well 17a was down from February 6 to February 7 for chemical treatment.
Well 17a was down from May 13 to June 17 for annual wellfield shutdown.
Well 17a was down from November 20 to December 18 for chemical treatment and repairs.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-6. Extraction Well 32276 (EW-22) Operational Summary for 2013

Reference Elevation (ft amsl) – 567.14 (top of well)
Northing Coordinate ('83) – 476,447.3
Easting Coordinate ('83) – 1,348,857.3

Hours in reporting period – 8,760
Hours not pumped – 1,543

Hours pumped – 7,217
Operational percent – 82.39
Adjusted operational percent[a] – 91.12

Target pumping rate – 300 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (μg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		335.1		14.958		25.2		0.21
Feb		316.9		12.778		24.7		0.21
Mar		334.7		14.942		23.8		0.20
Apr		333.6		14.410		23.8		0.20
May		128.9		5.752		26.0		0.22
Jun		152.5		6.587		28.5		0.24
Jul		332.5		14.845		25.8		0.22
Aug		331.6		14.802		26.8		0.22
Sep		334.3		14.442		27.2		0.23
Oct		331.7		14.808		26.1		0.22
Nov		278.1		12.012		27.1		0.23
Dec		86.5		3.859		25.3		0.21
	Average	274.7	Total	144.195	Average	25.9	Average	0.22

[a] Adjusted for planned annual well field shutdowns.
[b] Well 22 was down from February 11 to February 12 for chemical treatment.
Well 22 was down from May 13 to June 17 for annual wellfield shutdown.
Well 22 was down from November 26 to December 23 due to electrical problems.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-7. Extraction Well 32446 (EW-24) Operational Summary for 2013

Reference Elevation (ft amsl) – 578.367 (top of well)
Northing Coordinate ('83) – 476,634.53
Easting Coordinate ('83) – 1,349,312.38

Hours in reporting period – 8,760
Hours not pumped – 1,174

Hours pumped – 7,586
Operational percent – 86.6
Adjusted operational percent[a] – 95.78

Target pumping rate – 300 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		321.7		14.361		42.1		0.35
Feb		302.1		12.181		24.7		0.22
Mar		329.5		14.707		38.4		0.32
Apr		315.3		13.621		38.6		0.32
May		120.2		5.364		40.8		0.34
Jun		62.7		2.708		36.8		0.31
Jul		328.6		14.669		46.6		0.39
Aug		323.5		14.441		39.9		0.33
Sep		327.8		14.161		39.5		0.33
Oct		342.2		15.274		40.4		0.34
Nov		304.6		13.159		39.8		0.33
Dec		324.1		14.468		36.9		0.31
	Average	283.5	Total	149.114	Average	38.7	Average	0.32

[a] Adjusted for planned annual well field shutdowns.
[b] Well 24 was down from February 11 to February 12 for chemical treatment.
Well 24 was down from May 13 to June 25 for annual wellfield shutdown, and well problems.
Well 24 was down from November 5 to November 6 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-8. Extraction Well 32447 (EW-23) Operational Summary for 2013

Reference Elevation (ft amsl) – 574.528 (top of well)
Northing Coordinate ('83) – 477,150.24
Easting Coordinate ('83) – 1,349,421.19

Hours in reporting period – 8,760
Hours not pumped – 1,860
Hours pumped – 6,900
Operational percent – 78.76
Adjusted operational percent[a] – 87.12
Target pumping rate – 300 gpm

Monthly Measurements at Well Field								
Month		Monthly Average Pumping Rate[b] (gpm)		Volume Pumped (M gal)		Monthly Total Uranium Concentration[c] (µg/L)		Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan		222.5		9.931		28.9		0.24
Feb		324.5		13.082		45.9		0.38
Mar		282.2		12.598		43.9		0.37
Apr		301.5		13.025		43.1		0.36
May		119.4		5.331		45.7		0.38
Jun		151.5		6.545		38.2		0.32
Jul		327.5		14.620		42.8		0.36
Aug		326.2		14.560		44.8		0.37
Sep		330.4		14.274		44.0		0.37
Oct		275.7		12.306		42.7		0.36
Nov		117.3		5.065		46.1		0.38
Dec		290.5		12.970		44.0		0.37
	Average	255.8	Total	134.307	Average	42.5	Average	0.35

[a] Adjusted for planned annual well field shutdowns.
[b] Well 23 was down from January 1 to January 10 due to overheating problems.
Well 23 was down from January 10 to January 11 for chemical treatment.
Well 23 was down on January 27 due to a power outage.
Well 23 was down from March 19 to March 20 for chemical treatment.
Well 23 was down from April 1 to April 3 for variable frequency drive, pump, and motor replacement.
Well 23 was down from May 13 to June 17 for annual wellfield shutdown.
Well 23 was down from October 24 to October 28 due to a malfunction variable frequency drive.
Well 23 was down from November 5 to November 7 for chemical treatment.
Well 23 was down from November 14 to December 3 due to electrical problems.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-9. Extraction Well 33061 (EW-25) Operational Summary for 2013

Reference Elevation (ft amsl) – 575.56 (top of well)
Northing Coordinate ('83) – 478,318.82
Easting Coordinate ('83) – 1,349,531.03

Hours in reporting period – 8,760
Hours not pumped – 986

Hours pumped – 7,774
Operational percent – 88.75
Adjusted operational percent[a] – 98.16

Target pumping rate – 100 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		123.4		5.507		19.3		0.16
Feb		105.0		4.235		19.5		0.16
Mar		127.5		5.692		16.6		0.14
Apr		127.0		5.487		25.9		0.22
May		55.1		2.459		27.6		0.23
Jun		40.9		1.766		40.7		0.34
Jul		134.3		5.994		51.9		0.43
Aug		145.6		6.501		26.7		0.22
Sep		127.9		5.525		19.4		0.16
Oct		135.8		6.063		22.8		0.19
Nov		144.4		6.239		22.5		0.19
Dec		125.7		5.609		22.9		0.19
	Average	116	Total	61.078	Average	26.3	Average	0.22

[a] Adjusted for planned annual well field shutdowns.
[b] Well 25 was down from May 13 to June 17 for annual wellfield shutdown.
Well 25 was down from December 16 to December 17 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-10. Extraction Well 33262 (EW-15a) Operational Summary for 2013

Reference Elevation (ft amsl) – 568.368 (top of well)
Northing Coordinate ('83) – 477,799.912
Easting Coordinate ('83) – 1,348,149.97

Hours in reporting period – 8,760
Hours not pumped – 882

Hours pumped – 7,878
Operational percent – 89.93
Adjusted operational percent[a] – 99.46

Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	222.1	9.917	22.4	0.19
Feb	214.0	8.629	25.8	0.22
Mar	231.4	10.331	27.6	0.23
Apr	228.7	9.879	28.1	0.23
May	90.5	4.042	30.6	0.26
Jun	104.5	4.514	34.2	0.29
Jul	223.4	9.972	30.5	0.25
Aug	218.5	9.752	29.7	0.25
Sep	224.1	9.683	26.2	0.22
Oct	225.0	10.045	23.3	0.19
Nov	220.7	9.535	23.8	0.20
Dec	220.3	9.834	21.8	0.18
	Average 201.9	Total 106.132	Average 27.0	Average 0.23

[a] Adjusted for planned annual well field shutdowns.
[b] Well 15a was down from May 13 to June 17 for annual wellfield shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-11. Extraction Well 33264 (EW-30) Operational Summary for 2013

Reference Elevation (ft amsl) – 573.818 (top of well)
Northing Coordinate ('83) – 477,200.945
Easting Coordinate ('83) – 1,349,751.49

Hours in reporting period – 8,760
Hours not pumped – 1,032
Hours pumped – 7,728
Operational percent – 88.22
Adjusted operational percent[a] – 97.58
Target pumping rate – 200 gpm

Monthly Measurements at Well Field							
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		205.6		9.177		34.1		0.28
Feb		199.6		8.047		35.6		0.30
Mar		216.3		9.658		31.7		0.26
Apr		213.7		9.230		31.9		0.27
May		77.9		3.476		43.4		0.36
Jun		101.3		4.374		38.9		0.32
Jul		216.2		9.650		33.7		0.28
Aug		221.6		9.890		33.4		0.28
Sep		223.5		9.656		32.5		0.27
Oct		228.3		10.192		31.4		0.26
Nov		200.3		8.652		33.9		0.28
Dec		215.7		9.629		29.9		0.25
	Average	193.3	Total	101.63	Average	34.2	Average	0.29

[a] Adjusted for planned annual well field shutdowns.
[b] Well 30 was down on January 27 due to a power outage.
Well 30 was down from February 7 to February 8 for chemical treatment.
Well 30 was down from May 13 to June 17 for annual wellfield shutdown.
Well 30 was down from July 30 to July 31 for chemical treatment.
Well 30 was down from October 3 to October 7 due to a malfunctioning flow meter.
Well 30 was down from November 14 to November 15 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-12. Extraction Well 33265 (EW-31) Operational Summary for 2013

Reference Elevation (ft amsl) – 577.474 (top of well)
Northing Coordinate ('83) – 477,598.909
Easting Coordinate ('83) – 1,349,849.01

Hours in reporting period – 8,760
Hours not pumped – 1,169
Hours pumped – 7,591
Operational percent – 86.65
Adjusted operational percent[a] – 95.84
Target pumping rate – 300 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		321.3		14.342		11.3		0.09
Feb		307.0		12.380		10.9		0.09
Mar		322.4		14.393		10.9		0.09
Apr		323.4		13.970		11.4		0.10
May		78.8		3.517		13.2		0.11
Jun		150.3		6.492		15.8		0.13
Jul		329.3		14.701		13.2		0.11
Aug		311.5		13.904		11.2		0.09
Sep		332.6		14.368		9.2		0.08
Oct		331.4		14.794		10.3		0.09
Nov		314.4		13.584		10.6		0.09
Dec		295.1		13.175		10.4		0.09
	Average	284.8	Total	149.619	Average	11.5	Average	0.10

[a] Adjusted for planned annual well field shutdowns.
[b] Well 31 was down on January 27 due to a power outage.
Well 31 was down from February 27 to February 28 for chemical treatment.
Well 31 was down from May 13 to June 17 for annual wellfield shutdown.
Well 31 was down from August 20 to August 22 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-13. Extraction Well 33266 (EW-32) Operational Summary for 2013

Reference Elevation (ft amsl) – 579.625 (top of well)
Northing Coordinate ('83) – 476,997.576
Easting Coordinate ('83) – 1,350,046.97

Hours in reporting period – 8,760
Hours not pumped – 1,257

Hours pumped – 7,503
Operational percent – 85.65
Adjusted operational percent[a] – 94.73

Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	219.6	9.803	5.8	0.05
Feb	211.3	8.519	5.7	0.05
Mar	221.3	9.879	5.0	0.04
Apr	217.9	9.414	4.7	0.04
May	87.1	3.887	4.9	0.04
Jun	100.3	4.335	7.1	0.06
Jul	149.8	6.687	5.1	0.04
Aug	217.4	9.706	5.3	0.04
Sep	223.3	9.648	4.7	0.04
Oct	222.2	9.918	4.7	0.04
Nov	186.4	8.052	4.8	0.04
Dec	209.7	9.361	4.3	0.04
	Average 188.9	Total 99.207	Average 5.2	Average 0.04

[a] Adjusted for planned annual well field shutdowns.
[b] Well 32 was down from May 13 to June 17 for annual wellfield shutdown.
Well 32 was down from July 12 to July 22 due to a hole in the pipe.
Well 32 was down from November 14 to November 18 for electrical work.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-14. Extraction Well 33298 (EW-21a) Operational Summary for 2013

Reference Elevation (ft amsl) – 576.21 (top of well)
Northing Coordinate ('83) – 477,953.1
Easting Coordinate ('83) – 1,349,499.9

Hours in reporting period – 8,760
Hours not pumped – 1,192
Hours pumped – 7,568
Operational percent – 86.39
Adjusted operational percent[a] – 95.55
Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	206.1	9.200	30.4	0.25
Feb	203.0	8.186	33.9	0.28
Mar	221.1	9.872	31.9	0.27
Apr	221.0	9.545	36.6	0.31
May	87.1	3.890	42.7	0.36
Jun	28.8	1.244	42.7	0.36
Jul	214.3	9.565	20.1	0.17
Aug	225.2	10.053	40.7	0.34
Sep	222.9	9.630	38.2	0.32
Oct	232.1	10.361	33.0	0.28
Nov	211.4	9.135	35.6	0.30
Dec	216.9	9.681	31.0	0.26
	Average 190.8	Total 100.361	Average 34.7	Average 0.29

[a] Adjusted for planned annual well field shutdowns.
[b] Well 21a was down on January 27 due to a power outage.
Well 21a was down from February 7 to February 8 for chemical treatment.
Well 21a was down from May 13 to June 17 for annual wellfield shutdown.
Well 21a was down from July 30 to July 31 for chemical treatment.
Well 21a was down from November 6 to November 7 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-15. Extraction Well 3924 (RW-1) Operational Summary for 2013

Reference Elevation (ft amsl) – 533.51 (top of well)
Northing Coordinate ('83) – 474,219.7
Easting Coordinate ('83) – 1,348,314.3

Hours in reporting period – 8,760 | Hours pumped – 7,646 | Target pumping rate – 200 gpm
Hours not pumped – 1,114 | Operational percent – 87.28

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[a] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[b] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	221.7	9.896	17.2	0.14
Feb	215.9	8.706	22.4	0.19
Mar	219.4	9.796	21.2	0.18
Apr	175.6	7.587	19.3	0.16
May	201.4	8.991	17.3	0.14
Jun	217.2	9.383	16.2	0.14
Jul	113.7	5.073	14.8	0.12
Aug	89.8	4.008	14.8	0.12
Sep	220.3	9.516	15.1	0.13
Oct	219.2	9.785	15.2	0.13
Nov	232.2	10.033	16.8	0.14
Dec	215.7	9.630	15.5	0.13
	Average 195.2	Total 102.403	Average 17.2	Average 0.14

[a] Well 1 was down from April 24 to May 3 for variable frequency drive installation.
Well 1 was down from May 7 to May 8 for chemical treatment.
Well 1 was down from May 21 to May 22 for valve annual preventative maintenance.
Well 1 was down from July 18 to August 19 due to variable frequency drive and fuse damage caused by power surge.
Well 1 was down from December 18 to December 19 for chemical treatment.

[b] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-16. Extraction Well 3925 (RW-2) Operational Summary for 2013

Reference Elevation (ft amsl) – 542.01 (top of well)
Northing Coordinate ('83) – 474,319.7
Easting Coordinate ('83) – 1,348,565.4

Hours in reporting period – 8,760
Hours not pumped – 1,261
Hours pumped – 7,499
Operational percent – 85.61
Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[a] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[b] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	212.8	9.497	14.6	0.12
Feb	201.8	8.138	14.0	0.12
Mar	202.9	9.056	14.7	0.12
Apr	133.5	5.768	14.4	0.12
May	179.2	7.999	16.7	0.14
Jun	168.8	7.290	17.4	0.15
Jul	112.8	5.035	15.3	0.13
Aug	88.9	3.967	27.1	0.23
Sep	220.6	9.532	15.3	0.13
Oct	213.5	9.529	15.0	0.13
Nov	209.7	9.057	16.3	0.14
Dec	220.1	9.827	13.4	0.11
	Average 180.4	Total 94.696	Average 16.2	Average 0.14

[a] Well 2 was down on January 11 for an unknown reason.
Well 2 was down from February 12 to February 13 for chemical treatment.
Well 2 was down on March 31 for an unknown reason.
Well 2 was down from April 9 to April 16 for variable frequency drive installation.
Well 2 was down from May 21 to May 22 for valve annual preventative maintenance.
Well 2 was down from June 18 to June 19 for pump and motor replacement.
Well 2 was down from July 17 to August 19 due to variable frequency drive and fuse damage caused by power surge.
Well 2 was down from November 7 to November 8 for chemical treatment.

[b] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-17. Extraction Well 3926 (RW-3) Operational Summary for 2013

Reference Elevation (ft amsl) – 586.73 (top of well)
Northing Coordinate ('83) – 474,428.6
Easting Coordinate ('83) – 1,348,837.5

Hours in reporting period – 8,760 Hours pumped – 7,675 Target pumping rate – 200 gpm
Hours not pumped – 1,085 Operational percent – 87.62

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[a] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[b] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	220.5	9.845	18.9	0.16
Feb	215.4	8.687	19.6	0.16
Mar	218.4	9.750	17.9	0.15
Apr	166.0	7.171	18.3	0.15
May	213.2	9.519	19.8	0.17
Jun	216.9	9.370	21.0	0.18
Jul	114.5	5.111	19.6	0.16
Aug	87.1	3.887	41.2	0.34
Sep	220.5	9.525	21.4	0.18
Oct	205.4	9.168	21.9	0.18
Nov	204.9	8.850	23.6	0.20
Dec	220.2	9.830	23.3	0.19
	Average 191.9	Total 100.711	Average 22.2	Average 0.19

[a] Well 3 was down from April 15 to April 22 for variable frequency drive installation.
Well 3 was down from May 7 to May 8 for chemical treatment.
Well 3 was down from May 21 to May 22 for valve annual preventative maintenance.
Well 3 was down from July 18 to August 19 due to variable frequency drive and fuse damage caused by power surge.
Well 3 was down from November 7 to November 8 for chemical treatment.
[b] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-18. Extraction Well 3927 (RW-4) Operational Summary for 2013

Reference Elevation (ft amsl) – 591.84 (top of well)
Northing Coordinate ('83) – 474,541.8
Easting Coordinate ('83) – 1,349,127.3

Hours in reporting period – 8,760 | Hours pumped – 7,617 | Target pumping rate – 200 gpm
Hours not pumped – 1,143 | Operational percent – 86.95

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[a] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[b] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	173.7	7.756	3.1	0.03
Feb	205.8	8.297	3.4	0.03
Mar	222.1	9.916	3.3	0.03
Apr	223.9	9.674	3.0	0.03
May	199.7	8.913	3.8	0.03
Jun	220.4	9.520	3.4	0.03
Jul	108.5	4.844	3.0	0.03
Aug	40.4	1.806	4.9	0.04
Sep	219.6	9.487	3.1	0.03
Oct	219.5	9.800	3.2	0.03
Nov	220.1	9.508	3.2	0.03
Dec	211.1	9.423	2.7	0.02
	Average 188.7	Total 98.943	Average 3.3	Average 0.03

[a] Well 4 was down from January 10 to January 11 for chemical treatment.
Well 4 was down from January 26 to January 30 due to a failed flow meter.
Well 4 was down from April 30 to May 3 for electrical cabinet replacement.
Well 4 was down from May 21 to May 22 for valve annual preventative maintenance.
Well 4 was down from July 18 to August 19 due to variable frequency drive and fuse damage caused by power surge.
Well 4 was down from August 20 to August 23 for chemical treatment.
Well 4 down from August 28 to August 29 for pump/motor replacement.
Well 4 was down from December 18 to December 19 due to variable frequency drive malfunction.
[b] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-19. Extraction Well 32308 (RW-6) Operational Summary for 2013

Reference Elevation (ft amsl) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,078.83
Easting Coordinate ('83) – 1,348,693.9

Hours in reporting period – 8,760
Hours not pumped – 2,367
Hours pumped – 6,393
Operational percent – 72.98
Adjusted operational percent[a] – 80.72
Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	Monthly Average Pumping Rate[b] (gpm)	Volume Pumped (M gal)	Monthly Total Uranium Concentration[c] (µg/L)	Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan	190.0	8.480	31.8	0.27
Feb	208.8	8.419	30.7	0.26
Mar	218.2	9.739	28.4	0.24
Apr	172.2	7.438	29.0	0.24
May	84.0	3.750	31.4	0.26
Jun	14.8	0.640	29.9	0.25
Jul	0.0	0.000	22.5	0.00
Aug	86.4	3.856	30.5	0.25
Sep	224.0	9.677	29.7	0.25
Oct	227.6	10.158	29.6	0.25
Nov	225.2	9.728	32.1	0.27
Dec	223.3	9.967	29.9	0.25
	Average 156.2	Total 81.851	Average 29.6	Average 0.23

[a] Adjusted for planned annual well field shutdown.
[b] Well 6 was down from January 29 to January 30 for chemical treatment.
Well 6 was down from April 18 to April 24 for variable frequency drive installation.
Well 6 was down from May 13 to June 24 for annual wellfield shutdown, and well problems.
Well 6 was down from June 26 to August 20 for variable frequency drive and fuse damage caused by power surge.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-20. Extraction Well 32309 (RW-7) Operational Summary for 2013

Reference Elevation (ft amsl) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,109.60
Easting Coordinate ('83) – 1,348,366.34

Hours in reporting period – 8,760
Hours not pumped – 2,261

Hours pumped – 6,499 Target pumping rate – 200 gpm
Operational percent – 74.19
Adjusted operational percent[a] – 82.05

Monthly Measurements at Well Field				
Month	Monthly Average Pumping Rate[b] (gpm)	Volume Pumped (M gal)	Monthly Total Uranium Concentration[c] (µg/L)	Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan	196.8	8.783	25.7	0.21
Feb	215.9	8.706	26.6	0.22
Mar	212.9	9.503	24.5	0.20
Apr	168.0	7.257	25.9	0.22
May	77.0	3.439	29.0	0.24
Jun	0.0	0.000	29.0	0.00
Jul	93.2	4.159	49.6	0.41
Aug	90.5	4.039	33.6	0.28
Sep	224.0	9.678	27.6	0.23
Oct	224.6	10.027	28.7	0.24
Nov	222.3	9.601	29.0	0.24
Dec	214.9	9.592	25.8	0.22
	Average 161.7	Total 84.785	Average 29.6	Average 0.23

[a] Adjusted for planned annual well field shutdown.
[b] Well 7 was down from January 29 to January 30 for chemical treatment.
Well 7 was down from April 18 to April 24 for variable frequency drive installation.
Well 7 was down from May 13 to June 17 for annual wellfield shutdown.
Well 7 was down from June 26 to July 11 for electrical problem, variable frequency drive and fuse damage caused by power surge.
Well 7 was down from July 24 to August 19 due to voltage variances that could harm the variable frequency drive and motor.
Well 7 was down from December 19 to December 20 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-21. PRRS Groundwater Summary Statistics and Trend Analysis

Analyte	Monitoring Well	Number of Samples[a,b,c]	Min.[a,b,c,d] (mg/L)	Max.[a,b,c,d] (mg/L)	Avg.[a,b,c,d] (mg/L)	SD[a,b,c,d,e]	Trend[a,b,c,d,f]
Arsenic	2128	242	0.000195	0.188	0.0112	0.0204	Down
	2625	214	0.00110	0.0706	0.0119	0.0095	Down
	2636	184	0.010	0.0939	0.0441	0.0185	Down
	2898	59	0.000147	0.0820	0.0044	0.0114	**Up**
	2899	52	0.00032	0.0283	0.0023	0.0041	**Up**
	2900	241	0.00032	0.0609	0.0050	0.0054	Down
	3128	62	0.0004	0.234	0.0073	0.0297	No Trend
	3636	61	0.0005	0.0233	0.0028	0.0038	**Up**
	3898	59	0.0005	0.0434	0.0044	0.0066	**Up**
	3899	60	0.000147	0.0307	0.0027	0.0046	**Up**
	3900	60	0.000375	0.0208	0.0028	0.0033	No Trend
Phosphorus	2128	68	0.025	16.2	1.41	2.38	Down
	2625	38	0.307	18.6	3.81	3.88	**Up**
	2636	36	9.6	170	84.9	43.0	Down
	2898	60	0.005	9.95	0.258	1.30	No Trend
	2899	51	0.005	0.831	0.058	0.118	No Trend
	2900	58	0.050	4.74	0.471	0.663	Down
	3128	69	0.005	13.0	0.240	1.56	No Trend
	3636	60	0.00955	1.10	0.071	0.143	No Trend
	3898	58	0.0075	1.24	0.103	0.173	No Trend
	3899	59	0.005	0.830	0.089	0.148	Down
	3900	60	0.005	1.38	0.088	0.236	Down
Potassium	2128	60	0.83	18.0	3.37	3.32	No Trend
	2625	39	0.64	9.49	3.54	2.18	No Trend
	2636	36	4.6	218	64.9	51.1	Down
	2898	60	1.11	9.64	4.39	1.23	**Up**
	2899	52	1.36	8.85	4.08	0.99	**Up**
	2900	59	0.0095	6.00	2.01	1.06	No Trend
	3128	62	1.09	3.70	1.95	0.63	Down
	3636	60	1.09	4.24	2.18	0.55	Down
	3898	59	0.61	4.09	2.55	0.67	**Up**
	3899	60	0.875	4.54	2.63	0.63	**Up**
	3900	60	0.975	3.19	1.72	0.39	Down
Sodium	2128	60	12.3	75.2	34.6	11.5	Down
	2625	39	13.1	61.4	31.9	9.38	Down
	2636	36	19.1	148	52.7	26.6	No Trend
	2898	60	4.95	31.0	19.4	4.89	No Trend
	2899	52	11.2	25.1	17.6	3.37	No Trend
	2900	59	0.0136	43.3	26.7	7.44	Down
	3128	62	3.52	13.4	5.68	2.60	Down
	3636	60	3.14	13.0	5.83	2.76	Down
	3898	59	7.29	28.8	11.6	4.99	**Up**
	3899	60	6.24	43.6	11.4	8.07	**Up**
	3900	60	3.13	10.8	4.88	1.79	Down

Table A.1-21. (continued). PRRS Groundwater Summary Statistics and Trend Analysis

[a] The data are based on unfiltered samples from the Operable Unit 5 Remedial Investigation/Feasibility Study data set (1988 through 1993) and 1994 through 2013 groundwater data (unfiltered and filtered for 2001 through 2013).
[b] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, standard deviation, and Mann-Kendall test for trend).
[c] Rejected data qualified with an R were not included in this count or the summary statistics.
[d] Where concentrations are below the detection limit each result used in the summary statistics is set at half the detection limit.
[e] SD = standard deviation.
[f] Trend starts on August 27, 1993, and is based on the start-up of the South Plume extraction wells (DOE 1993).

Table A.1-22. Extraction Well 32761 (EW-26) Operational Summary for 2013

Reference Elevation (ft amsl) – 570.88 (top of casing)
Northing Coordinate ('83) – 479,892.36
Easting Coordinate ('83) – 1,347,364.02

Hours in reporting period – 8,760
Hours not pumped – 923

Hours pumped – 7,837
Operational percent – 89.46
Adjusted operational percent[a] – 98.95

Target pumping rate – 300 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	326.0	14.552	24.5	0.20
Feb	318.2	12.828	25.3	0.21
Mar	313.0	13.970	24.0	0.20
Apr	322.4	13.927	26.1	0.22
May	127.5	5.692	29.5	0.25
Jun	150.2	6.488	36.3	0.30
Jul	325.2	14.517	27.5	0.23
Aug	326.7	14.582	26.1	0.22
Sep	331.3	14.313	23.8	0.20
Oct	331.1	14.779	23.2	0.19
Nov	325.8	14.075	22.5	0.19
Dec	319.8	14.276	21.2	0.18
	Average 293.1	Total 153.999	Average 25.8	Average 0.22

[a] Adjusted for planned annual well field shutdowns.
[b] Well 26 was down from May 13 to June 17 for annual wellfield shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-23. Extraction Well 33062 (EW-27) Operational Summary for 2013

Reference Elevation (ft amsl) – 575.1 (top of casing)
Northing Coordinate ('83) – 480,013.01
Easting Coordinate ('83) – 1,348,037.2

Hours in reporting period – 8,760
Hours not pumped – 1,609
Hours pumped – 7,151
Operational percent – 81.63
Adjusted operational percent[a] – 90.29
Target pumping rate – 200 gpm

Monthly Measurements at Well Field							
Month	Monthly Average Pumping Rate[b] (gpm)		Volume Pumped (M gal)		Monthly Total Uranium Concentration[c] (µg/L)		Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan	221.4		9.883		29		0.24
Feb	208.8		8.418		29.7		0.25
Mar	221.0		9.867		27.9		0.23
Apr	214.1		9.250		28.4		0.24
May	72.2		3.223		31.8		0.27
Jun	98.4		4.253		34.3		0.29
Jul	223.8		9.991		28.1		0.23
Aug	224.4		10.019		31.5		0.26
Sep	184.4		7.964		28.5		0.24
Oct	77.7		3.470		26.4		0.22
Nov	217.5		9.398		29.7		0.25
Dec	210.9		9.414		27.4		0.23
Average	181.2	Total	95.148	Average	29.39	Average	0.25

[a] Adjusted for planned annual well field shutdowns.
[b] Well 27 was down from February 6 to February 7 for chemical treatment.
Well 27 was down from April 30 to April 2 for chemical treatment and over temperature problems.
Well 27 was down from May 13 to June 18 for annual wellfield shutdown, and cable problem.
Well 27 was down from September 26 to October 21 to replace the variable frequency drive.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-24. Extraction Well 33334 (EW-28a) Operational Summary for 2013

Reference Elevation (ft amsl) – 570.441 (top of casing)
Northing Coordinate ('83) – 479,918.959
Easting Coordinate ('83) – 1,348,686.378

Hours in reporting period – 8,760
Hours not pumped – 948

Hours pumped – 7,812
Operational percent – 89.17
Adjusted operational percent[a] – 98.63

Target pumping rate – 200 gpm

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[b] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[c] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	219.3	9.792	9.40	0.08
Feb	209.4	8.442	9.00	0.08
Mar	217.2	9.695	8.60	0.07
Apr	213.4	9.218	8.50	0.07
May	85.6	3.822	9.30	0.08
Jun	104.5	4.515	11.43	0.10
Jul	222.6	9.937	9.30	0.08
Aug	218.0	9.730	9.60	0.08
Sep	216.3	9.345	9.70	0.08
Oct	221.8	9.901	9.20	0.08
Nov	215.2	9.296	10.00	0.08
Dec	204.3	9.119	9.00	0.08
	Average 195.6	Total 102.812	Average 9.40	Average 0.08

[a] Adjusted for planned annual well field shutdowns.
[b] Well 28a was down from May 13 to June 17 for annual wellfield shutdown.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-25. Extraction Well 33347 (EW-33a) Operational Summary for 2013

Reference Elevation (ft amsl) – 574.86 (top of casing)
Northing Coordinate ('83) – 481,031.762
Easting Coordinate ('83) – 1,346,715.817

Hours in reporting period – 8,760
Hours not pumped – 1,012

Hours pumped – 7,748
Operational percent – 88.45
Adjusted operational percent[a] – 97.83

Target pumping rate – 300 gpm

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[b] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[c] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		327.8		14.632		19.9		0.17
Feb		327.8		13.215		20.1		0.17
Mar		319.3		14.256		20.7		0.17
Apr		322.1		13.916		23.7		0.20
May		127.3		5.681		24.8		0.21
Jun		152.2		6.575		22.4		0.19
Jul		327.8		14.632		23.7		0.20
Aug		318.4		14.211		23.6		0.20
Sep		307.6		13.287		20.9		0.17
Oct		329.1		14.690		20.7		0.17
Nov		328.3		14.183		21.1		0.18
Dec		295.9		13.210		18.4		0.15
	Average	290.3	Total	152.489	Average	21.7	Average	0.18

[a] Adjusted for planned annual well field shutdowns.
[b] Well 33a was down from May 13 to June 17 for annual wellfield shutdown.
Well 33a was down from September 24 to September 26 for environmental sampling.
Well 33a was down from December 17 to December 18 for chemical treatment.
[c] Average is used if more than one concentration measurement is available for a particular month.

Table A.1-26. Regression Equations for Uranium Concentration Data Collected at Extraction Wells—Data Collected Through December 31, 2013

Extraction Well	Database ID	Data Trend	R^2	95% Upper Confidence Level	R^2	Function Type
RW-1	3924	y = 6.53E+04e^-2.05E-04x	0.79	y = 3.01E+03e^-1.04E-04x	0.72	Exponential Function
RW-2	3925	y = 9.089E-07x^2 - 7.400E-02x + 1.522E+03	0.71	y = 9.09E-07x^2 - 7.40E-02x + 1.54E+03	0.71	Polynomial
RW-3	3926	y = -1.76E-06x^2 + 1.36E-01x - 2.59E+03	0.73	y = -1.76E-06x^2 + 1.36E-01x - 2.57E+03	0.73	Polynomial
RW-4	3927	y = 1.33E-02e^1.37E-04x	0.31	y = 4.27E-01e^6.34E-05x	0.26	Exponential Function
RW-6	32308	y = 5.51E+04e^-1.84E-04x	0.86	y = 6.06E+03e^-1.13E-04x	0.85	Exponential Function
RW-7	32309	y = 1.78E+05e^-2.14E-04x	0.88	y = 9.26E+03e^-1.22E-04x	0.85	Exponential Function
EW-15a	33262	y = 3.65E+48x^-1.02E+01	0.78	y = 1.28E+30x^-6.15E+00	0.77	Power Function
EW-17a	33326	y = 8.38E+03e^-1.49E-04x	0.61	y = 1.55E+03e^-9.17E-05x	0.58	Exponential Function
EW-18	31550	y = 1.12E+04e^-1.43E-04x	0.45	y = 2.21E+03e^-8.48E-05x	0.44	Exponential Function
EW-19	31560	y = 8.94E+07e^-3.79E-04x	0.87	y = 4.38E+04e^-1.53E-04x	0.76	Exponential Function
EW-20	31561	y = 3.08E+03e^-1.14E-04x	0.51	y = 1.08E+03e^-7.59E-05x	0.50	Exponential Function
EW-21a	33298	y = 7.83E+05e^-2.45E-04x	0.77	y = 1.76E+04e^-1.27E-04x	0.74	Exponential Function
EW-22	32276	y = 8.79E+08e^-4.26E-04x	0.94	y = 1.37E+05e^-1.69E-04x	0.86	Exponential Function
EW-23	32447	y = 7.12E+07e^-3.51E-04x	0.89	y = 1.25E+05e^-1.66E-04x	0.82	Exponential Function
EW-24	32446	y = 6.44E+04e^-1.82E-04x	0.73	y = 6.70E+03e^-1.10E-04x	0.68	Exponential Function
EW-25	33061	y = 3.97E+04e^-1.76E-04x	0.44	y = 3.49E+03e^-1.02E-04x	0.41	Exponential Function
EW-30	33264	y = 1.04E+09e^-4.19E-04x	0.90	y = 4.13E+05e^-2.01E-04x	0.87	Exponential Function
EW-31	33265	y = 1.51E+06e^-2.86E-04x	0.75	y = 1.49E+04e^-1.53E-04x	0.70	Exponential Function
EW-32	33266	y = 1.63E+10e^-5.33E-04x	0.90	y = 1.57E+05e^-2.16E-04x	0.80	Exponential Function
EW-26	32761	y = 4.30E+08e^-4.08E-04x	0.87	y = 1.45E+05e^-1.81E-04x	0.79	Exponential Function
EW-27	33062	y = 9.75E+08e^-4.26E-04x	0.81	y = 1.47E+05e^-1.75E-04x	0.68	Exponential Function
EW-28a	33334	y = 2.94E+12e^-6.48E-04x	0.88	y = 1.17E+05e^-1.73E-04x	0.66	Exponential Function
EW-33a	33347	y = 3E+61x^-13.05	0.23	y = 1E+30x^-6.141	0.27	Power Function

Table A.1-27. Estimate of Pounds of Uranium to be Removed and Mass Removal Completeness

Year	Estimate of Annual pounds of Uranium To Be Extracted Based on Regression of Concentration Data	Estimate of Annual pounds of Uranium To Be Extracted Based on Model Predictions	Estimate of Annual pounds Uranium To Be Extracted Based on Regression of 95% UCL
2014	430	335	1,375
2015	388	307	1,302
2016	272	276	1,046
2017	245	247	989
2018	221	225	935
2019	199	208	884
2020	180	193	836
2021	163	180	791
2022	148	169	748
2023	135	159	708
2024	123	150	670
Estimate of Total To Be Extracted	2,504	2,449	10,284
Actual Pounds Extracted Through December 23, 2013	11,784	11,784	11,784
Estimate of Total Pounds to be Extracted	14,288	14,233	22,068

Year	Estimate of Mass Removal Completeness Based on Concentration Data	Estimate of Mass Removal Completeness Based on Model Predictions	Estimate of Mass Removal Completeness Based on 95% UCL of Concentration Data
2013	83	83	53
2012	77	80	47
2011	76	77	45
2010	75	74	43
2009	72	70	41
2008	69	66	39
2007	66	61	37
2006	59	55	33

Notes: Highlighting indicates years when modeled cleanup predictions are more optimistic than measured concentration data indicates

Table A.1-28. Model Predicted Versus Actual Uranium Concentrations at Extraction Wells

Extraction Well	Model Trend Compared to Actual Data Trend	Model Concentration December 2013	Actual Concentration December 2013	Residual Actual Model
3924 (RW-1)	Lower	6.26	15.5	9.24
3925 (RW-2)	Higher to Lower	9.98	13.4	3.42
3926 (RW-3)	Lower	9.6	23.3	13.7
3927 (RW-4)	Higher to Lower	3.62	2.7	-0.92
32308 (RW-6)	Lower	17.98	29.9	11.92
32309 (RW-7)	Lower	18.08	25.8	7.72
33262 (EW-15a)	Lower to Higher	14.74	21.8	7.06
33326 (EW-17a)	Lower to Higher	15.82	16.5	0.68
31550 (EW-18)	Lower	16.65	33.2	16.55
31560 (EW-19)	Lower to Higher	13.84	14.8	0.96
31561 (EW-20)	Lower	21.44	26.8	5.36
33298 (EW-21a)	Lower	19.31	31.0	11.69
32276 (EW-22)	Lower	16.65	25.3	8.65
32447 (EW-23)	Lower	17.25	44.0	26.75
32446 (EW-24)	Lower	13.84	36.9	23.06
33061 (EW-25)	Lower	19.31	22.9	3.59
33264 (EW-30)	Higher to Lower	16.65	29.9	13.25
33265 (EW-31)	Lower to Higher	4.59	10.4	5.81
33266 (EW-32)	Lower	1.94	4.3	2.36
32761 (EW-26)	Lower to Higher	29.04	21.2	-7.84
33062 (EW-27)	Lower	23.32	27.4	4.08
33334 (EW-28a)	Lower to Higher	13.96	9.0	-4.96
33347 (EW-33a)	Higher	35.94	18.4	-17.54
	Average	15.64	21.9	6.29
	Standard Deviation	7.83	10.3	9.60
	Maximum	35.94	44.0	26.75
	Minimum	1.94	2.7	-17.54
	Range	34.00	41.3	44.29

Table A.1-29. Additional Analysis—Regression Equations for Extraction Wells with Uranium Concentrations above 30 µg/L

Extraction Well	Database ID	Data Trend	R^2	95% UCL	R^2	Function Type
RW-6	32308	y = -4.89E-03x + 2.32E+02	0.63	y = -4.89E-03x + 2.63E+02	0.63	Linear
EW-18	31550	y = -1.70E-03x + 1.07E+02	0.89	y = -1.70E-03x + 1.46E+02	0.89	Linear
EW-21a	33298	y = 3.60E+04e^-1.66E-04x	0.35	y = 1.53E+03e^-6.50E-05x	0.34	Exponential Function
EW-23	32447	y = 3.75E+05e^-2.19E-04x	0.81	y = 4.17E+03e^-8.05E-05x	0.85	Exponential Function
EW-24	32446	y = 9.08E+03e^-1.33E-04x	0.75	y = 1.67E+03e^-7.44E-05x	0.75	Exponential Function
EW-30	33264	y = -1.03E-02x + 4.60E+02	0.52	y = -1.03E-02x + 5.34E+02	0.52	Linear

Table A.1-30. Additional Estimate of Pounds of Uranium to be Removed and Mass Removal Completeness

Year	Estimate of Annual Pounds of Uranium To Be Extracted Based on Regression of Concentration Data (lb)	Estimate of Annual Pounds of Uranium To Be Extracted Based on Model Predictions (lb)	Estimate of Annual Pounds Uranium To Be Extracted Based on Regression of 95% UCL
2014	460	335	1,443
2015	420	307	1,380
2016	304	276	1,126
2017	277	247	1,076
2018	253	225	1,029
2019	230	208	984
2020	210	193	941
2021	191	180	900
2022	174	169	861
2023	158	159	824
2024	143	150	789
Estimate of Total To Be Extracted	2,821	2,449	11,354
Actual Pounds Extracted Through December 31, 2013	11,784	11,784	11,784
Estimate of Total Pounds to be Extracted	14,605	14,233	23,138

Year	Estimate of Mass Removal Completeness Based on Concentration Data	Estimate of Mass Removal Completeness Based on Model Predictions	Estimate of Mass Removal Completeness Based on 95% UCL of Concentration Data
2013	81	83	51

Table A.1-31. Extraction Well Target Pumping Rates

Module	Extraction Well	January 1 to December 31 (gpm)
South Plume	3924 (RW-1)	200
	3925 (RW-2)	200
	3926 (RW-3)	200
	3927 (RW-4)	200
	32308 (RW-6)	200
	32309 (RW-7)	200
Subtotal		1,200
Waste Storage Area	32761 (EW-26)	300
	33062 (EW-27)	200
	33334 (EW-28a)	200
	33347 (EW-33a)	300
Subtotal		1,000
South Field Extraction	31550 (EW-18)	100
	31560 (EW-19)	100
	31561 (EW-20)	100
	33298 (EW-21a)	200
	33326 (EW-17a)	175
	32276 (EW-22)	300
	32446 (EW-24)	300
	32447 (EW-23)	300
	33061 (EW-25)	100
	33264 (EW-30)	200
	33265 (EW-31)	300
	33266 (EW-32)	200
	33262 (EW-15a)	200
Subtotal		2,575
Total Pumping		4,775

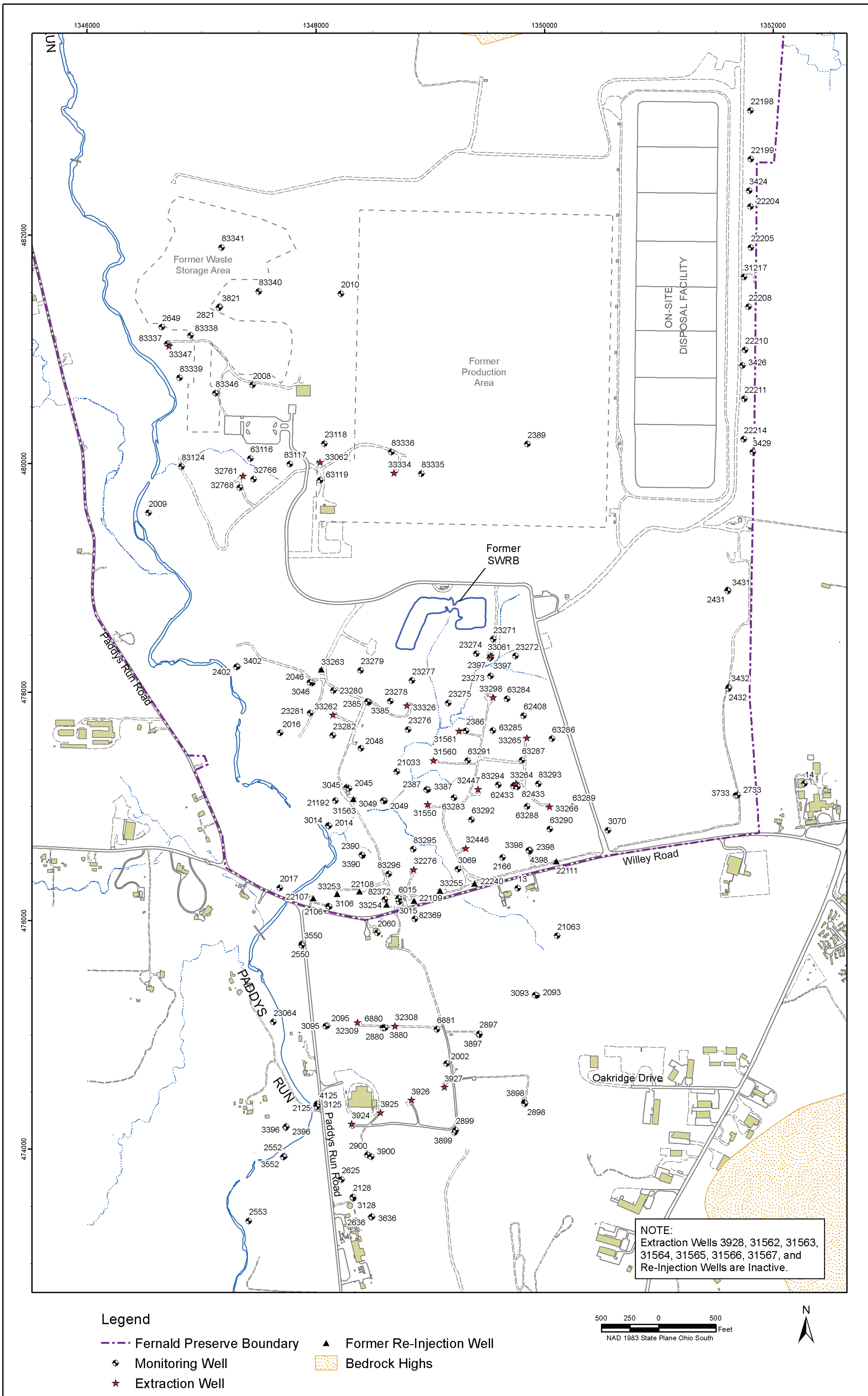

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Figure A.1-1. Well Locations for South Plume, South Field, Waste Storage Area, and PRRS Monitoring Activities

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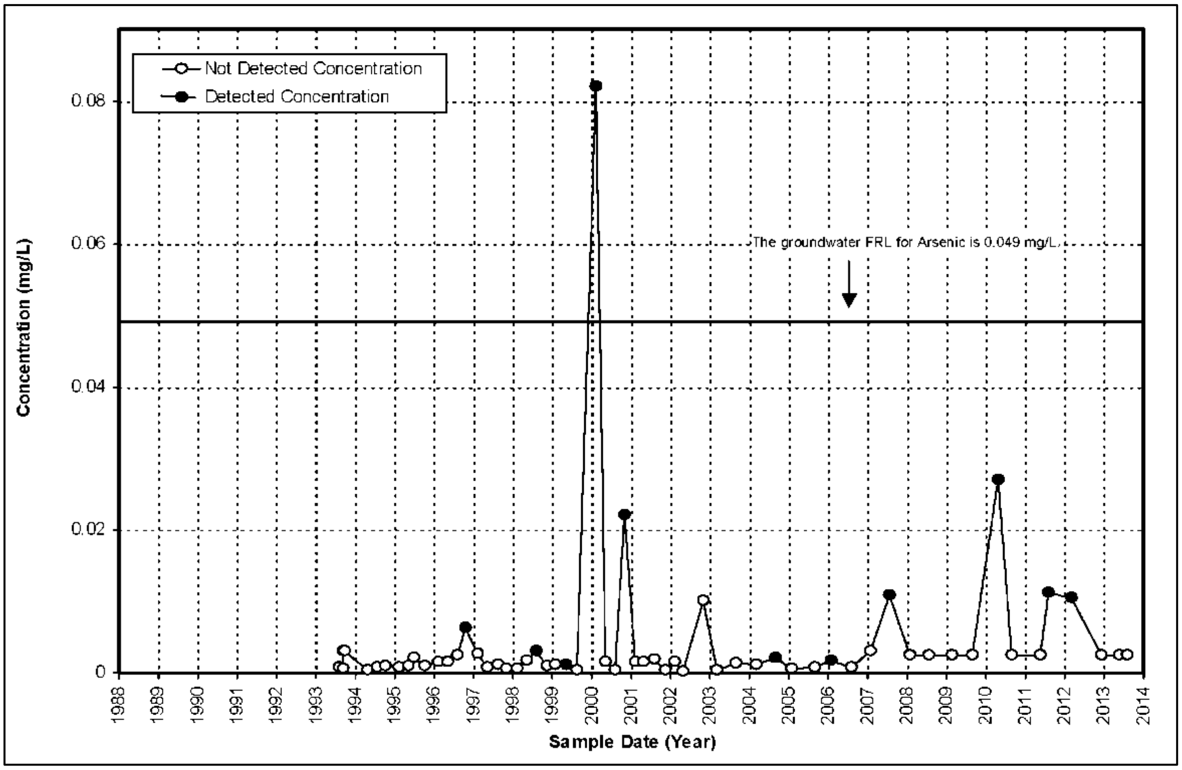

Figure A.1-2. Arsenic Concentration Versus Time Plot for Monitoring Well 2898

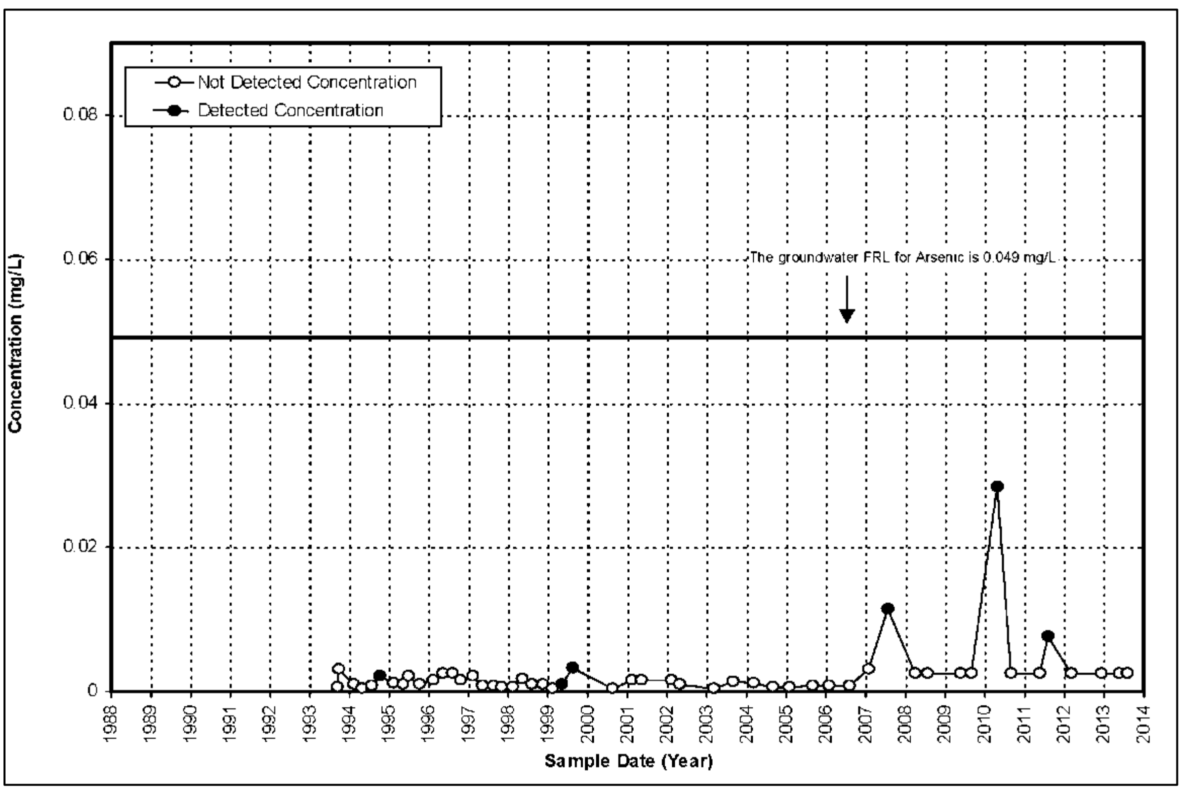

Figure A.1-3. Arsenic Concentration Versus Time Plot for Monitoring Well 2899

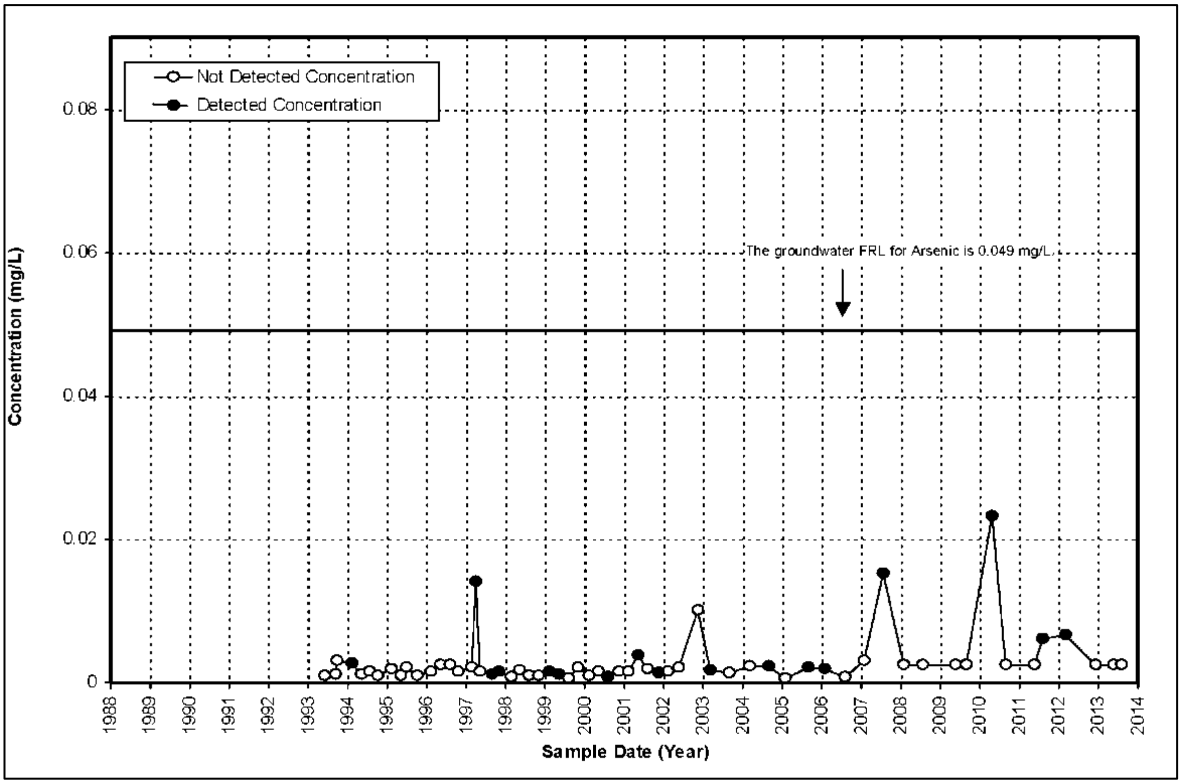

Figure A.1-4. Arsenic Concentration Versus Time Plot for Monitoring Well 3636

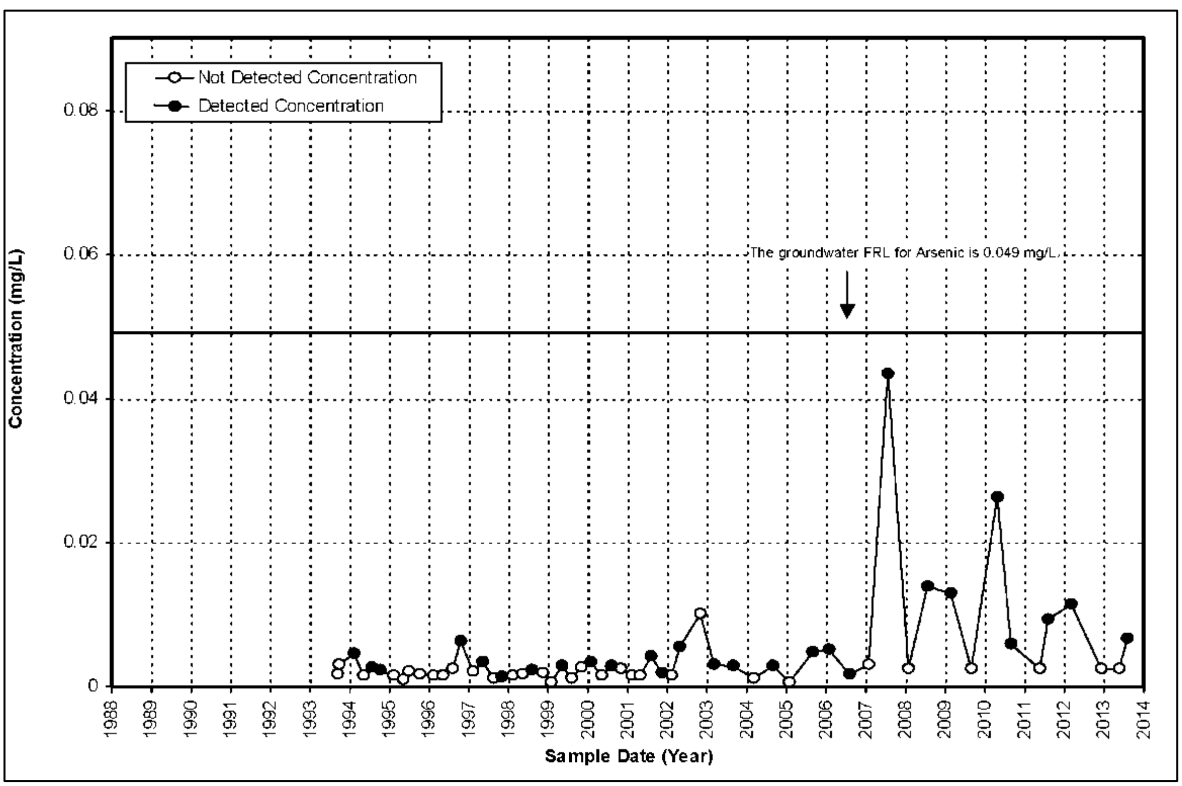

Figure A.1-5. Arsenic Concentration Versus Time Plot for Monitoring Well 3898

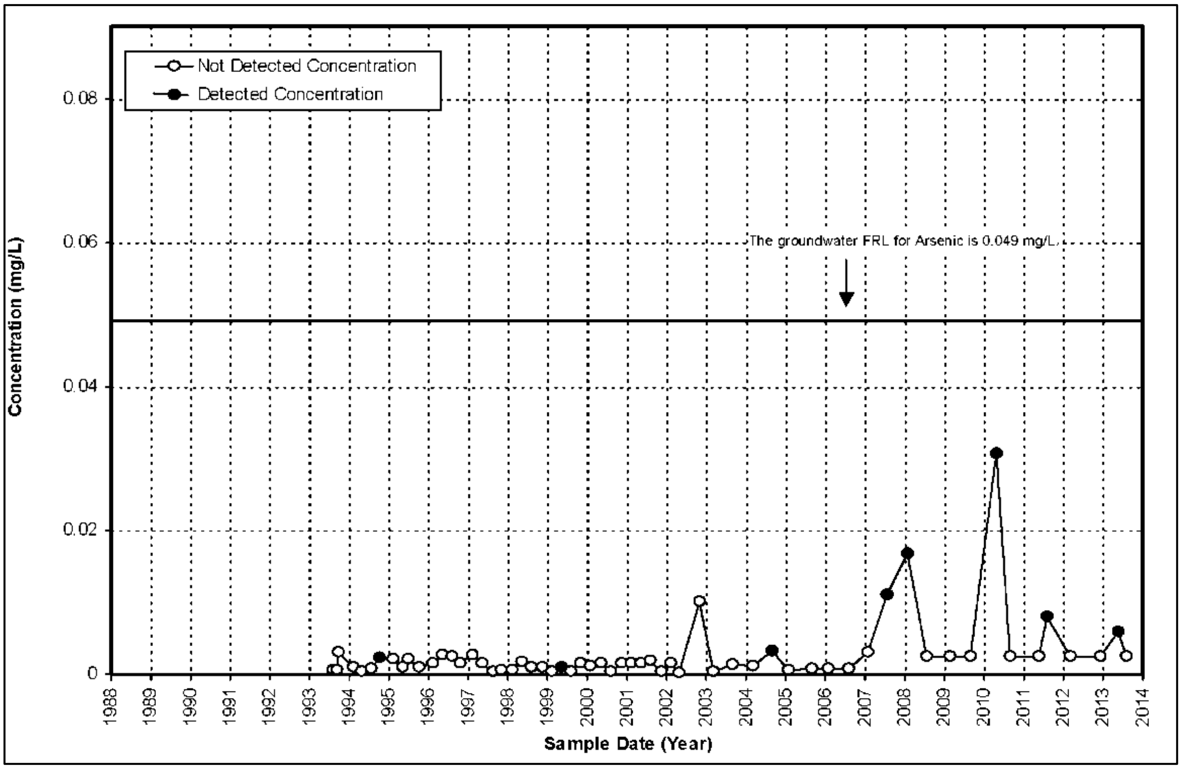

Figure A.1-6. Arsenic Concentration Versus Time Plot for Monitoring Well 3899

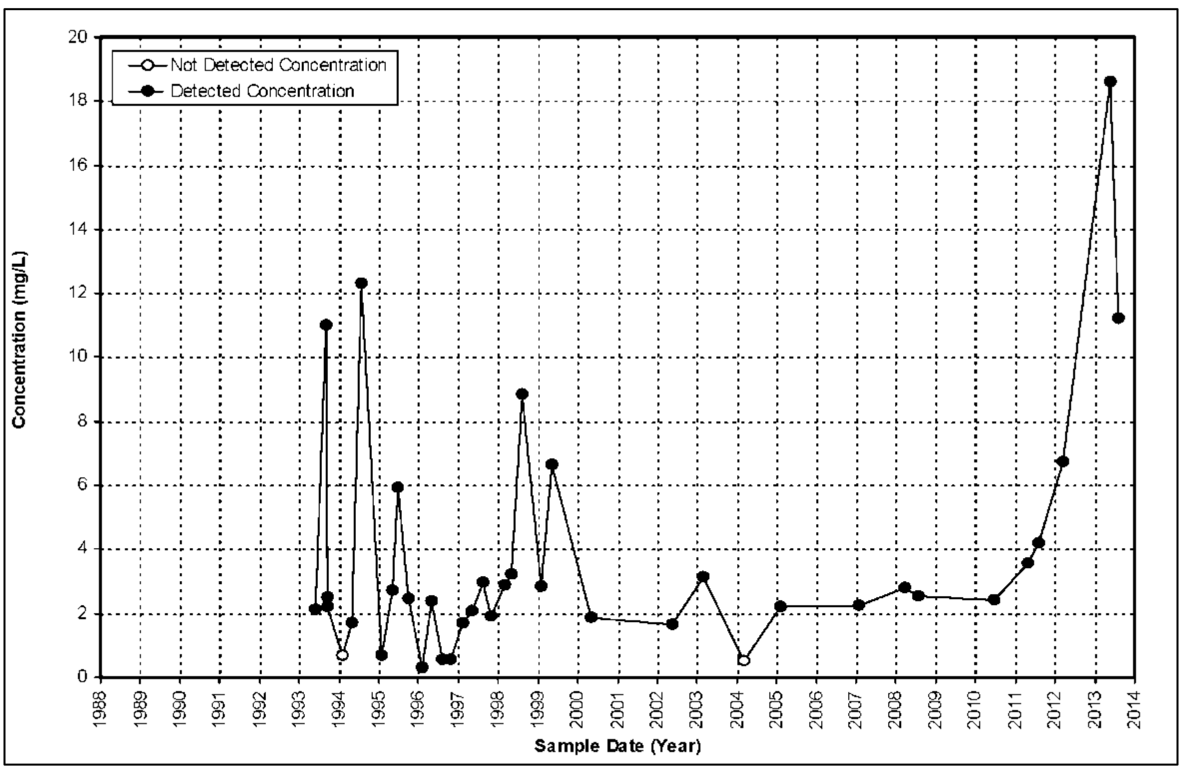

Figure A.1-7. Phosphorous Concentration Versus Time Plot for Monitoring Well 2625

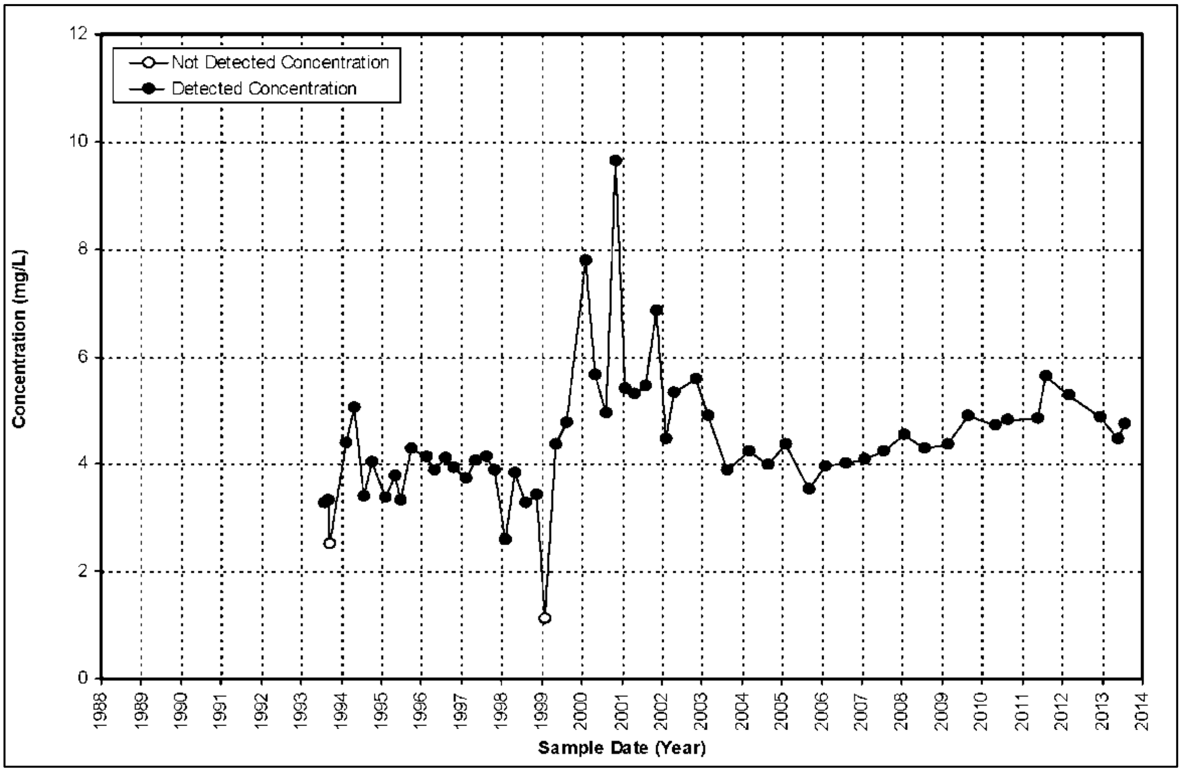

Figure A.1-8. Potassium Concentration Versus Time Plot for Monitoring Well 2898

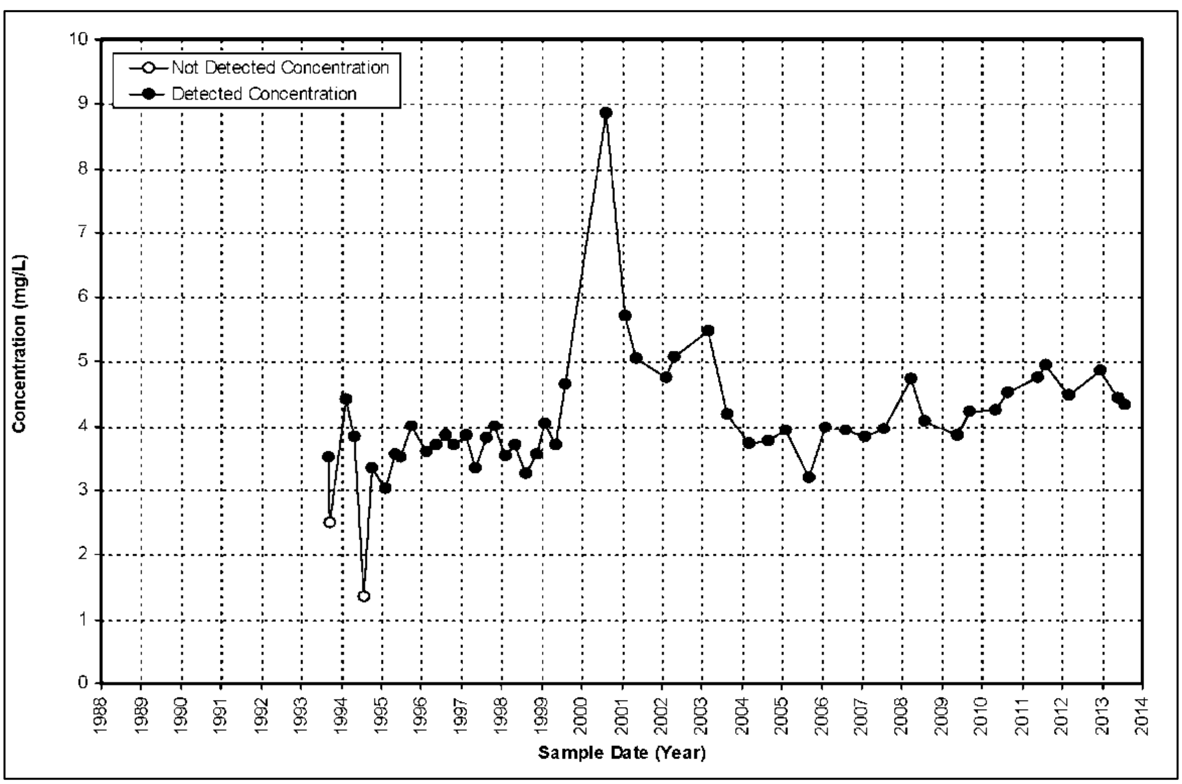

Figure A.1-9. Potassium Concentration Versus Time Plot for Monitoring Well 2899

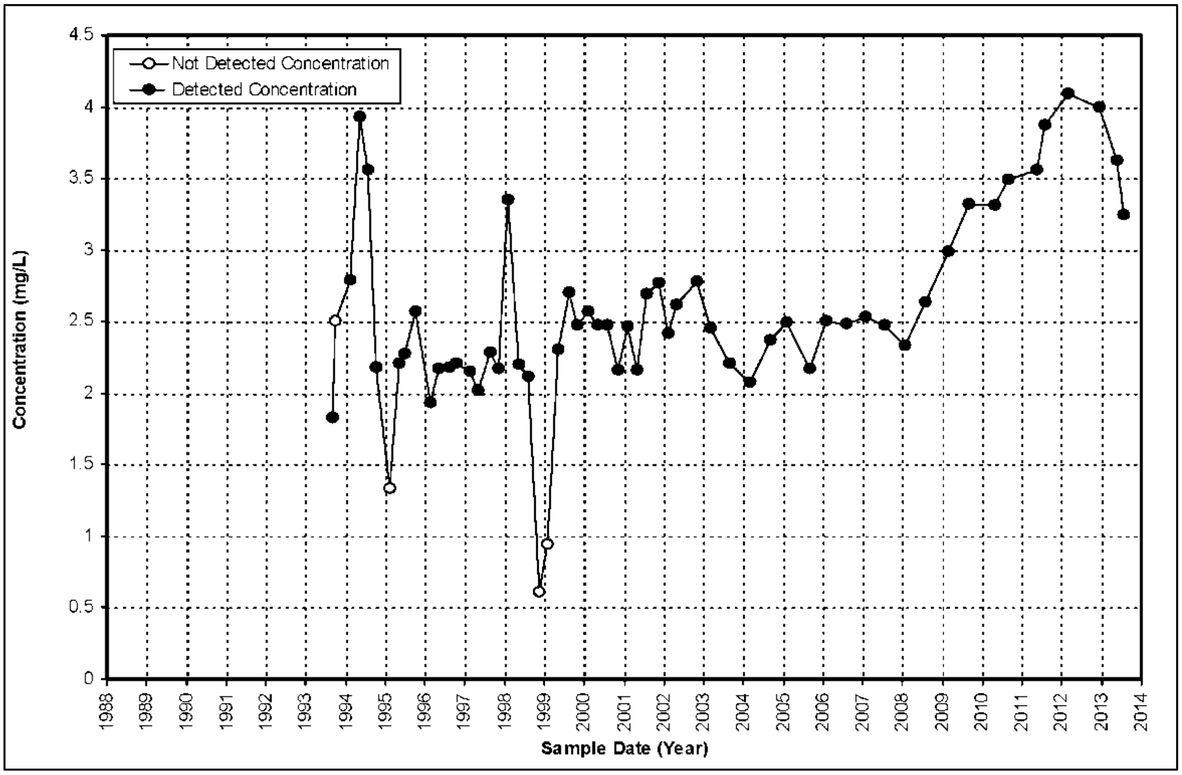

Figure A.1-10. Potassium Concentration Versus Time Plot for Monitoring Well 3898

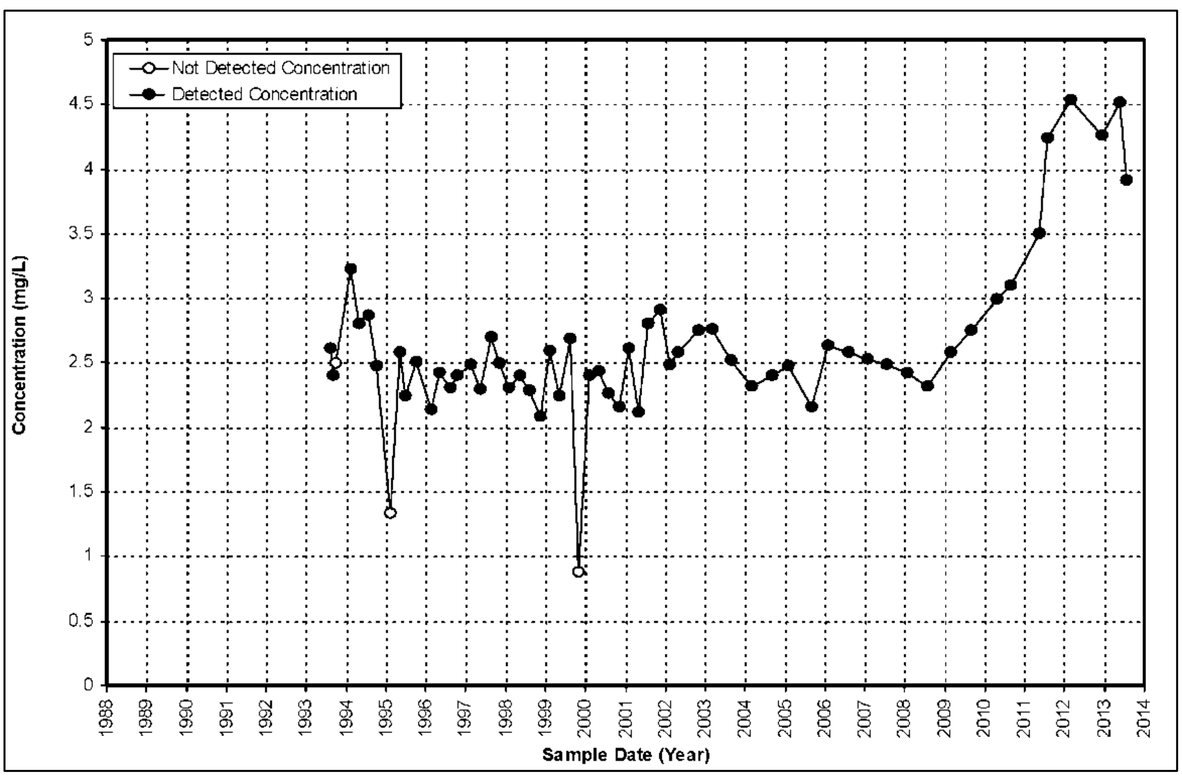

Figure A.1-11. Potassium Concentration Versus Time Plot for Monitoring Well 3899

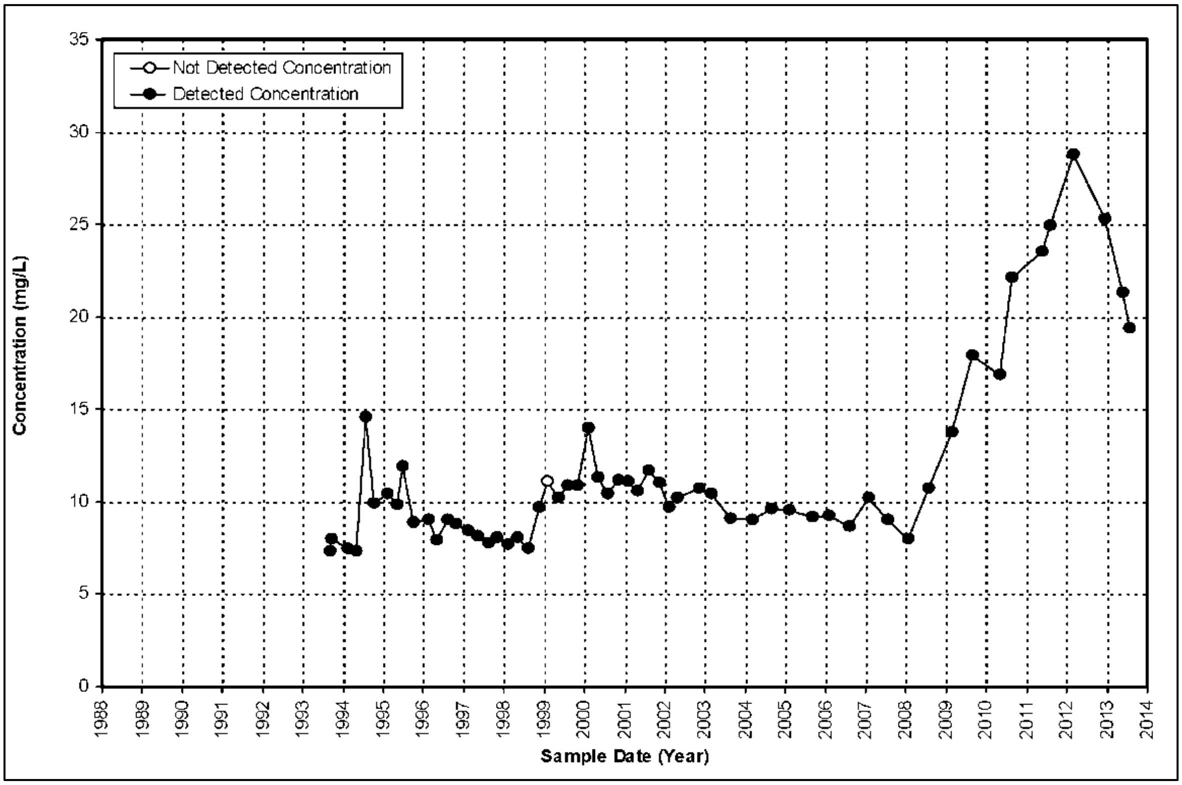

Figure A.1-12. Sodium Concentration Versus Time Plot for Monitoring Well 3898

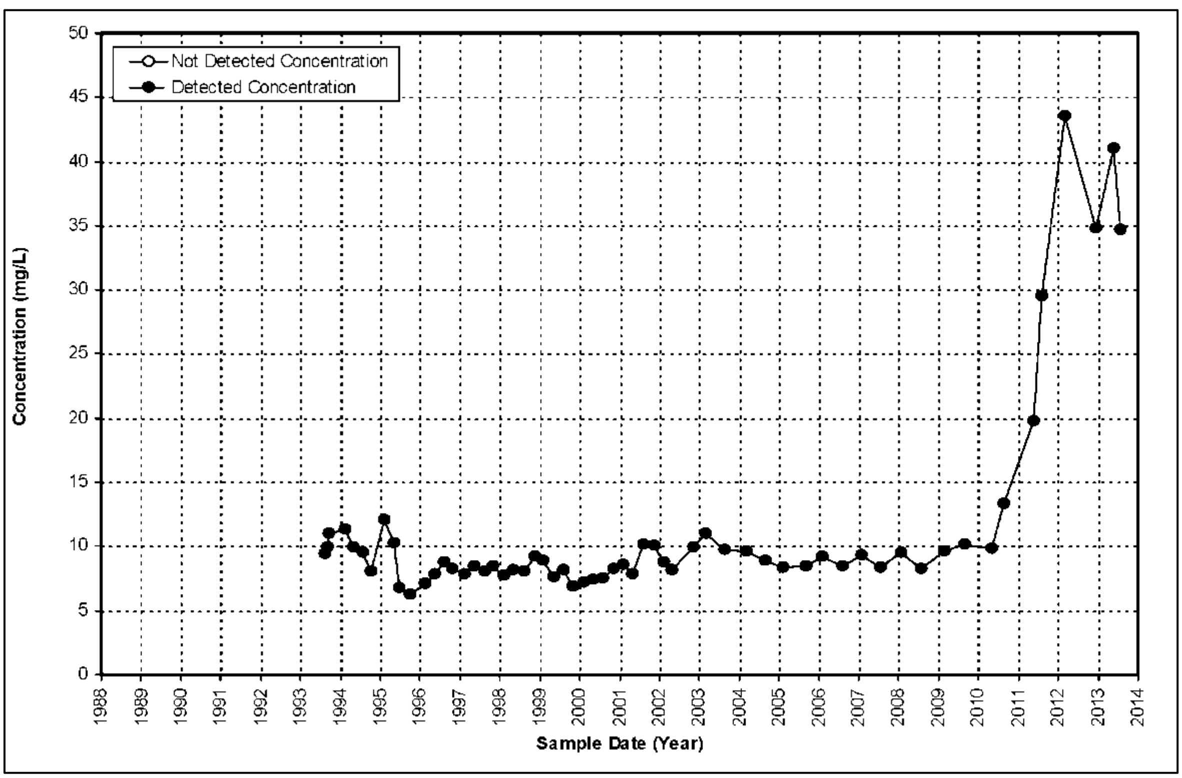

Figure A.1-13. Sodium Concentration Versus Time Plot for Monitoring Well 3899

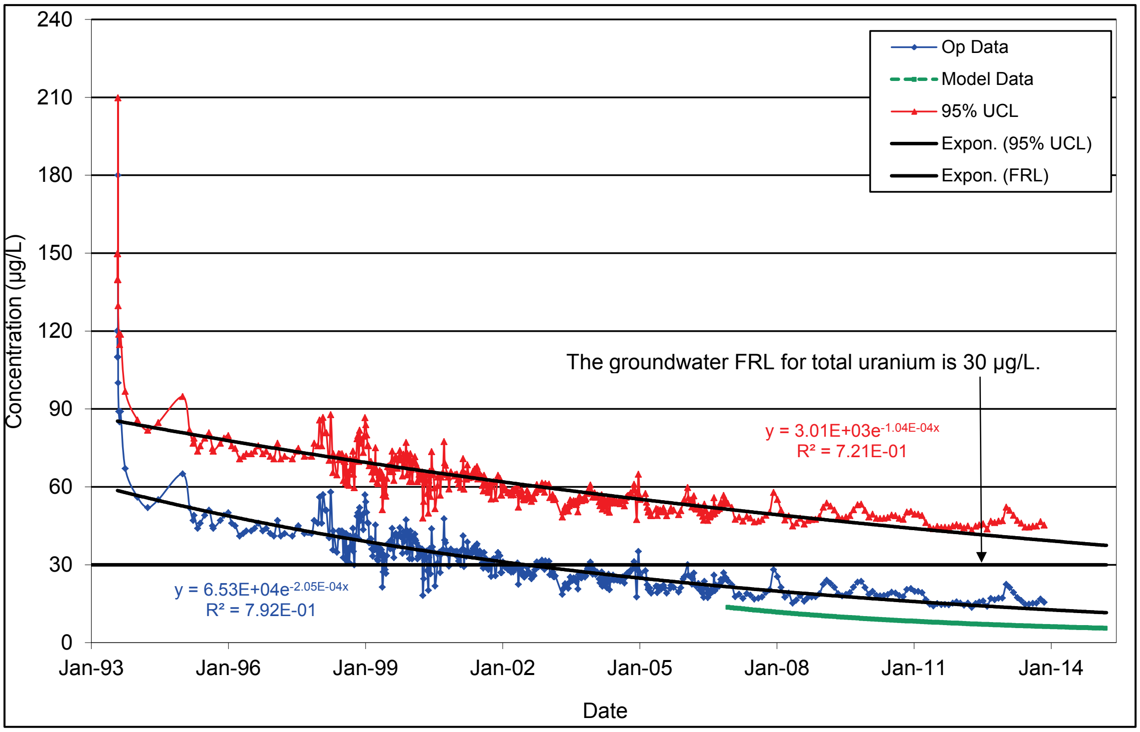

Figure A.1-14. Total Uranium Concentration Versus Time Plot for Extraction Well 3924 (RW-1) with Regression Analysis

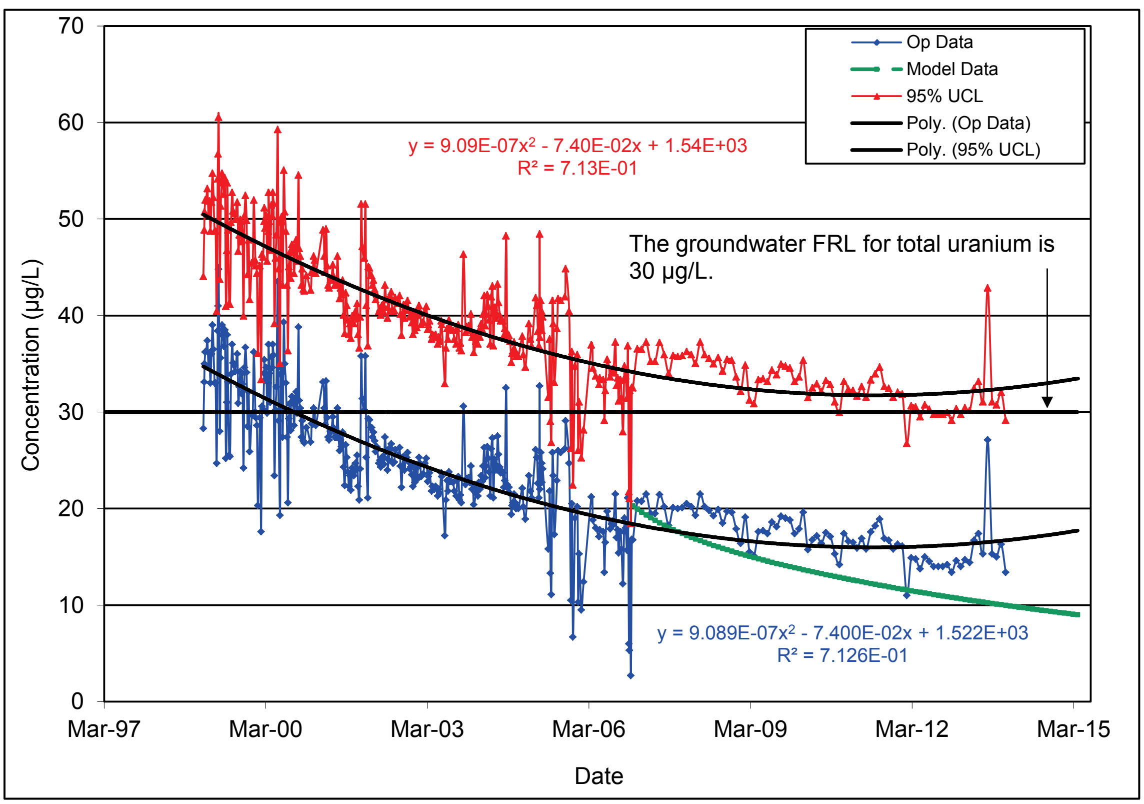

Figure A.1-15. Total Uranium Concentration Versus Time Plot for Extraction Well 3925 (RW-2) with Regression Analysis

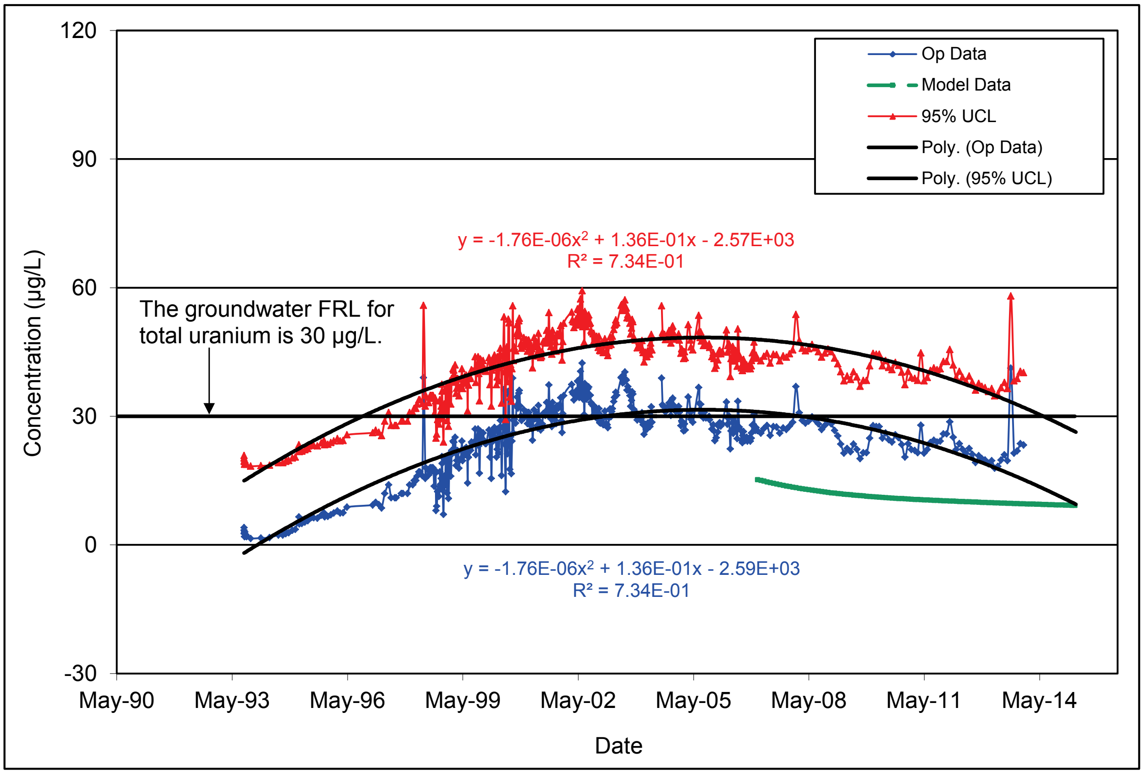

Figure A.1-16. Total Uranium Concentration Versus Time Plot for Extraction Well 3926 (RW-3) with Regression Analysis

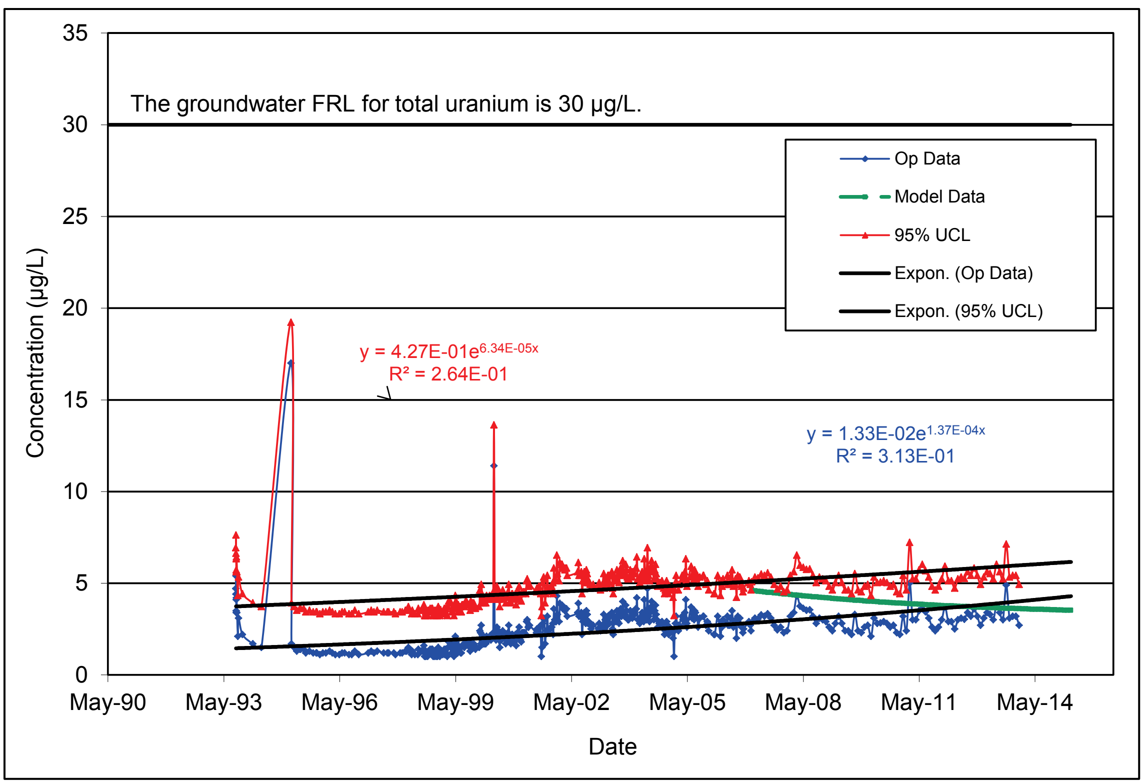

Figure A.1-17. Total Uranium Concentration Versus Time Plot for Extraction Well 3927 (RW-4) with Regression Analysis

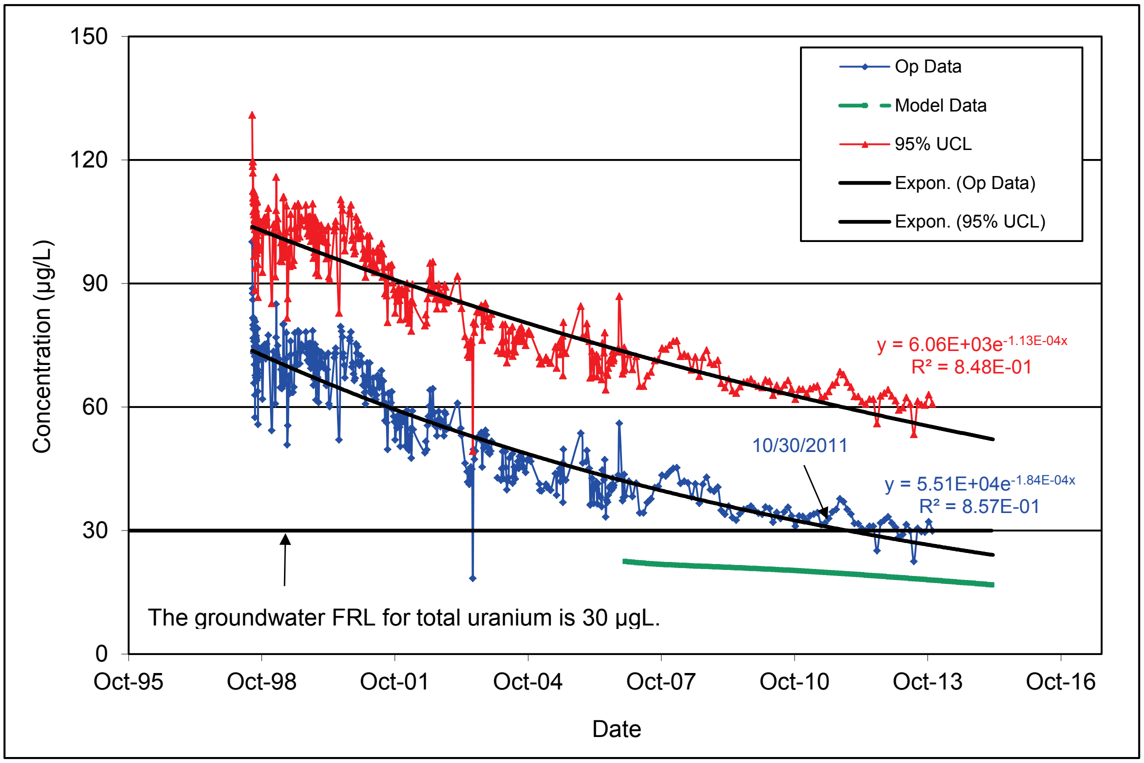

Figure A.1-18. Total Uranium Concentration Versus Time Plot for Extraction Well 32308 (RW-6) with Regression Analysis

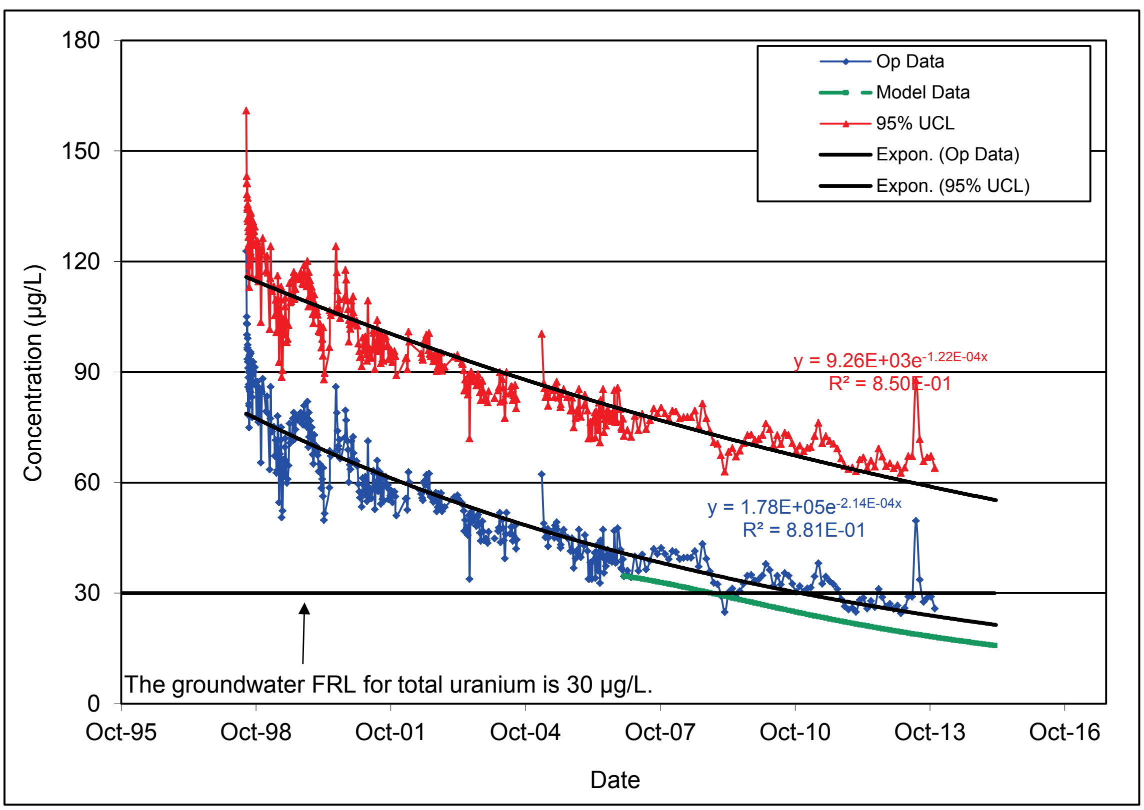

Figure A.1-19. Total Uranium Concentration Versus Time Plot for Extraction Well 32309 (RW-7) with Regression Analysis

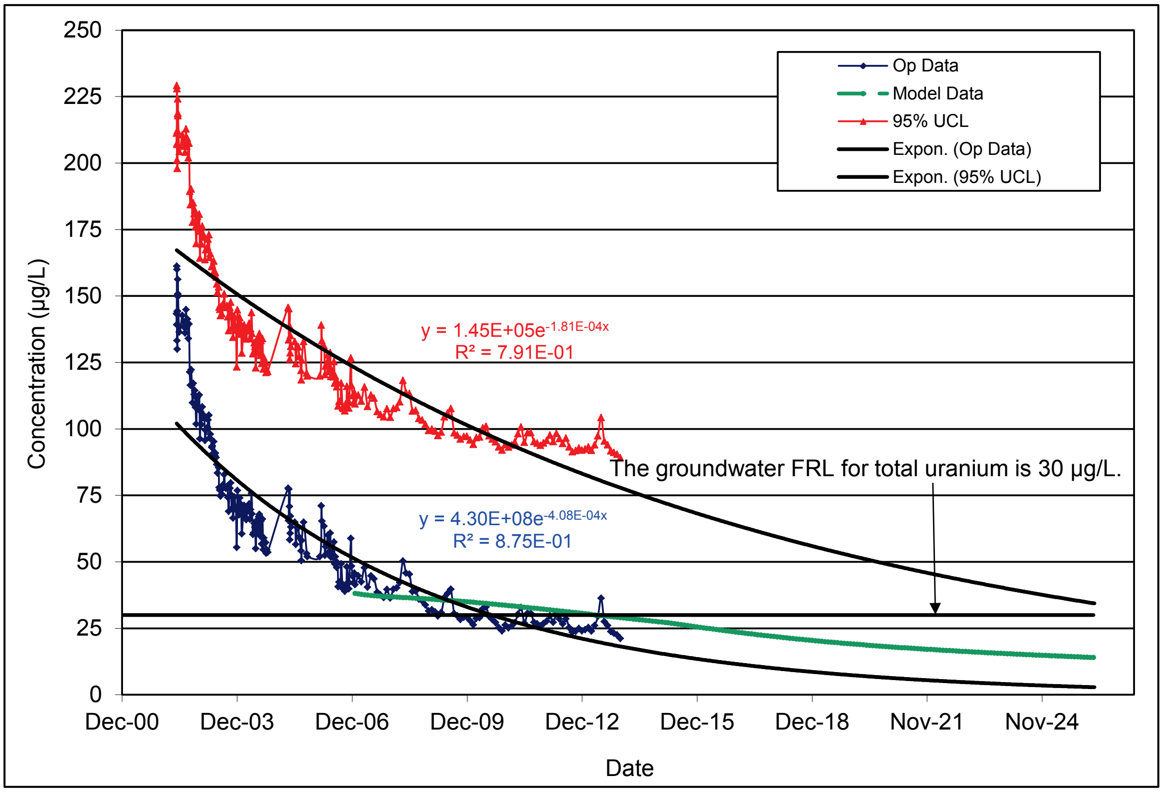

Figure A.1-20. Total Uranium Concentration Versus Time Plot for Extraction Well 32761 (EW-26) with Regression Analysis

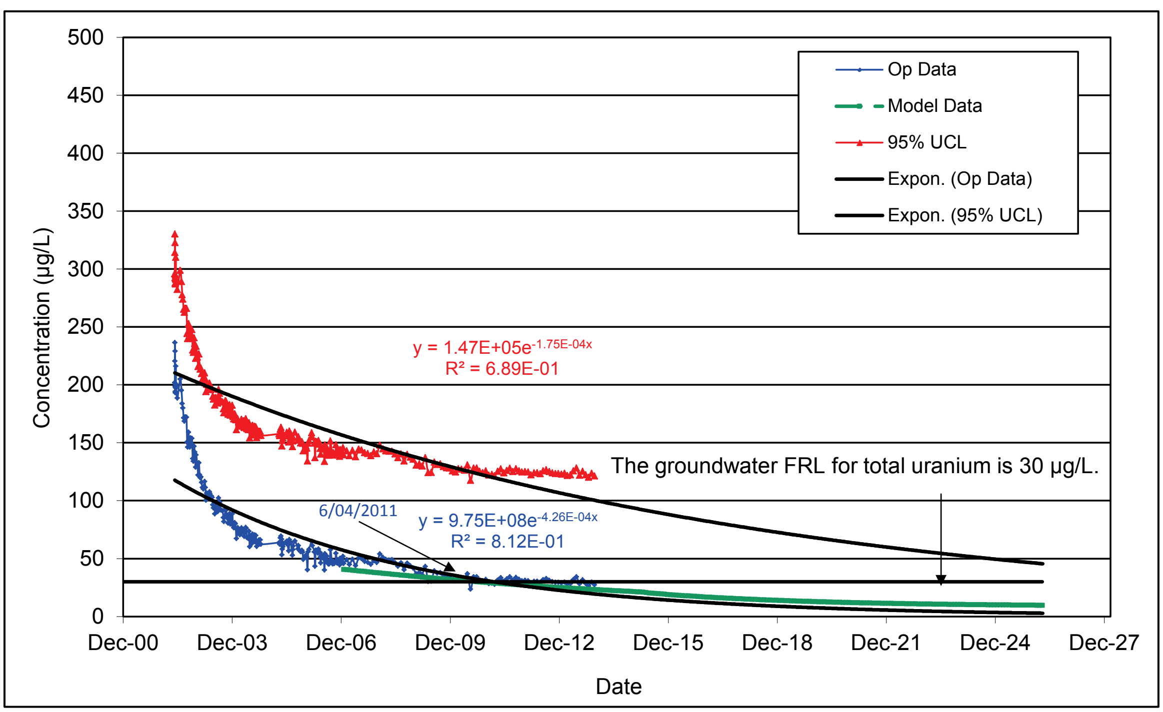

Figure A.1-21. Total Uranium Concentration Versus Time Plot for Extraction Well 33062 (EW-27) with Regression Analysis

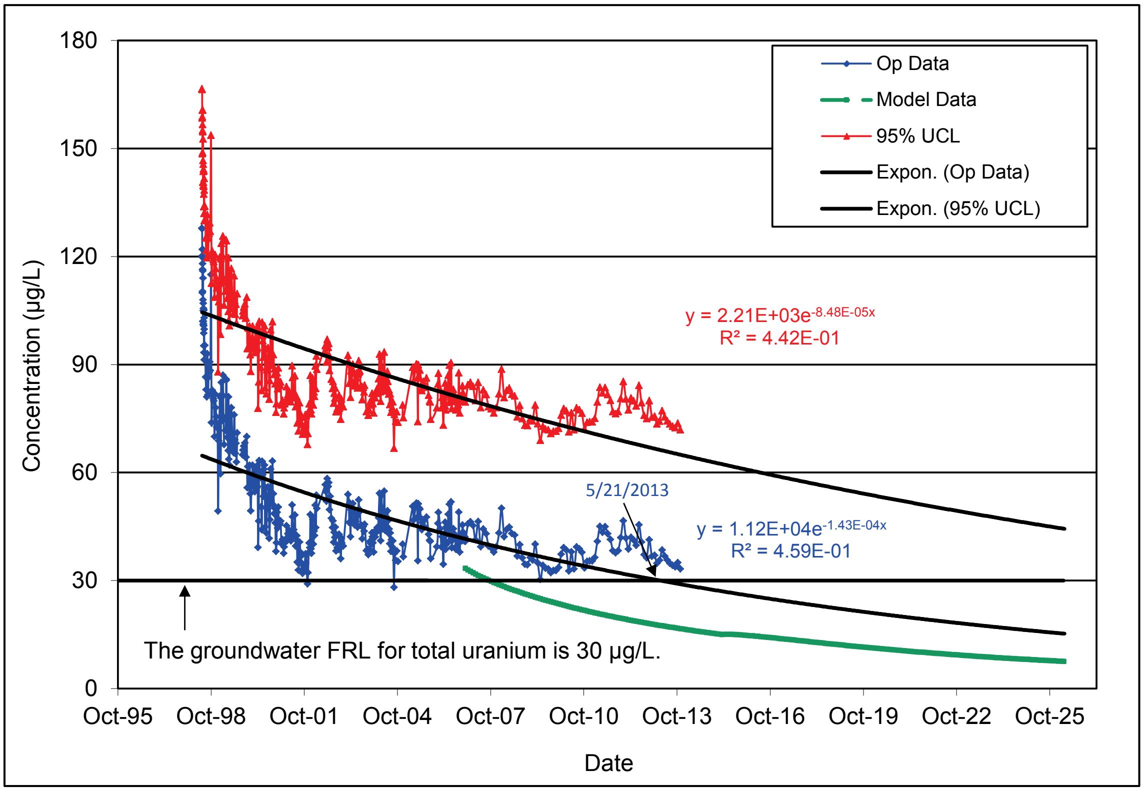

Figure A.1-22. Total Uranium Concentration Versus Time Plot for Extraction Well 31550 (EW-18) with Regression Analysis

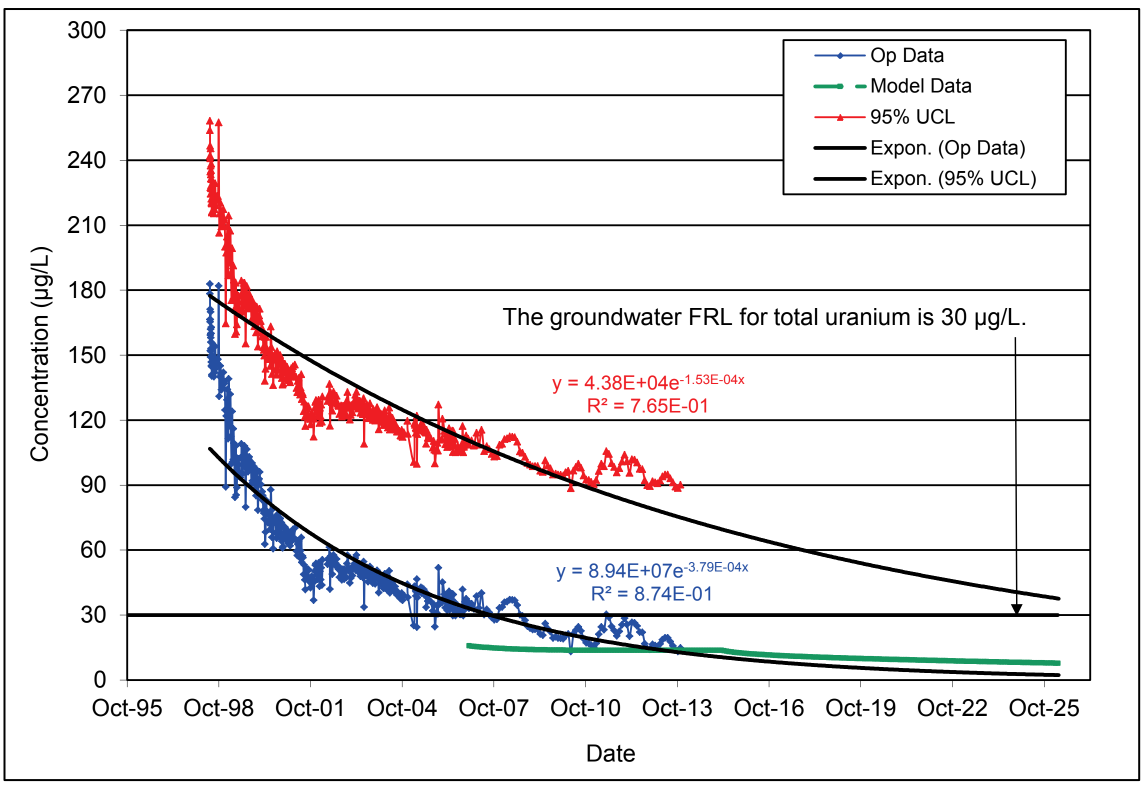

Figure A.1-23. Total Uranium Concentration Versus Time Plot for Extraction Well 31560 (EW-19) with Regression Analysis

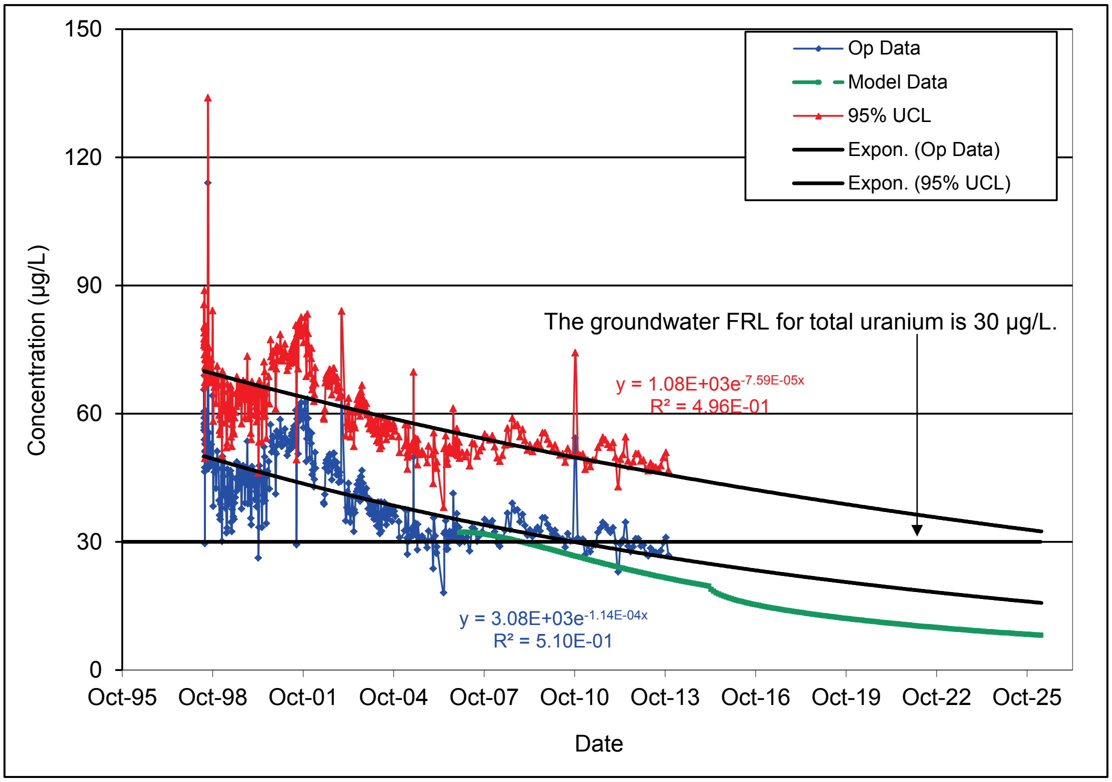

Figure A.1-24. Total Uranium Concentration Versus Time Plot for Extraction Well 31561 (EW-20) with Regression Analysis

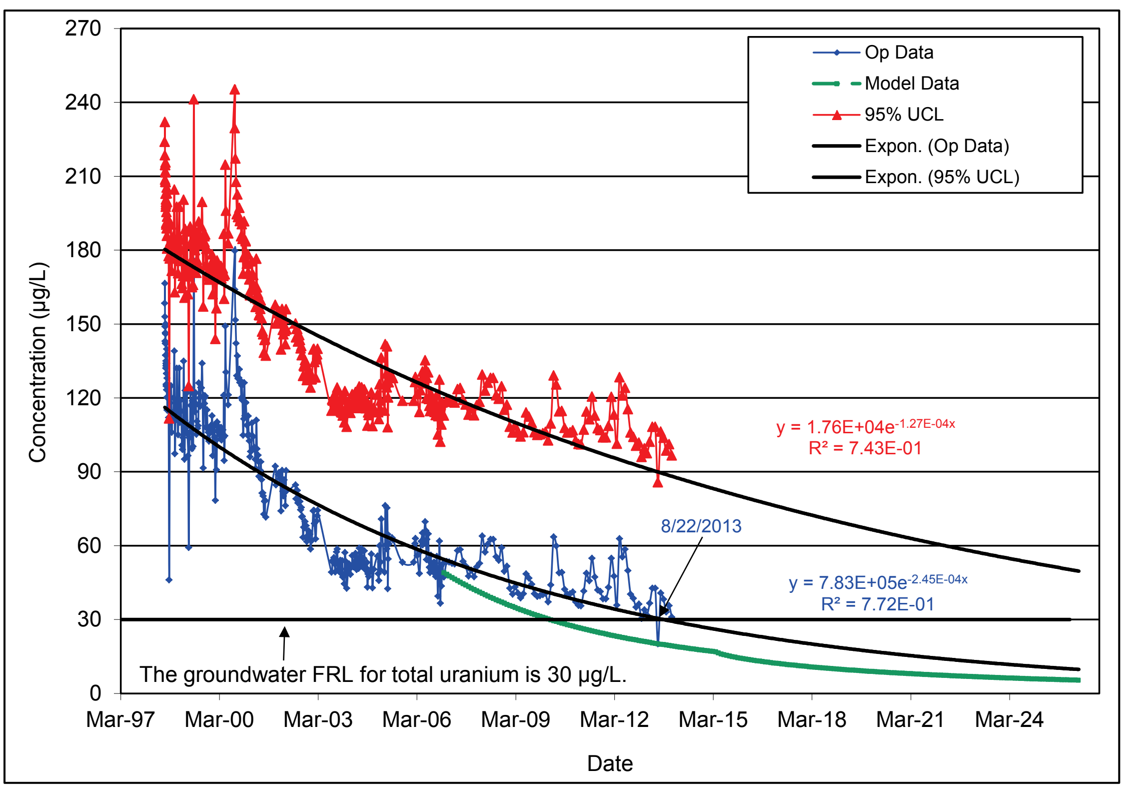

Figure A.1-25. Total Uranium Concentration Versus Time Plot for Extraction Well 31562 (EW-21)/33298 (EW-21a) with Regression Analysis

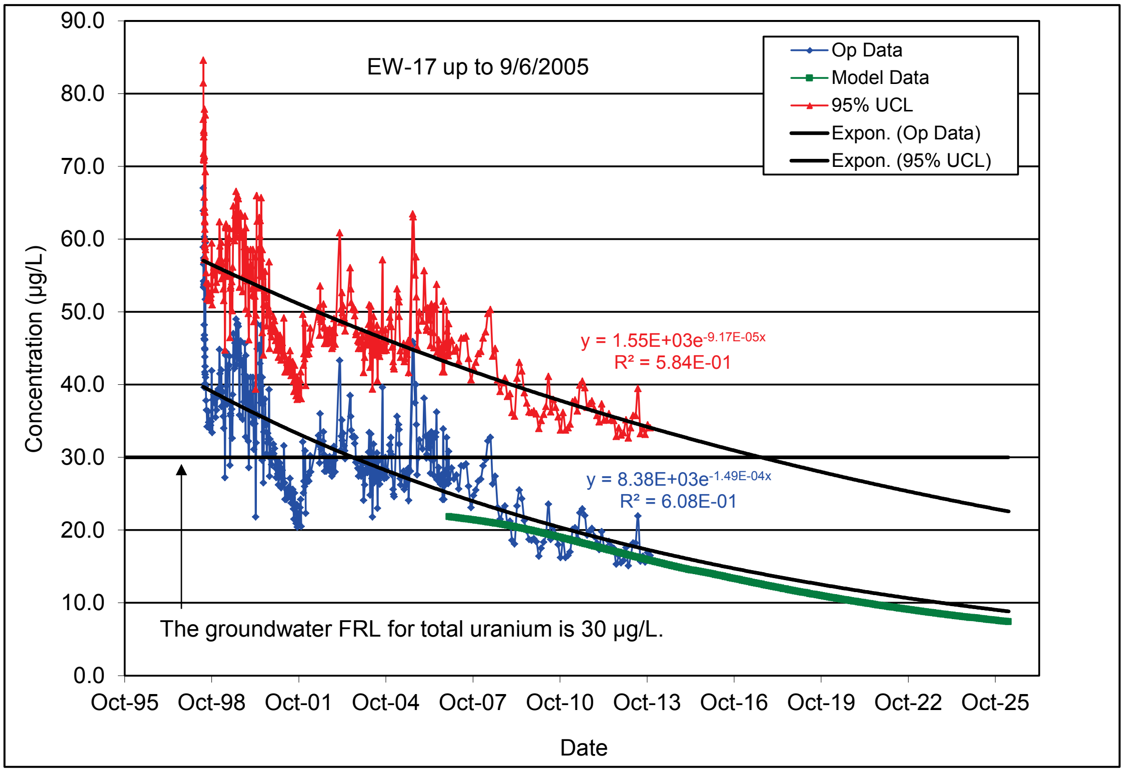

Figure A.1-26. Total Uranium Concentration Versus Time Plot for Extraction Well 31567 (EW-17)/33326 (EW-17a) with Regression Analysis

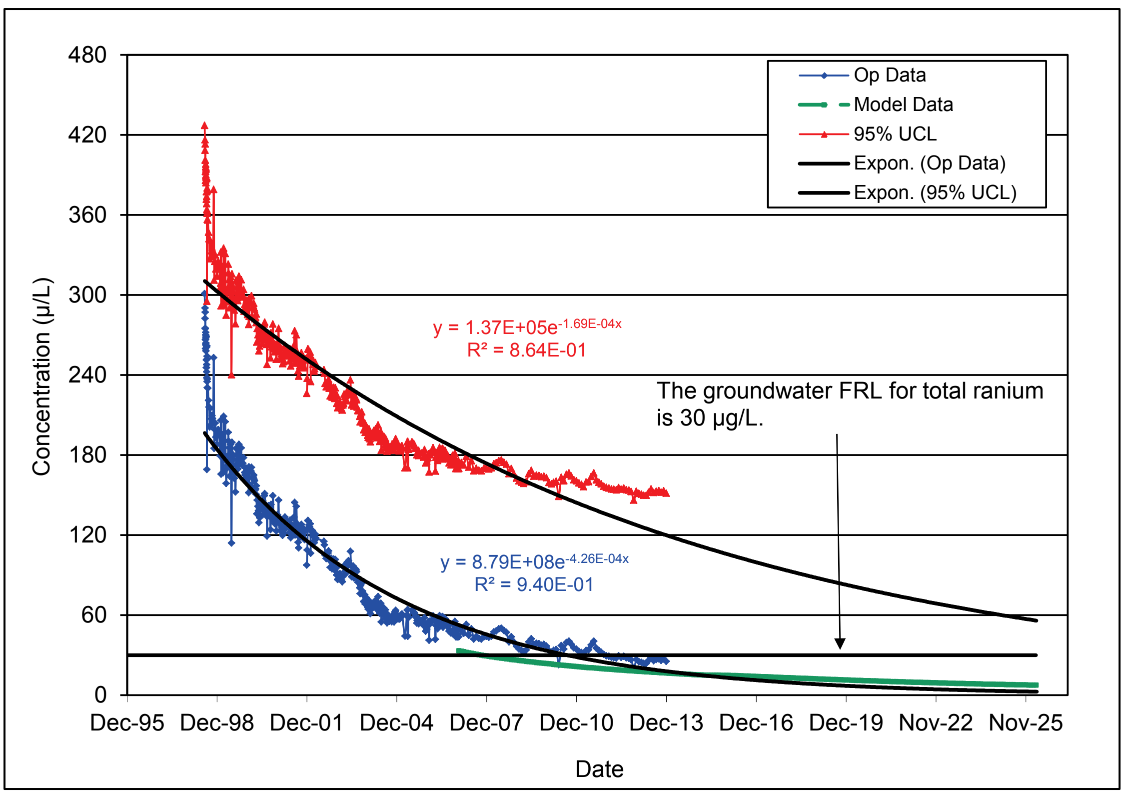

Figure A.1-27. Total Uranium Concentration Versus Time Plot for Extraction Well 32276 (EW-22) with Regression Analysis

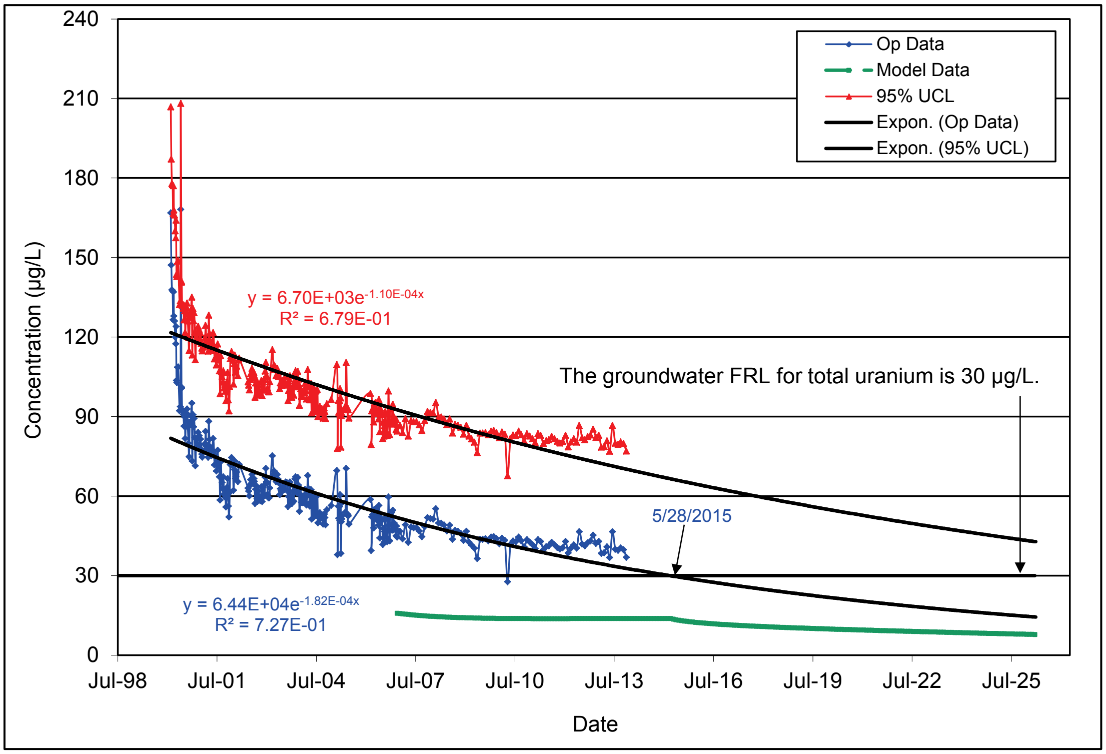

Figure A.1-28. Total Uranium Concentration Versus Time Plot for Extraction Well 32446 (EW-24) with Regression Analysis

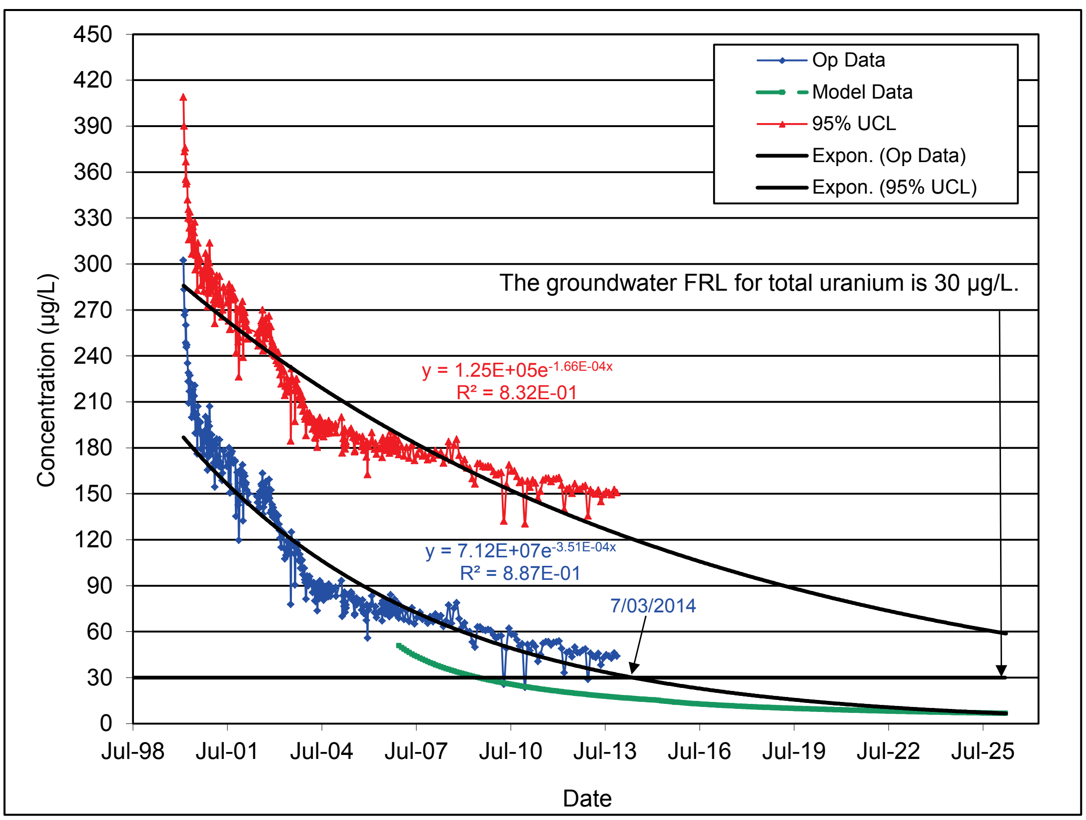

Figure A.1-29. Total Uranium Concentration Versus Time Plot for Extraction Well 32447 (EW-23) with Regression Analysis

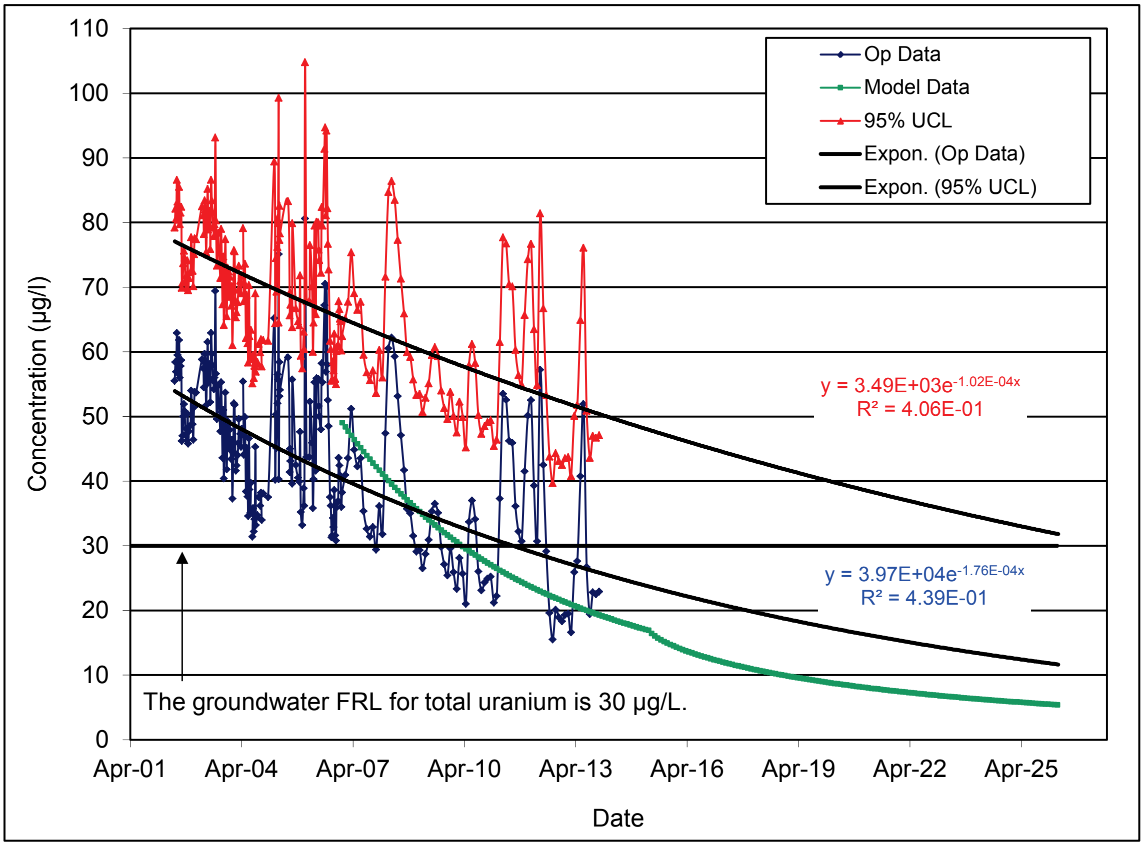

Figure A.1-30. Total Uranium Concentration Versus Time Plot for Extraction Well 33061 (EW-25) with Regression Analysis

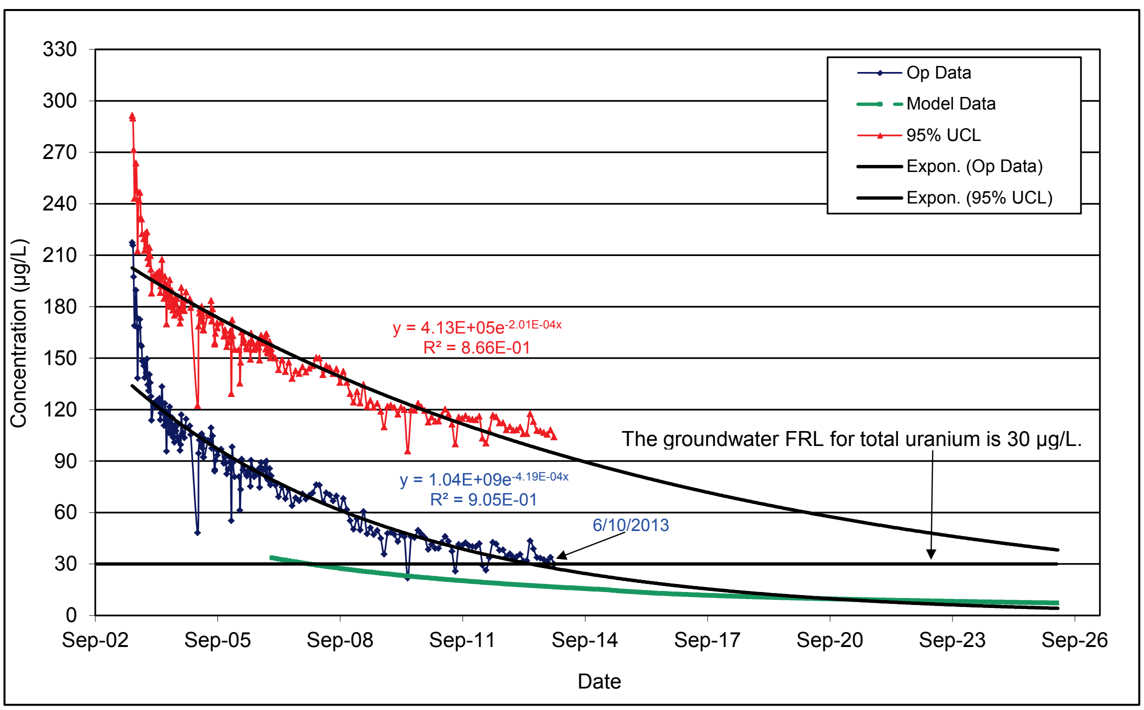

Figure A.1-31. Total Uranium Concentration Versus Time Plot for Extraction Well 33264 (EW-30) with Regression Analysis

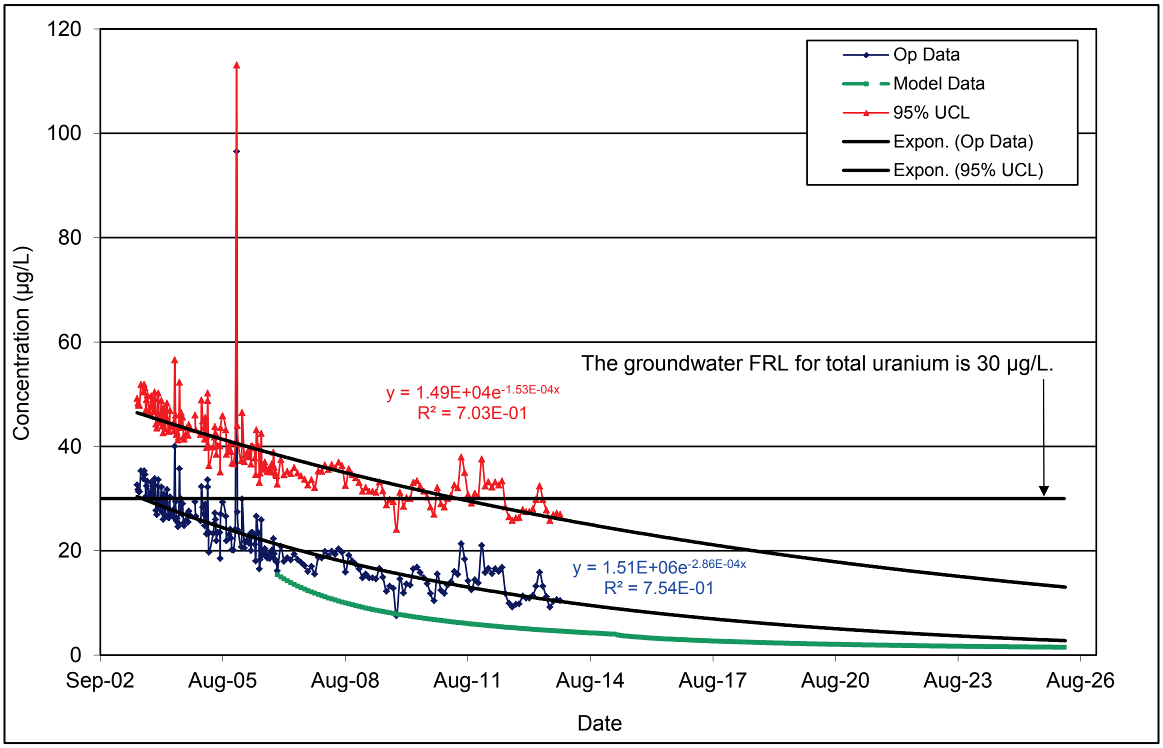

Figure A.1-32. Total Uranium Concentration Versus Time Plot for Extraction Well 33265 (EW-31) with Regression Analysis

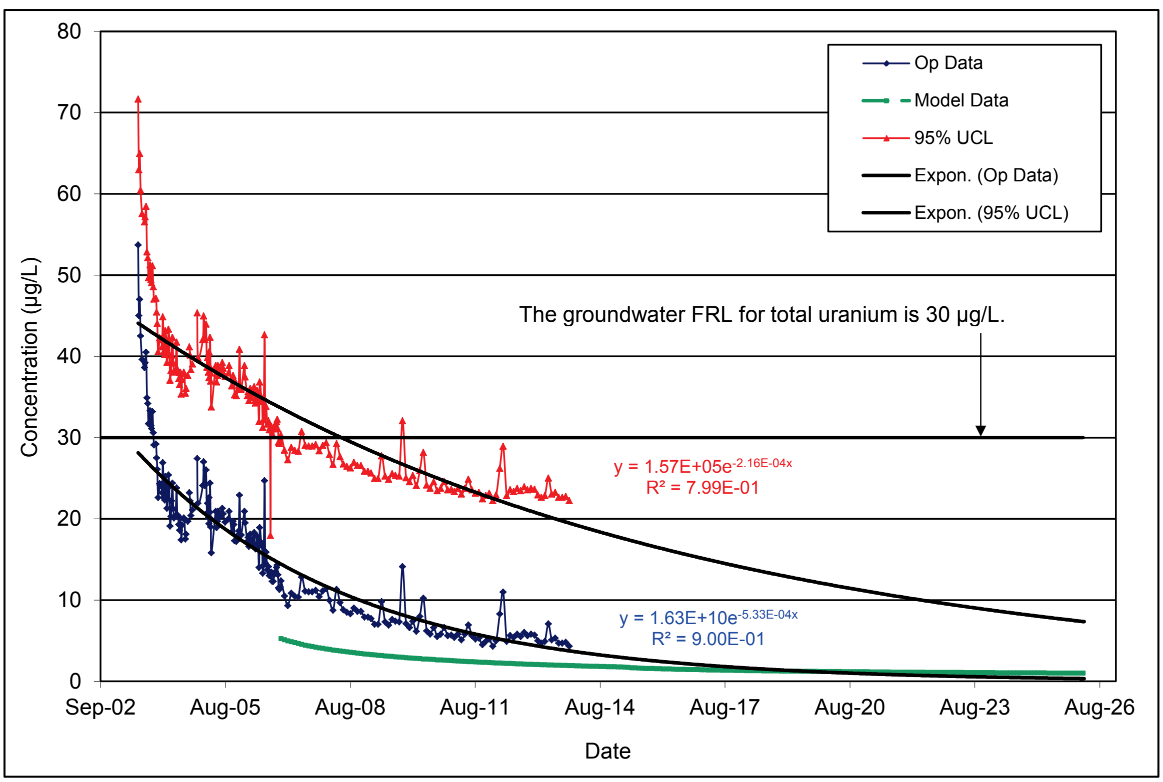

Figure A.1-33. Total Uranium Concentration Versus Time Plot for Extraction Well 33266 (EW-32) with Regression Analysis

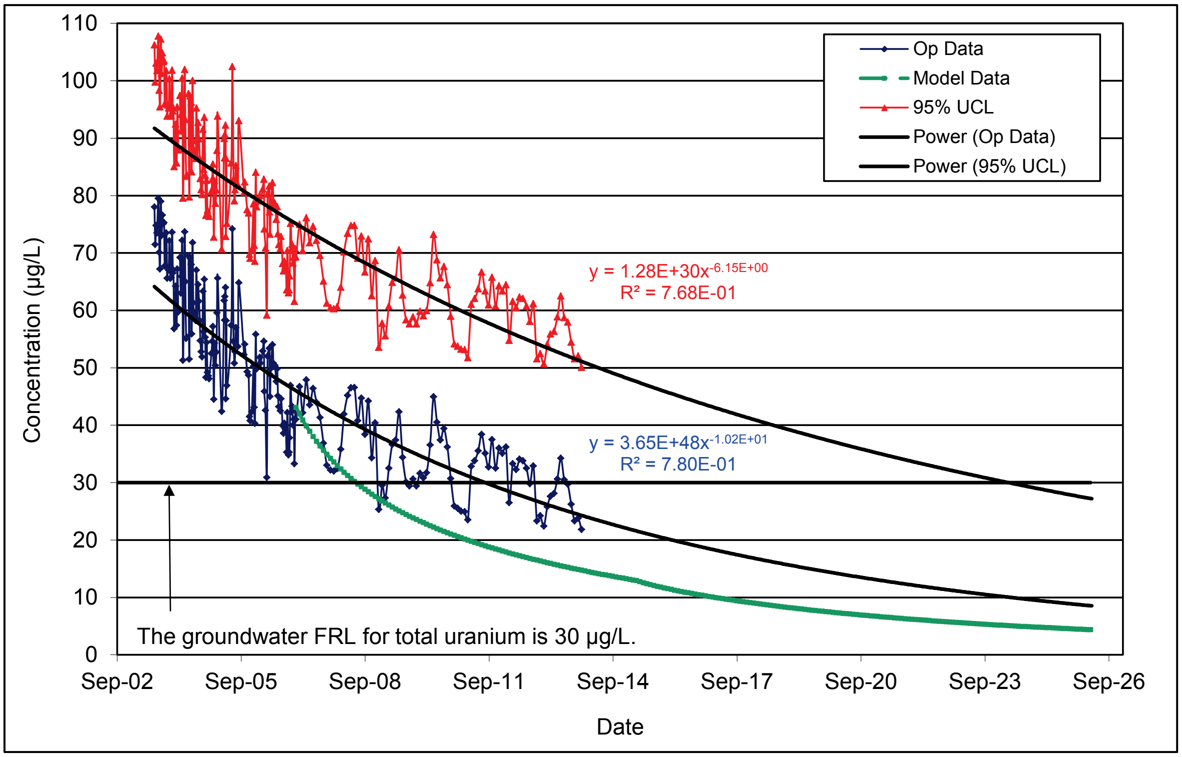

Figure A.1-34. Total Uranium Concentration Versus Time Plot for Extraction Well 33262 (EW-15a) with Regression Analysis

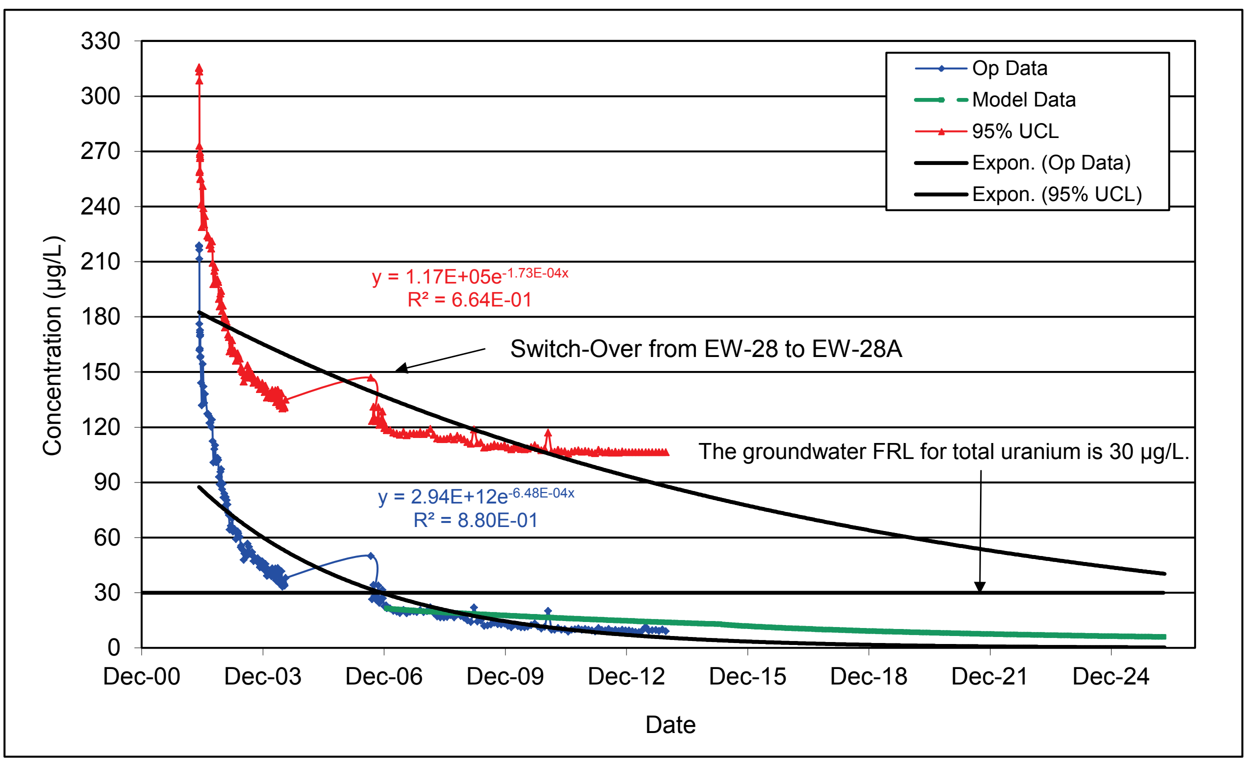

Figure A.1-35. Total Uranium Concentration Versus Time Plot for Extraction Well 33063 (EW-28)/33334 (EW-28a) with Regression Analysis

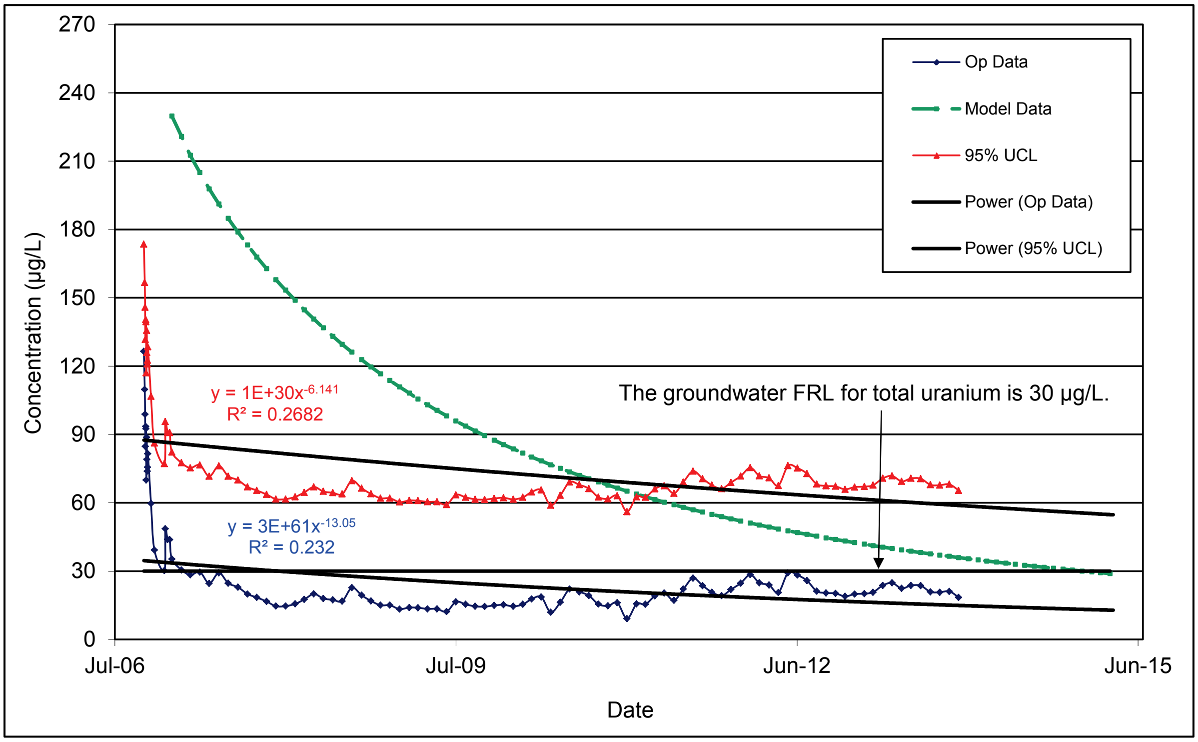

Figure A.1-36. Total Uranium Concentration Versus Time Plot for Extraction Well 33347 (EW-33a) with Regression Analysis

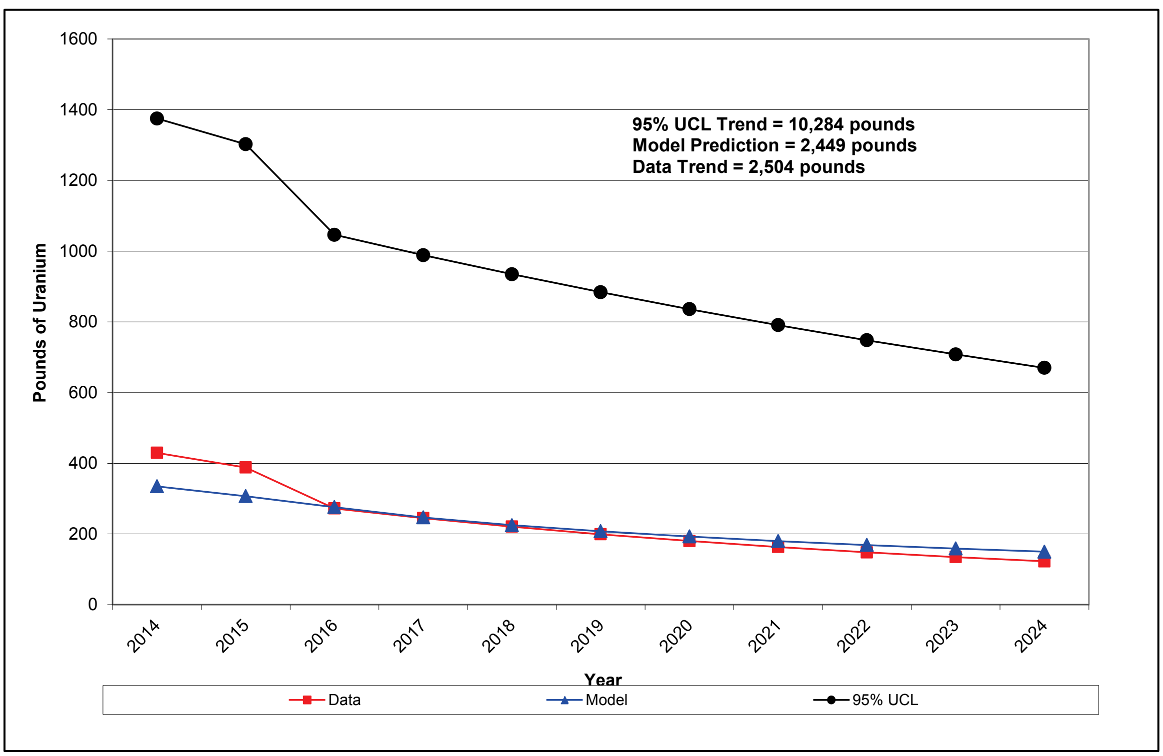

Figure A.1-37. Estimate of Yearly Pounds of Uranium to be Pumped from Aquifer (Model Predictions Versus Measured Concentration Trends) Data Collected Through 2013

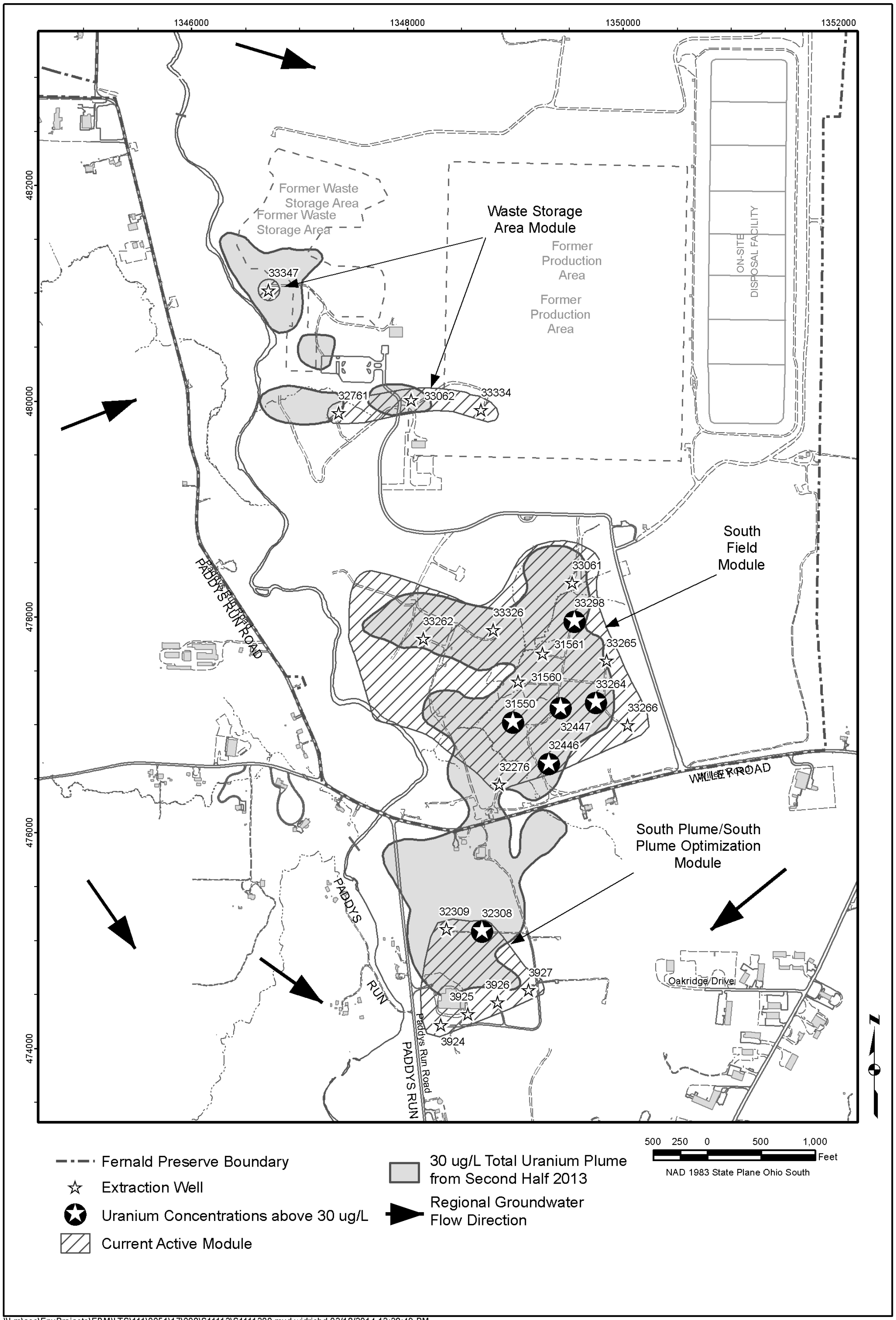

Figure A.1-38. Extraction Wells Active in 2013

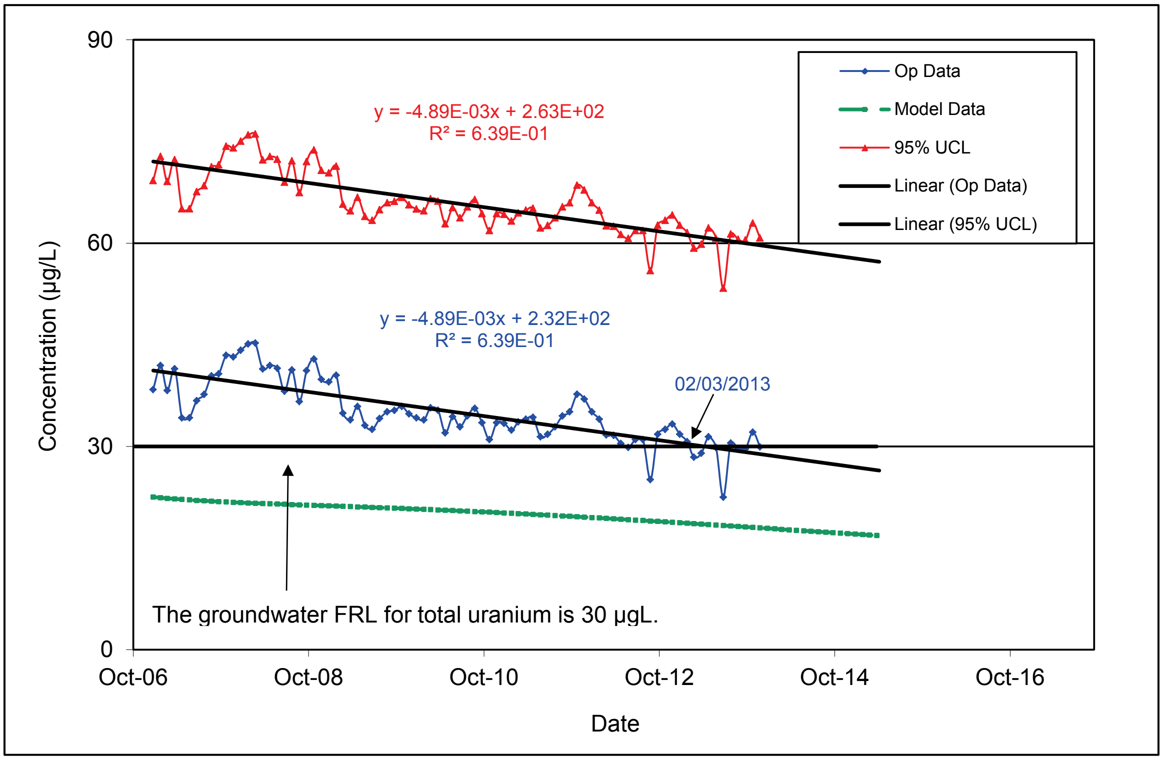

Figure A.1-39. Total Uranium Concentration Versus Time Plot for Extraction Well 32308 (RW-6) with Additional Regression Analysis

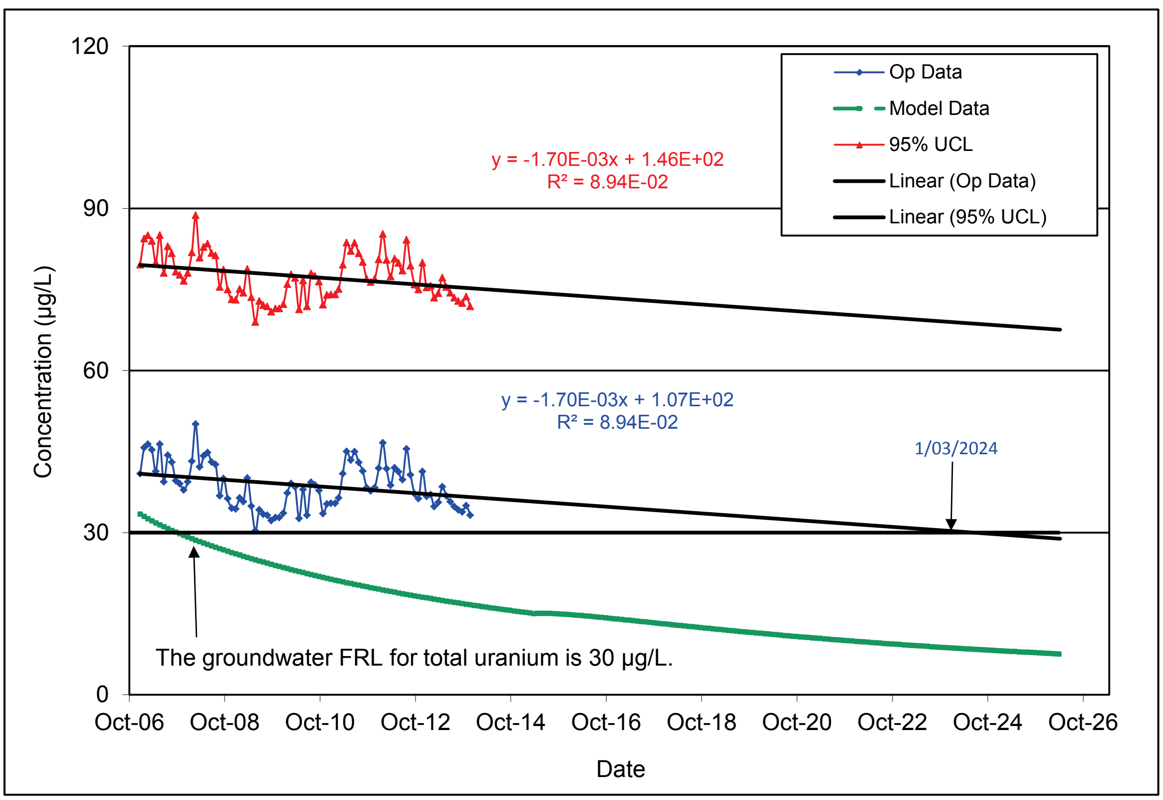

Figure A.1-40. Total Uranium Concentration Versus Time Plot for Extraction Well 31550 (EW-18) with Additional Regression Analysis

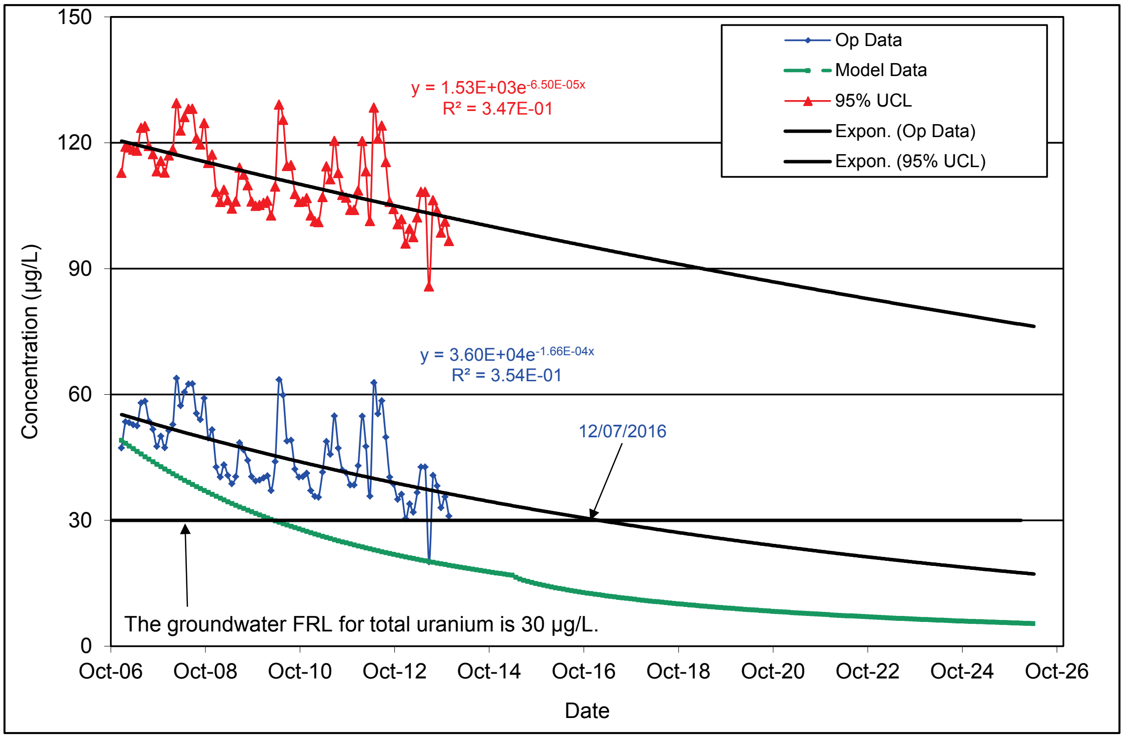

Figure A.1-41. Total Uranium Concentration Versus Time Plot for Extraction Well 31562 (EW-21)/33298 (EW-21a) with Additional Regression Analysis

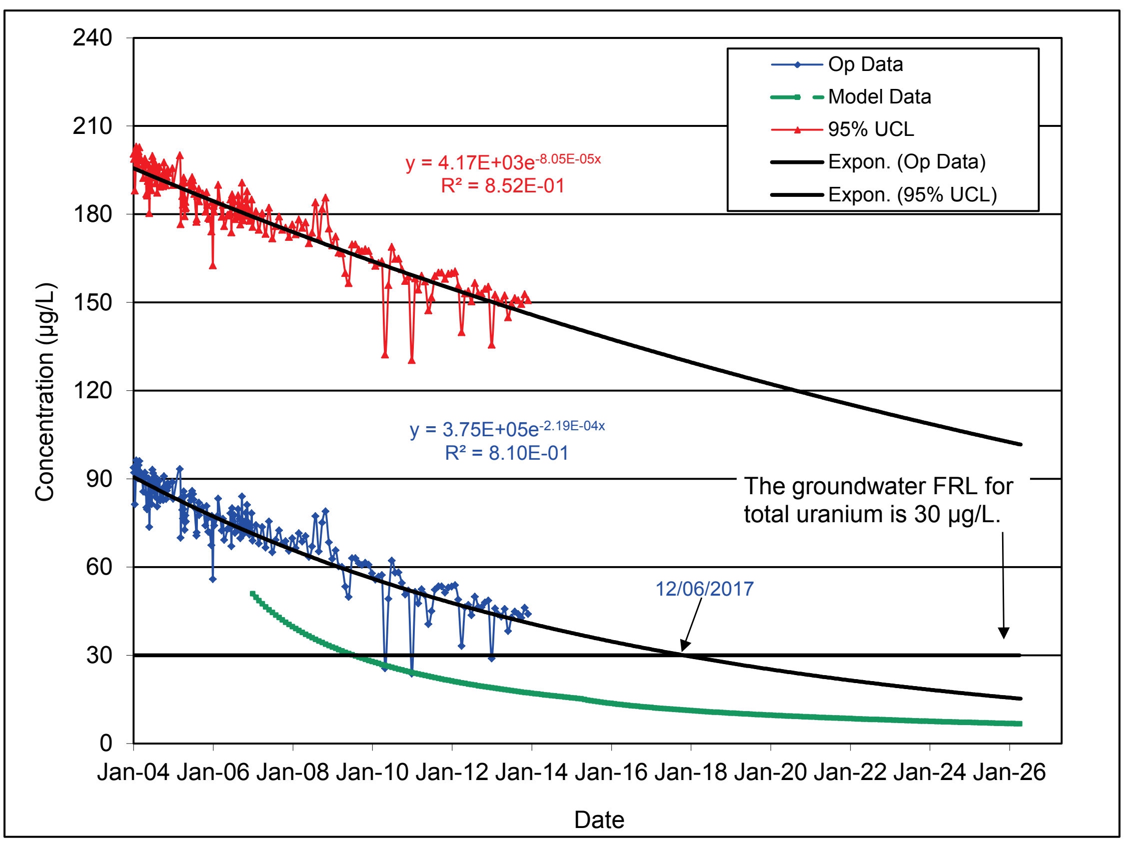

Figure A.1-42. Total Uranium Concentration Versus Time Plot for Extraction Well 32447 (EW-23) with Additional Regression Analysis

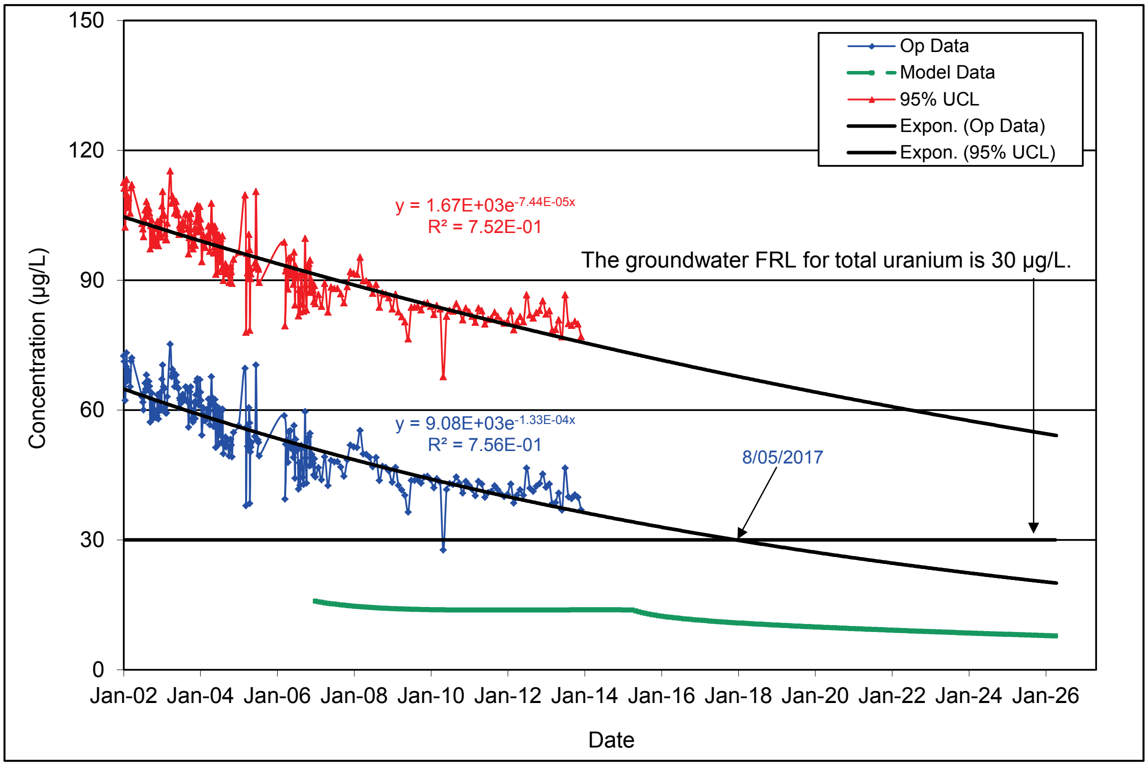

Figure A.1-43. Total Uranium Concentration Versus Time Plot for Extraction Well 32446 (EW-24) with Additional Regression Analysis

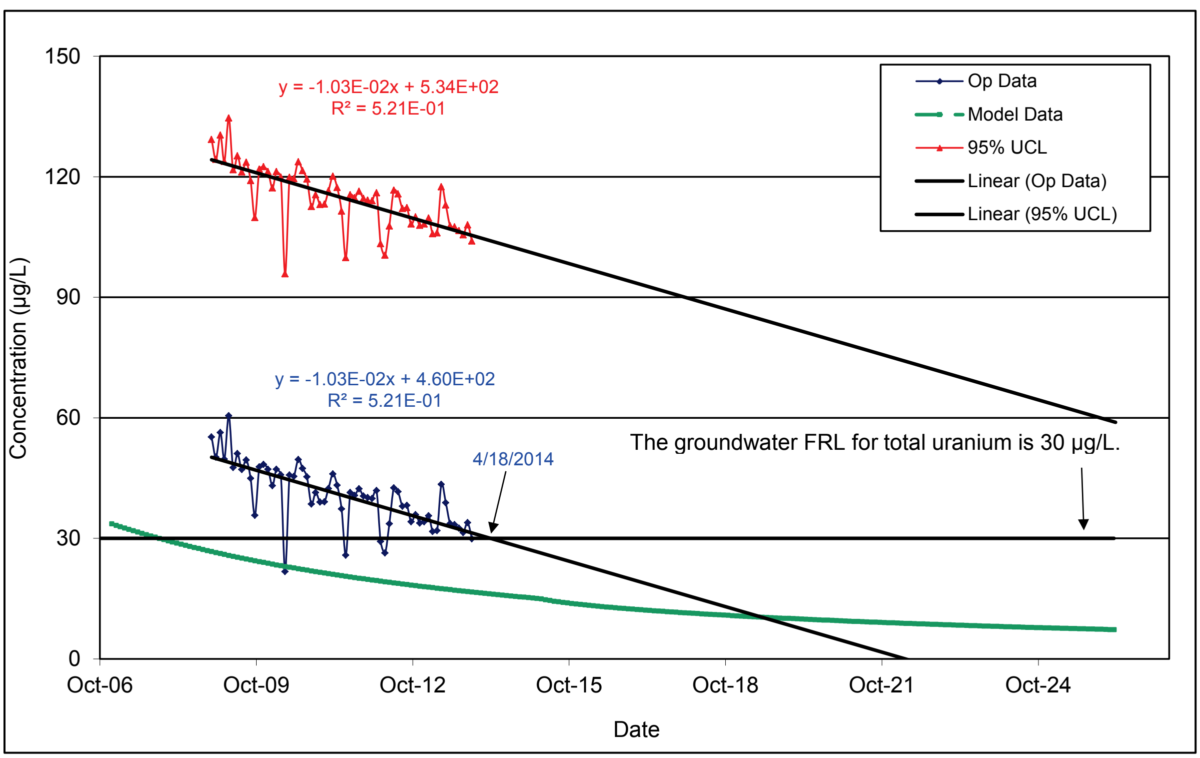

Figure A.1-44. Total Uranium Concentration Versus Time Plot for Extraction Well 33264 (EW-30) with Additional Regression Analysis

Attachment A.2

Contents

Tables

Figures

Abbreviations

amsl	above mean sea level
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
LMICP	*Comprehensive Legacy Management and Institutional Controls Plan*
PPDD	Pilot Plant Drainage Ditch
SSOD	Storm Sewer Outfall Ditch
WSA	Waste Storage Area

Measurement Abbreviations

ft	feet
gpm	gallons per minute
µg/L	micrograms per liter

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A.2.0 Assessment of Total Uranium Results

This attachment discusses groundwater monitoring total uranium results through 2013. The groundwater remediation at Fernald is a concentration based cleanup. The *Record of Decision for Operable Unit 5* (DOE 1996) states that "areas of the Great Miami Aquifer exceeding final remediation levels will be restored through extraction methods." Uranium is the primary constituent of concern for groundwater. The groundwater final remediation level (FRL) for uranium is 30 micrograms per liter (µg/L). The background uranium concentration for unfiltered groundwater samples from the Great Miami Aquifer near the Fernald Preserve is 1.2 µg/L. This background value is based on the 95th percentile of unfiltered samples (*Remedial Investigation Report for Operable Unit 5* [DOE 1995], Section 4, Table 4-8). The statistical procedures that will be used to verify that aquifer cleanup objectives have been achieved are presented in the *Fernald Groundwater Certification Plan* (DOE 2006).

Groundwater total uranium sampling requirements are presented in the Integrated Environmental Monitoring Plan (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2014). IEMP groundwater monitoring and extraction well locations are shown in Figure A.2-1. For integration purposes, the On-Site Disposal Facility monitoring well locations are also shown on Figure A.2-1. In addition to the routine well monitoring specified in the IEMP, 28 locations were sampled using a direct-push sampling tool (Geoprobe) in 2013. Direct-push sampling results for the 28 locations (12230B, 12231B, 12232B, 12410A, 12824B, 12842A, 12845A, 13227B, 13229C, 13230C, 13233A, 13234A, 13238A, 13239A, 13240C, 13267A, 13300B, 13301B, 13302B, 13306B, 13308B, 13461, 13462, 13464, 13465, 13369A, 13374A, and 13463) are presented in Tables A.2-1 through A.2-28. Direct-push sampling locations are often sampled several times over the course of the remediation. When a direct-push location is resampled, the convention is to identify the new sample with the same location number but with an alphabetic extension to differentiate the earlier sample (e.g., 12230, 12230A, 12230B). If a resample location is moved more than 50 feet (ft) from the original location though, a new number is assigned.

Figures A.2-2A, A.2-2B, A.2-3A, and A.2-3B show maximum total uranium plume maps for the first and second halves of 2013, respectively. Figures A.2-2A and A.2-3A show direct-push data. Figures A.2-2B and A.2-3B show monitoring well and extraction well data. Data collected from the aquifer are used to progressively update the maximum total uranium plume maps in the following conservative manner:

- Total uranium concentration data are posted on a map with the contours from the previous map. The highest representative total uranium value at a monitoring well location is posted. The highest concentration associated with each direct-push location is also posted.
- If a recently measured concentration from a well is greater than the previous concentration contour value at that location, then the plume is re-contoured using the higher value.
- If the most recent concentration measurement from a well is less than the previous contour for that location, then the new data are posted, but the plume contours are not adjusted using the new data until confirmatory direct-push sampling can be conducted.
- If direct-push data or multi-level monitoring well data are available and a complete vertical profile of an area indicates that concentrations have changed, then the map is re-contoured

using the new direct-push data or multi-level well data. Note, under this strategy, a reduction in the size of the mapped plume is based on vertical profile data.

- If a location has a history of intermittent exceedances and the location appears to be isolated from the main plume, then the location is identified on the maximum uranium plume map as a location with intermittent exceedances. This serves to keep track of the locations with intermittent exceedances so that their presence can be carried forward into the certification stage of the remediation project.

Table A.2-29 lists the monitoring wells where total uranium concentrations exceeded the 30 µg/L FRL during 2013. Included in the table are total uranium statistical summaries for each well, which include Mann-Kendall trend analyses. Table A.2-30 provides total uranium statistical summaries for the extraction wells, including Mann-Kendall trend analyses. Extraction well trends were discussed in Attachment A.1. Figure A.2-4 illustrates the statistics presented in Table A.2-29 (e.g., where total uranium concentrations have, an “up,” “down,” or a “no” trend). Monitoring wells with a statistically significant “up” trend based on the Mann-Kendell analysis are further discussed.

Tracking the size of the maximum total uranium plume provides a means for assessing progress in achieving remediation goals. Figure A.2-5 shows the footprint of the 30 µg/L total uranium plume from the second half of 2012 compared to the footprint of the 30 µg/L total uranium plume from the second half of 2013. Overall, the 30 µg/L uranium footprint interpretation remained about the same for both years. Of importance to note for the 2013 interpretation, is the reduction in concentrations within the 30 µg/L footprint (i.e., area above 50 µg/L and area above 100 µg/L). A breakdown of the reductions is provided below.

Comparison of 2012 and 2013 Maximum Uranium Plume Footprint Area

Year	Area > 30 µg/L	Area > 50 µg/L	Area > 100 µg/L
2012	130.3	97.4	50.5
2013	127.3	76.3	37.1
Difference (acres)	3.00	21.1	13.4
Difference (percent)	2.3%	21.7%	26.5%

Information concerning the plume is presented in three sections as outlined below.

- Section A.2.1, “Former Waste Storage Area,” including the Pilot Plant Drainage Ditch (PPDD) Area
- Section A.2.2, “Former Plant 6 Area”
- Section A.2.3, “South Field and Off-Property South Plume Uranium Plumes”

For each section, information is presented concerning:

- New direct-push sampling data,
- Intermittent uranium FRL exceedance locations, and
- Monitoring wells with increasing uranium concentration trends.

Also presented, is information concerning the Storm Sewer Outfall Ditch (SSOD) and monitoring well maintenance as outlined below:

- Section A.2.4, "Flow Monitoring in the Storm Sewer Outfall Ditch"
- Section A.2.5, "Monitoring Well Maintenance"

A.2.1 Former Waste Storage Area

A.2.1.1 Former Waste Storage Area Maximum Uranium Plume

Changes were made to the mapped footprint of the former Waste Storage Area (WSA) for this report. The mapped footprint of the 30 µg/L maximum uranium plume in the former WSA decreased approximately 0.49 acre in size compared to the mapped footprint at the end of 2012. At the end of 2012, the mapped footprint was estimated to be 21.09 acres. At the end of 2013, the mapped footprint was estimated to be 20.6 acres, a decrease of 2.3 percent (Figure A.2-5). The slight decrease in the size of the 30 µg/L footprint is accompanied by an increase in uranium concentrations within the northwest corner of the plume.

A.2.1.1.1 New Direct-Push Sampling Data in the Former WSA

Direct-push sampling was conducted in 2013 at three locations in the former WSA (location 13369A, location 13374A, and location 13463). Sampling results are provided in Tables A.2-1 through A.2-3.

<u>Location 13369A</u>
Direct-push sampling location 13369A is located in the northwest corner of the former WSA plume. This location was originally sampled in 2007 (location 13369). Direct-push sampling results from location 13369A are provided in Table A.2-1. The location is identified on Figure A.2-3A. The maximum uranium concentration (202 µg/L) was measured at an elevation of 517 ft above mean sea level (amsl). Uranium concentration data from both sampling dates (2007 and 2013) are presented below.

Location 13369 (2007)		**Location 13369A (2013)**	
Midpoint Screen Elevation (ft amsl)	**Uranium (µg/L)**	**Midpoint Screen Elevation (ft amsl)**	**Uranium (µg/L)**
514	166	517	202
504	16.4	507	37.9
494	4.1	497	6.08
484	10.4		

The uranium concentration data indicates that the maximum uranium concentration increased between 2007 and 2013 from 166 µg/L to 202 µg/L (22 percent).

<u>Location 13374A</u>
Direct-push sampling location 13374A is located in the northwest corner of the former WSA plume. This location was originally sampled in 2008 (location 13374). Direct-push sampling results from location 13374A are provided in Table A.2-2. The location is identified on

Figure A.2-3A. The maximum uranium concentration (293 µg/L) was measured at an elevation of 519 ft amsl. Uranium concentration data from both sampling dates (2008 and 2013) are presented below.

Location 13374 (2008)		**Location 13374A (2013)**	
Midpoint Screen Elevation (ft amsl)	**Uranium (µg/L)**	**Midpoint Screen Elevation (ft amsl)**	**Uranium (µg/L)**
517	74	519	293
507	70.1	509	13.2
		499	2.05
		489	1.93

The uranium concentration data indicates that the maximum uranium concentration increased between 2008 and 2013 from 74 µg/L to 293 µg/L, approximately 296 percent.

It should be noted that location 13374A is upgradient from location 13369A and had a larger percent increase in uranium concentrations than location 13369A (296 percent versus 22 percent) in a shorter time period (5 years versus 6 years). This indicates that the source of the increase is closer to location 13374A than it is to 13369A. The U.S. Department of Energy (DOE) plans to conduct additional direct-push sampling in this area in 2014.

<u>Location 13463</u>

Direct-push sampling location 13463 is located on the northern edge of the former WSA plume. This location was previously sampled in 2005 (referred to as location 13322). When a direct-push location is resampled, the convention is to identify the new sample with the same location number but with an alphabetic extension to differentiate the earlier sample (e.g., 13322A, 13322B). If a resample location is moved more than 50 ft from the original location though, a new number is assigned. The resample location for 13322 had to be moved more than 50 ft; therefore, the new location sampled in 2013 was assigned a new number (13463). Direct-push sampling results from location 13463 are provided in Table A.2-3. The locations of both 13322 and 13463 are identified on Figure A.2-3A. The maximum uranium concentration in 13463 (50.2 µg/L) was measured at an elevation of 516 ft amsl. The mapped maximum uranium plume for the end of 2013 was adjusted to honor the 50.2 µg/L concentration. Uranium concentration data from 13322 in 2005 and 13463 in 2013 are presented below.

Location 13322 (2005)		**Location 13463 (2013)**	
Midpoint Screen Elevation (ft amsl)	**Uranium (µg/L)**	**Midpoint Screen Elevation (ft amsl)**	**Uranium (µg/L)**
520	133.9	516	50.2
511	11.4	506	33.7
		496	7.50

The uranium concentration data indicates that the maximum uranium concentration decreased between 2005 and 2013 from 133.9 µg/L to 50.2 µg/L.

A.2.1.1.2 Intermittent Uranium FRL Exceedance Locations in the Former WSA

Two monitoring wells are identified on the maximum uranium plume maps for 2013 in the former WSA (Figures A.2-2A, A.2-2B, A.2-3A, and A.2-3B) as being monitoring locations with intermittent uranium FRL exceedances. These two locations are 83340 and 83341. As shown in Table A.2-29, monitoring well 83340 also had an "up" trend in uranium concentrations. Results from monitoring well 83340 are discussed in the section below concerning increasing uranium trends. Results from location 83341 are discussed here.

Figure A.2-6 is a time versus concentration plot for monitoring well 83341. The graph shows that the uranium concentrations for all channels of the well were below 30 µg/L in 2013. This location (along with location 83340) will continue to be monitored. If future monitoring indicates that the intermittent uranium FRL exceedances are continuing or increasing, additional direct-push sampling may be conducted in the area when water levels are high to determine if a plume can be defined. Monitoring wells 83340 and 83341 will continue to be identified on maximum uranium plume maps as being locations where intermittent uranium FRL exceedances have been measured so that their presence will be carried forward into the certification stage of the aquifer remediation.

A.2.1.1.3 Monitoring Wells with Increasing Uranium Concentration Trends in the Former WSA

As shown on Figure A.2-4, four monitoring wells have increasing uranium concentration trends in the former WSA (2649, 3821, 83337, and 83340). Summary statistics for the four wells are provided in Table A.2-29. All four of these monitoring locations are within capture of the groundwater remediation system.

Figure A.2-7 is a uranium concentration versus time plot for monitoring well 2649. The figure shows a correlation between high water levels and high uranium concentrations. Figure A.2-8 is a uranium concentration versus time plot for monitoring well 83337. The increasing trend is shown for the shallowest channel in the well, which is Channel 1. The increasing trends at these two monitoring wells (2649 and 83337) are probably due to residual uranium contamination that is sorbed to aquifer sediments in the vadose zone. When water levels are high, the higher uranium concentrations are measured.

Figure A.2-9 and Figure A.2-10 are uranium concentration versus time plots for monitoring wells 2821 and 3821, respectively. As shown in Table A.2-29 and on Figure A.2-4, monitoring well 3821 had a statistically significant "up" uranium concentration trend in 2013. Monitoring well 3821 is screened several feet beneath the water table. As shown in Figure A.2-10, the uranium concentration in monitoring well 3821 increased above 30 µg/L intermittently between 2012 and 2013. Monitoring well 2821 is screened at the same location as monitoring well 3821, but is screened across the water table. As shown in Figure A.2-9, the uranium concentration at monitoring well 2821 has also increased slightly since 2012, but is still well below 30 µg/L. For now, DOE plans to continue to monitor this location to see if trend in 3821 continues. If it does, then perhaps the increase represents a small slug of contamination that moved by the well in response to pumping.

Figure A.2-11 is a uranium concentration versus time plot for monitoring well 83340. The data shows that prior to 2009 only one uranium FRL exceedance was detected at this monitoring well. Since 2011, the uranium FRL exceedances have become more prevalent. DOE plans to continue to monitor this well. If data in 2014 shows continued persistent concentrations above 30 µg/L, DOE will conduct additional direct-push sampling in the area, and revise the maximum uranium plume map accordingly.

A.2.1.1.4 Former WSA Summary

High uranium concentrations that correspond to high water levels continue to be a concern for the former WSA plume. Located beneath a former source area, uranium contamination is sorbed to aquifer sediments in the vadose zone. When pumping is stopped and the water level rises, uranium concentrations dissolved in the groundwater may increase (rebound) enough to increase above groundwater FRLs.

Increasing uranium concentrations in the northwest corner of the plume have also become a concern. The groundwater data indicates that the increase in uranium concentration is greater in the northwest area of the plume. Intermittent puddles of surface water collect in a swale that is located northwest of the former WSA uranium plume. The swale is bounded by Paddys Run to the west and former waste pits to the east. As presented in Appendix B, the uranium concentration of many of the samples collected from this area exceed the groundwater FRL.

Surface water runoff in the former WSA is directed to where the Clear Well and Pit 3 were once located. The surface water infiltrates into the ground and serves as a source of recharge to the aquifer. The area of infiltration is within capture of the groundwater remediation system. Because the area is within capture there is no risk to the public from the high uranium concentrations in the groundwater in this area. Of concern though, (as noted by the increasing uranium concentrations in the northwest corner of the plume) is that a residual source may be present in the area that is migrating into the aquifer in the area of the swale. A residual source could prolong the groundwater remediation unless it is addressed. DOE plans to work with the U.S. Environmental Protection Agency (EPA) and Ohio EPA to determine the best path forward for this area.

A.2.1.2 PPDD Maximum Uranium Plume

No change was made to the size of the mapped 30 µg/L total uranium plume footprint in the PPDD area for this report. The size of the 30 µg/L total uranium plume footprint remained at 7.9 acres (Figure A.2-5).

A.2.1.2.1 New Direct-Push Sampling Data in the PPDD Area

No direct-push samples were collected from the PPDD in 2013.

A.2.1.2.2 Intermittent Uranium FRL Exceedance Locations in the PPDD Area

One monitoring well (monitoring well 83335) is identified on the maximum uranium plume maps for 2013 in the former WSA (Figures A.2-2A, A.2-2B, A.2-3A, and A.2-3B) as being a monitoring location with intermittent uranium FRL exceedances.

A time versus uranium concentration plot for monitoring well 83335 is provided in Figure A.2-12. The figure shows that uranium concentrations measured in 2013 were below the uranium groundwater FRL for all monitoring channels. This well will continue to be identified on maximum uranium plume map as being a location where intermittent uranium FRL exceedances have been measured so that its presence will be carried forward into the certification stage of the aquifer remediation.

A.2.1.2.3 Monitoring Wells with Increasing Uranium Concentration Trends in the PPDD Area

As shown on Figure A.2-4, one monitoring well had an increasing uranium concentration trend in 2013 in the PPDD Area (monitoring well 83124_C4). This well is a multi-channel monitoring well with six monitoring horizons referred to as channels (numbered from 1 through 6 with increasing depth); channel C4 is the fourth channel. Summary statistics for monitoring well 83124_C4 are provided in Table A.2-19.

Figure A.2-13 is a uranium concentration versus time plot for all of the channels in monitoring well 83124. The historical range of uranium concentrations in channels 2 through 6 are less than approximately 100 µg/L. The uranium concentration measured in channel 1 has consistently been near or above 200 µg/L since 2001. The increasing concentration trend in channel 4 is attributed to contamination moving toward the monitoring well in response to nearby pumping. DOE will continue to monitor this well but plans no action at this time in response to the increasing concentration trend in channel 4. This well is within capture of the groundwater remediation system.

A.2.2 Former Plant 6 Area

A.2.2.1 New Direct-Push Sampling Data in the Plant-6 Area

No new direct-push samples were collected in 2013 in the Plant-6 Area.

A.2.2.2 Intermittent Uranium FRL Exceedance Locations and Monitoring Wells with Increasing Uranium Concentration Trends

Plans for a groundwater restoration module in the former Plant 6 Area were abandoned in 2001 based on the outcome of the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001). This design provided data that indicated that the total uranium plume in the former Plant 6 area was no longer present. EPA and Ohio EPA concurred with this decision.

Monitoring well 2389 is the only groundwater monitoring well remaining in the area where Plant 6 was located in the former production area (Figure A.2-1). This well is identified as a location with intermittent uranium FRL exceedances on the maximum uranium plume maps (Figures A.2-2A, A.2-2B, A.2-3A, and A.2-3B). It is also identified as a monitoring location where uranium concentrations are trending up (Figure A.2-4 and Table A.2-19).

Figure A.2-14 is a uranium concentration versus time plot for uranium at monitoring well 2389 that shows that sporadic uranium FRL exceedances have been detected at this well over the past 12 years. As discussed below, the FRL exceedances in this area are detected when the water elevation is approximately 515 ft amsl or higher. The two uranium FRL exceedances in 2013 were 55.1 µg/L and 52.9 µg/L in the first half and second half of 2013, respectively. As shown in Figure A.2-11, the water level during both sampling events was approximately 515 ft amsl or higher.

Previous direct-push sampling in this area indicates that the intermittent uranium FRL exceedances are associated with high water table conditions. The former Plant 6 area is targeted for direct-push sampling when the water-table elevation is above 515 ft amsl. As shown below, unless the water table is above an elevation of 515 ft amsl, uranium FRL exceedances are usually not detected. The last direct-push sampling was collected in 2011 (13360C). The regional water table was high enough in 2011 for the sampling to detect an exceedance. The concentration of the exceedance (37.7 µg/L) is similar to the exceedance detected in 2008 (37.2 µg/L).

Year	Location	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)
2007	13360	< 1.0	512
2008	13360A	37.2	515
2010	13360B	4.4	510
2011	13360C	37.7	515

Monitoring well 2389 will continue to be identified on maximum uranium plume map as being a location where intermittent uranium FRL exceedances have been measured so that its presence will be carried forward into the certification stage of the aquifer remediation. This well is within capture of the groundwater remediation system.

A.2.3 South Field and Off-Property South Plume Uranium Plumes

The mapped footprint of the 30 µg/L maximum uranium plume in the South Field and off-property South Plume decreased approximately 2.44 acres in 2013, compared to 2012. In 2012, the mapped footprint was estimated to be 109.2 acres. In 2013, the mapped footprint is estimated to be 106.8 acres, a decrease of 2.2 percent (Figure A.2-5).

Although the size of the 30 µg/L footprint only decreased by 2.3 percent, the uranium concentrations within the 30 µg/L footprint decreased significantly more. The footprint of the plume greater than 50 µg/L was reduced from 83.2 acres in 2012 to 62.4 acres in 2013; a decrease of 20.8 acres (25 percent). The footprint of the plume greater than 100 µg/L was reduced from 40.8 acres in 2012 to 27.3 acres in 2013, a decrease of 13.5 acres (33 percent).

A.2.3.1 South Field

The plume reductions noted above were based on new direct-push sampling data obtained in 2013. In 2013, direct-push sampling was conducted at eight locations in the South Field (locations 12824B, 13462, 12842A, 12845A, 12230B, 12231B, 12410A, and 12232B).

Four of the eight direct-push locations (location 12824B, 13462, 12842A, and 12845A) were in or near the northwest South Field area. The other four direct-push locations (location 12230B, 12231B, 12410A, and 12232B) were located more in the center of the southern half of the South Field.

A.2.3.1.1 New Direct-Push Sampling Data in the Northwest South Field Area

Location 12824B

This direct-push location had been sampled twice before 2013. It was originally sampled in 2001 (location 12824) and resampled in 2008 (location 12824A). The sample collected in 2013 is identified as location 12824B. Direct-push sampling results for location 12824B are provided in Table A.2-4. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 12824 (2001)		Location 12824A (2008)		Location 12824B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
512	405	513	632.2	518	445
504	30	503	124.4	508	161
494	20	493	18.6	498	21.0
484	34	483	15	488	18.7
474	29	474			
464	2.1	464			
454	1.1	454			
		444			

As shown above, the maximum uranium concentration measured in 2013 at location 12824B was 445 µg/L at an elevation of 518 ft amsl. The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13462

Direct-push location 13462 is a resampling of location 12837A. Location 12837 was originally sampled in 2001 and was sampled again in 2008 (12837A). When a direct-push location is resampled, the convention is to identify the new sample with the same location number but with an alphabetic extension to differentiate it from the earlier sample (e.g., 12837, 12837A). If a resample location is moved more than 50 ft from the original location though, a new number is assigned. The resample location in 2013 for 12837A had to be moved more than 50 ft; therefore, the identification was changed from 12837B to 13462.

Direct-push sampling results for location 13462 are provided in Table A.2-5. The locations of 13462 and 12837A are identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 12837 (2001)		Location 12837A (2008)		Location 13462 (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
511	463	515	407.1	514	190
502	62	505	43.5	504	16.6
492	18	495	22.8	494	10.8
482	45	485	19.5	484	8.30
472	31	475	12.9		
462	3.8				
452	1.3				

The maximum uranium concentration at this location has decreased from 463 µg/L in 2001 (elevation of 511 ft amsl) down to 190 µg/L in 2013 (elevation of 514 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 12842A

This direct-push location was originally sampled in 2001 (location 12842). Direct-push sampling results for location 12842A are provided in Table A.2-6. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 12842 (2001)		Location 12842A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium Concentration (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium Concentration (µg/L)
511	139	513	65.4
504	58	503	22.2
493	4.6	493	5.20
483	1.1		
473	1.8		
463	1.2		
453	1.9		

The maximum uranium concentration at this location has decreased from 139 µg/L in 2001 (elevation of 511 ft amsl) down to 65.4 µg/L in 2013 (elevation of 513 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 12845A

This location was originally sampled in 2001 (location 12845). Direct-push sampling results for location 12845A are provided in Table A.2-7 and the location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 12845 (2001)		Location 12845A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
513	109	514	57.3
503	7.3	504	14.1
493	2.6	494	5.40
483	3.8		
473	2.7		
463	2.7		
453	1.6		

The maximum uranium concentration at this location has decreased from 109 µg/L in 2001 (elevation of 513 ft amsl) down to 57.3 µg/L in 2013 (elevation of 514 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

A.2.3.1.2 New Direct-Push Sampling Data in the Center of the Southern Half of the South Field

Location 12230B

This direct-push location has been sampled twice before. It was original sampled in 1997 (location 12230) and resampled in 2003 (location 12230A). The sample collected in 2013 is identified as location 12230B. Direct-push sampling results for location 12230B are provided in Table A.2-8. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 12230 (1997)		Location 12230A (2003)		Location 12230B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
521	168				
511	258	513	151.3	511	43.4
501	193	506	60.7	501	33.6
491	245	496	103.8	491	36.7
481	125	486	95.5	481	19.3
471	69	476	13.2	471	9.90
461	59	466	45.8	461	15.7
451	13	456	31.7	451	6.00
441	6	446	8.9	441	5.50
431	3	436	3.4		

The maximum uranium concentration at this location has decreased from 258 µg/L in 1997 (elevation of 511 ft amsl) down to 43.4 µg/L in 2013 (elevation of 511 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 12231B

This location has been sampled twice before. It was originally sampled in 1997 (location 12231) and resampled in 2003 (location 12231A). The sample collected in 2013 is identified as location 12231B. Direct-push sampling results for location 12231B are provided in Table A.2-9. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 12231 (1997)		Location 12231A (2003)		Location 12231B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
520	240	520	227.7		
511	387	510	111.0	512	48.5
501	397	500	153.7	502	37.3
491	287	490	111.3	492	36.6
481	177	480	104.3	482	24.0
471	113	470	104.9	472	13.7
461	8	460	8.2	462	11.2
451	7.4	450	3.7	452	2.30
441	5	440	< 1.0		
431	1				

The maximum uranium concentration at this location has decreased from 397 µg/L in 1997 (elevation of 501 ft amsl) down to 48.5 µg/L in 2013 (elevation of 512 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 12410A

This location was originally sampled in 1999 (location 12410). Direct-push sampling results for location 12410A are provided in Table A.2-10. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 12410 (1999)		Location 12410A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
519	2.8		
509	3.8	512	1.00
499	40	502	1.30
489	227	492	50.8
479	108	482	56.6
469	17	472	36.6
459	8.3	462	2.20
449	17		

The maximum uranium concentration at this location has decreased from 227 µg/L in 1999 (elevation of 489 ft amsl) down to 56.6 µg/L in 2013 (elevation of 482 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 12232B

This direct-push location has been sampled twice before. It was originally sampled in 1997 (location 12232) and resampled in 2003 (location 12232A). The sample collected in 2013 is identified as location 12232B. Direct-push sampling results for location 12232B are provided in Table A.2-11. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 12232 (1997)		Location 12232A (2003)		Location 12232B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
521	44	518	51.1		
511	160	508	179	510	35.8
501	325	498	135	500	32.5
491	76	488	116	490	69.0
481	16	478	12.1	480	54.0
471	3.4	468	3.1	470	20.9
461	3.2	458	4.6	460	1.90
451	3.0	448	3.0		
		438	<1.0		

The maximum uranium concentration at this location has decreased from 325 µg/L 1997 (elevation of 501 ft amsl) down to 69.0 µg/L in 2013 (elevation of 490 ft amsl). The 2013 maximum uranium concentration is posted on the 2013 maximum uranium plume map and map concentration contours are adjusted accordingly.

A.2.3.1.3 Intermittent Uranium FRL Exceedance Locations in the South Field

There are no intermittent uranium FRL exceedance locations identified for the South Field.

A.2.3.1.4 Monitoring Wells with Increasing Uranium Concentration Trends in the South Field

As shown in Figure A.2-4 and Table A.2-19, five monitoring wells had "up" trends for uranium concentrations in 2013 (monitoring wells 2045, 23275, 2387, 83294_C1, and 83295_C6). Time versus uranium concentration plots for these five wells are provided in Figures A.2-15 through A.2-19, respectively). With the exception of monitoring well 2045, the increases are attributed to changes in the plume caused by the active groundwater remediation. Uranium contamination is being pulled toward the extraction wells. As shown in Figure A.2-15, the uranium concentration at monitoring well 2045 has an "up" trend since 1999, but the more recent data since 2004 shows that the trend has been more or less level.

DOE will continue to monitor these wells but plans no action at this time in response to the increasing concentration trends. All of these wells are within capture of the groundwater remediation system.

A.2.3.2 South Plume

A.2.3.2.1 New Direct-Push Sampling Data

In 2013, direct-push sampling was conducted at 17 locations in the South Plume (13227B, 13229C, 13230C, 13233A, 13234A, 13238A, 13239A, 13240C, 13267A, 13300B, 13301B, 13302B, 13306B, 13308B, 13461, 13464, and 13465). Sampling locations are shown in Figure A.2-3A. Sampling results are discussed below.

Three of the 2013 direct-push sampling locations had maximum uranium concentrations above 50 µg/L: locations 13229C, 13238A, and 13239A. Data from these three direct-push locations were used to define an area of the South Plume that remains above 50 µg/L.

<u>Location 13229C</u>
This location has been sampled three times in previous years. The location was originally sampled in 2002 (location 13229), resampled in 2003 (location 13229A), and resampled again in 2008 (13229B). The sample collected in 2013 is identified as location 13229C. Direct-push sampling results for location 13229C are provided in Table A.2-12. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13229 (2002)		Location 13229A (2003)		Location 13229B (2008)		Location 13229C (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
518	58	516	81.8			510	61.2
508	101	506	86.3	504	72.7	500	40.8
498	47	496	92.7	494	65.3	490	41.2
488	29	486	51.2	484	42.2	480	15.2
478	19	476	11.3	474	37.4	470	5.90
468	15	466	4.5	464	17.8	460	3.40
458	3.2	456	1.2				
448	1						
438	0.7						

The maximum uranium concentration at this location has decreased from 101 µg/L in 2002 (elevation of 508 ft amsl) to 61.2 µg/L in 2013 (elevation of 510 ft amsl). The location was mapped for 2013 as being in an area of the South Plume that remains above 50 µg/L.

<u>Location 13238A</u>
This location was original sampled in 2002 (location 13238). Direct-push sampling results for location 13238A are provided in Table A.2-13. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13238 (2002)		Location 13238A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
517	78.4		
507	84.5	511	51.0
497	73.8	501	20.7
487	38.9	491	15.2
477	8.8	481	12.9
467	2.5	471	13.3
457	1.7		
447	1.3		

The maximum uranium concentration at this location has decreased from 84.5 µg/L in 2002 (elevation of 507 ft amsl) to 51.0 µg/L in 2013 (elevation of 511 ft amsl). The location was mapped for 2013 as being in an area of the South Plume that remains above 50 µg/L.

Location 13239A

This location was original sampled in 2002 (location 13239). Direct-push sampling results for location 13239A are provided in Table A.2-14. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13239 (2002)		Location 13239A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	65	511	64.0
507	49	501	43.5
497	69	491	25.5
487	32	481	5.70
477	12	471	2.00
467	4.9		
457	1.9		
447	1.2		

The maximum uranium concentration at this location has remained fairly constant between 2002 and 2013. The maximum uranium concentration was 69 µg/L in 2002 (elevation of 497 ft amsl) and it was 64.0 µg/L in 2013 (elevation of 511 ft amsl). The location was mapped for 2013 as being in an area of the South Plume that remains above 50 µg/L.

The remaining 14 direct-push sampling locations in the South Plume in 2013 all had maximum uranium concentrations that were below 50 µg/L; locations 13227B, 13230C, 13240C, 13464, 13233A, 13267A, 13234A, 13300B, 13301B, 13302B, 13306B, 13308B, 12461, and 13465.

Location 13227B

This location has been sampled twice in past years. The location was originally sampled in 2002 (location 13227) and resampled in 2005 (location 13227A). The sample collected in 2013 is identified as location 13227B. Direct-push sampling results for location 13227B are provided in Table A.2-15. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13227 (2002)		Location 13227A (2005)		Location 13227B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	91	517	47.7	511	45.2
506	97	507	50.4	501	27.1
496	49	497	39	491	25.9
486	27	487	21.3	481	7.00
476	18	477	18.8		
466	2.6	467	3.0		

The maximum uranium concentration at this location has decreased from 97 µg/L in 2002 (elevation of 506 ft amsl) to 45.2 µg/L in 2013 (elevation of 511 ft amsl). Based on the 2013 maximum uranium results (45.2 µg/L) the location was mapped for 2013 as being below 50 µg/L.

<u>Location 13230C</u>

This location has been sampled three times before. It was original sampled in 2002 (location 13230), resampled in 2003 (location 13230A), and again in 2008 (13230B). The sample collected in 2013 is identified as location 13230C. Direct-push sampling results for location 13230C are provided in Table A.2-16. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13230 (2002)		Location 13230A (2003)		Location 13230B (2008)		Location 13230C (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	36	517	23.5				
506	116	507	79.9	509	68.8	510	34.1
496	101	497	63.6	499	32.7	500	44.7
486	66	487	32.9	489	48.9	490	33.9
476	12	477	36.1	479	37.4	480	27.8
466	11	467	2.9	469	4.2	470	4.70
456	3.1	457	1.6			460	3.80
446	1.8						
436	1.1						

The maximum uranium concentration at this location has decreased from 116 µg/L in 2002 (elevation of 506 ft amsl) to 44.7 µg/L in 2013 (elevation of 500 ft amsl). Based on the 2013 maximum uranium results (44.7µg/L) the location was mapped for 2013 as being below 50 µg/L.

Location 13240C

This location has been sampled three times before. It was original sampled in 2002 (location 13240), resampled in 2003 (location 13240A), and again in 2005 (13240B). The sample collected in 2013 is identified as location 13240C). Direct-push sampling results for location 13240C are provided in Table A.2-17. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13240 (2002)		Location 13240A (2003)		Location 13240B (2005)		Location 13240C (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	4.7	517	11				
505	23	507	122.5	509	28.6	511	18.7
495	114	497	62.3	499	62.4	501	26.0
485	92	487	53.9	489	63	491	29.7
475	36	477	15.2	479	15.5	481	23.1
465	3.4	467	4.4	469	5.9	471	1.40
455	1.6	457	1.3	459	4.4	461	3.30
445	1.7						

The maximum uranium concentration at this location has decreased from 114 µg/L in 2002 (elevation of 495 ft amsl) to 29.7 µg/L in 2013 (elevation of 491 ft amsl). Although the 2013 maximum uranium result (29.7 µg/L) was below 30 µg/L, the location was not mapped as being below 30 µg/L. As shown on the total uranium plume maps, a location to the southeast (location 13234A) remains above 30 µg/L. When the uranium concentration at location 13234A decreases below 30 µg/L, the eastern edge of the 30 µg/L plume footprint will be adjusted to the west.

Location 13464

This location is a resample of location 13303A. The location had to be moved more than 50 ft, so was assigned a new identification number (location 13464). Location 13303 was originally sampled in 2003 (location 13303) and resampled in 2009 (location 13303A). Direct-push sampling results for location 13464 are provided in Table A.2-18. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling events are provided below.

Location 13303 (2003)		Location 13303A (2009)		Location 13464 (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	66.2				
506	23.4	507	9.8	511	23.4
496	24.1	497	19.8	501	6.10
486	24.8	487	24.6	491	15.5
476	63.9	477	40.3	481	22.4
466	40.5	467	48.6	471	42.4
456	43.4	457	17.4	461	40.6
446	13.7	447	6.2	451	23.8
436	1.4	437	<1.0		
426	<1.0				

The maximum uranium concentration at this location has decreased from 66.2 in 2003 (elevation of 516 ft amsl) to 42.4 µg/L in 2013 (elevation of 471 ft amsl). Based on the 2013 maximum uranium result (42.4 µg/L) the location was mapped for 2013 as being below 50 µg/L.

<u>Location 13233A</u>
This location was original sampled in 2002 (location 13233). Direct-push sampling results for location 13233A are provided in Table A.2-19. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13233 (2002)		Location 13233A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
514	20	511	44.8
505	54	501	20.4
495	55	491	16.7
485	38	481	10.2
475	33	471	1.00
465	4.2	461	1.00
455	1.3	451	3.10
445	0.6		

The maximum uranium concentration at this location went from 55 µg/L in 2002 (elevation of 495 ft amsl) to 44.8 µg/L in 2013 (elevation of 511 ft amsl). Based on the 2013 maximum uranium result (44.8 µg/L) the location was mapped for 2013 as being below 50 µg/L.

<u>Location 13267A</u>
This location was original sampled in 2002 (location 13267). Direct-push sampling results for location 13267A are provided in Table A.2-20. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13267 (2002)		Location 13267A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
518	5.8		
508	64	511	16.3
498	60	501	18.8
488	54	491	16.8
478	30	481	18.2
468	3.6	471	7.70
458	0.9	461	1.00
448	0.8		

The maximum uranium concentration at this location went from 64 µg/L in 2002 (elevation of 508 ft amsl) to 18.8 µg/L in 2013 (elevation of 501 ft amsl). Although the 2013 maximum uranium result (18.8 µg/L) was below 30 µg/L, the location was not mapped below 30 µg/L. As shown on the total uranium plume maps, a location to the east (location 13234A) remains above 30 µg/L. When the uranium concentration at location 13234A decreases below 30 µg/L, the eastern edge of the 30 µg/L plume footprint will be remapped as being more to the west.

Location 13234A

This location was original sampled in 2002 (location 13234). Direct-push sampling results for location 13234A are provided in Table A.2-21. The location is identified on Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13234 (2002)		Location 13234A (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
517	6.1		
507	32	510	32.8
497	12	500	37.8
487	2.4	490	2.70
477	1.5		
467	1.3		
457	0.5		

The maximum uranium concentration at this location went from 32 µg/L in 2002 (elevation of 507 ft amsl) to 37.8 µg/L in 2013 (elevation of 500 ft amsl). Based on the 2013 maximum uranium result (37.8 µg/L) the location was mapped for 2013 as being below 50 µg/L.

Location 13300B

This location has been sampled twice before. It was original sampled in 2003 (location 13300) and resampled in 2009 (location 13300A). The sample collected in 2013 is identified as location 13300B). Direct-push sampling results for location 13300B are provided in

Table A.2-22. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13300 (2003)		Location 13300A (2009)		Location 13300B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
515	32.2			512	46.4
505	25	506	33.9	502	7.80
495	6.5	496	18.7	492	8.40
485	15	486	29.1	482	21.3
475	25.6	476	43.5	472	35.4
465	18.3	466	46.6	462	46.2
455	4	456	26.4	452	9.30
445	1.9				
435	1.5				

The maximum uranium concentration at this location has increased from 32.2 µg/L in 2003 (elevation of 515 ft amsl) to 46.4 µg/L in 2013 (elevation of 512 ft amsl). Based on the 2013 maximum uranium results (46.4 µg/L) the location was mapped for 2013 as being below 50 µg/L.

<u>Location 13301B</u>

This location has been sampled twice before. It was original sampled in 2003 (location 13301) and resampled in 2009 (location 13301A). The sample collected in 2013 is identified as location 13301B). Direct-push sampling results for location 13300B are provided in Table A.2-23. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13301 (2003)		Location 13301A (2009)		Location 13301B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium Concentration (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium Concentration (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium Concentration (µg/L)
514	4.3	509	54.1	511	18.5
504	68.4	499	39.4	501	15.3
494	35.4	489	27.2	491	16.1
484	11.1	479	13.1	481	9.60
474	2.8				
464	1.4				
454	1.4				
444	< 1.0				
434	< 1.0				

The maximum uranium concentration at this location has decreased from 68.4 µg/L in 2003 (elevation of 504 ft amsl) to 18.5 µg/L in 2013 (elevation of 511 ft amsl). Although the 2013 maximum uranium result (18.5 µg/L) was below 30 µg/L, the location was not mapped as being below 30 µg/L. As shown on the total uranium plume maps, a location to the east (location 13234A) remains above 30 µg/L. When the uranium concentration at location 13234A decreases below 30 µg/L, the eastern edge of the 30 µg/L plume footprint will be remapped as being more to the west.

Location 13302B

This location has been sampled twice before. It was original sampled in 2003 (location 13302) and resampled in 2009 (location 13302A). The sample collected in 2013 is identified as location 13302B). Direct-push sampling results for location 13302B are provided in Table A.2-24. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13302 (2003)		Location 13302A (2009)		Location 13302B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	6				
506	16.3	508	30.9	512	7.50
496	36.3	498	19.7	502	18.9
486	51.9	488	19.7	492	13.7
476	3.8	478	7	482	1.20
466	< 1.0	468	2.1		
456	< 1.0				
446	< 1.0				
436	< 1.0				

The maximum uranium concentration at this location has decreased from 51.9 µg/L in 2003 (elevation of 486 ft amsl) to 18.9 µg/L in 2013 (elevation of 501 ft amsl). Based on the 2013 maximum uranium result (18.9 µg/L) the location was mapped for 2013 as being below 30 µg/L.

Location 13306B

This location has been sampled twice in previous years. The location was originally sampled in 2003 (location 13306) and resampled in 2009 (location 13306A). The sample collected in 2013 is identified as location 13306B). Direct-push sampling results for location 13306B are provided in Table A.2-25. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13306 (2003)		Location 13306A (2009)		Location 13306B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	69.7				
506	30.7	508	13.7	511	43.0
496	24.4	498	43.1	501	11.8
486	39.9	488	10.7	491	9.80
476	47.2	478	15.7	481	12.5
466	5.9	468	5	471	9.60
456	5.1	458	2.2		
446	< 1.0				
436	< 1.0				
426	< 1.0				

The maximum uranium concentration at this location has decreased from 69.7 µg/L in 2003 (elevation of 516 ft amsl) to 43.0 µg/L in 2013 (elevation of 511 ft amsl). Based on the 2013 maximum uranium result (43.0 µg/L) the location was mapped for 2013 as being below 50 µg/L.

Location 13308B

This location has been sampled twice in previous years. The location was originally sampled in 2003 (location 13308) and resampled in 2009 (location 13308A). The sample collected in 2013 is identified as location 13308B). Direct-push sampling results for location 13308B are provided in Table A.2-26. The location is identified on Figure A.2-3A. Uranium concentrations from all sampling dates are provided below.

Location 13308 (2003)		Location 13308A (2009)		Location 13308B (2013)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
513	39.5	513	31.2	510	22.0
503	67.6	503	32.8	500	38.6
493	22.1	493	2.1	490	6.00
483	3.1	483	2.6	480	3.10
473	4.2				
463	1.8				
453	2.1				
443	1.5				
433	3.4				

The maximum uranium concentration at this location has decreased from 67.6 µg/L in 2003 (elevation of 503 ft amsl) to 38.6 µg/L in 2013 (elevation of 500 ft amsl). Based on the 2013 maximum uranium result (38.6 µg/L) the location was mapped for 2013 as being below 50 µg/L.

Location 13461

Direct-push sampling results for location 13461 are provided in Table A.2-27. The location is identified on Figure A.2-3A. Based on the 2013 maximum uranium result (31.5 µg/L) the location was mapped for 2013 as being below 50 µg/L.

Location 13465
Direct-push sampling results for location 13465 are provided in Table A.2-28. The location is identified on Figure A.2-3A. Based on the 2013 maximum uranium result (26.5 µg/L) the location was mapped for 2013 as being below 50 µg/L.

A.2.3.2.2 Intermittent Uranium FRL Exceedance Locations in the South Plume

Two monitoring wells are identified on the maximum uranium plume maps for 2013 in the South Plume (Figures A.2-2A, A.2-2B, A.2-3A, and A.2-3B) as being monitoring locations with intermittent uranium FRL exceedances: monitoring wells 2552 and 2900.

A time versus uranium concentration plot for monitoring well 2552 is provided in Figure A.2-20. The figure shows that uranium concentrations measured since 2005 have all been below the uranium groundwater FRL.

A time versus uranium concentration plot for monitoring well 2900 is provided in Figure A.2-21. The figure shows that only two uranium FRL exceedances have been measured at this well since 1993. These wells will continue to be identified on maximum uranium plume maps as being locations where intermittent uranium FRL exceedances have been measured so that their presence will be carried forward into the certification stage of the aquifer remediation.

A.2.3.2.3 Monitoring Wells with Increasing Uranium Concentration Trends in the South Plume

As shown in Figure A.2-4 and Table A.2-19, two monitoring wells (monitoring wells 2880 and 82369_C1) had "up" uranium concentration trends in 2013.

Monitoring Well 2880
Table A.2-19 and Figure A.2-4 show that uranium concentrations at monitoring well 2880 had an "up" trend in 2013. Figure A.2-22 is a time versus concentration chart for monitoring well 2880. The uranium concentration "up" trend at this monitoring well is attributed to nearby pumping wells pulling uranium contamination toward the monitoring well in response to pumping. This monitoring well is within capture of the groundwater remediation system.

Monitoring Well 82369_C1
Monitoring well 82369 is a multi-channel monitoring well with three monitoring channels. The channels are numbered 1 through 3 with channel 1 situated at the highest elevation. Monitoring well 82369 was installed in 2012. Table A.2-19 and Figure A.2-4 show that channel 1 in monitoring well 82369 had an "up" trend for uranium concentrations in 2013. Figure A.2-23 is a time versus concentration plot for all three channels in monitoring well 82369. As the figure shows, the uranium concentrations in channel 1 have been increasing since monitoring began in 2012.

Prior to 2012 this location was monitored using a direct-push sampling tool. Table A.2-31 provides a summary of the direct-push sampling results from 2001 through 2011. The last time that the location was sampled using a direct-push tool (2011), the maximum uranium concentration (67.8 µg/L) was measured at the water table. When monitoring well 82369 was first sampled, April 2012, all three monitoring channels had total uranium concentrations below 30 µg/L; the maximum uranium concentration (25.1 µg/L) was measured in channel 2 which is installed several feet beneath the normal water table depth. From October 2012 through 2013, the maximum uranium concentration was measured in channel 1; the concentration ranged from 151 µg/L to 210 µg/L. Because this location is within capture of the groundwater remediation system, the increasing concentration trend is attributed to shifting uranium concentrations in response to nearby pumping.

A.2.4 Flow Monitoring in the Storm Sewer Outfall Ditch

Flow monitoring in the SSOD was routinely conducted between 2006 through 2012. As reported in the *Fernald Preserve 2012 Site Environmental Report* (DOE 2013), DOE met with Ohio EPA and EPA in 2012 and received concurrence to stop monitoring the flumes at the end of 2012 and to remove the flumes from the SSOD. The flumes were safely removed from the SSOD in 2013.

In the process of revising the LMICP for 2013, and in light of the fact that the flumes had been removed, DOE proposed that pumping to supplement flow down the SSOD would no longer be an objective of the groundwater remedy, but that pumping would continue (when necessary) to maintain the health of the Lodge Pond. EPA and Ohio EPA approved this approach, but only after additional justification for suspending the supplemental pumping operation down the SSOD was provided. The following information was provided to Ohio EPA in response to LMICP Comment Number 5 and is repeated below.

The benefit to be gained by the supplemental pumping operation was never considered to be significant. The benefit was based on groundwater modeling presented in the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004). The modeling indicated that an infiltration rate of 500 gallons per minute (gpm) through the SSOD decreased the model predicted cleanup time estimate by 1 year. A field study was conducted in 2005 which concluded that the operation would not be cost effective. Subsequent discussions with EPA and Ohio EPA led to an agreement to continue the infiltration operation, which consisted of supplemental pumping into the SSOD until wells, pumps, or motors were no longer serviceable. At that time, operations would be suspended, pending a determination that the remedy was benefiting from the operation.

A determination was conducted in advance (i.e., while wells are still serviceable) for the purpose of determining what benefit would be gained by maintaining the flumes. It was reported in the *Fernald Preserve 2012 Site Environmental Report* that the average infiltration rate measured in the metered portion of the SSOD during the duration of the project (2007 through 2012) was 109 gpm to 129 gpm. This rate is well below what the model predicted would be needed (500 gpm) to decrease the model predicted cleanup time estimate by 1 year. This indicates that the supplemental pumping operation was falling short of the objective of achieving an infiltration rate of 500 gpm and, therefore, provided negligible benefit to the groundwater remediation. This conclusion is supported by uranium concentration data collected in the South Field and used to construct uranium plume maps that indicate that the area beneath the SSOD where infiltration would be taking place does not appear to be cleaning up any faster than the surrounding areas.

Figure A.2-24 is a location map for the SSOD that shows the SSOD in relation to the fourth quarter 2012 groundwater elevation contours. These elevation contours are the most recent groundwater elevation contours reported in the *Fernald Preserve 2012 Site Environmental Report*. It should be noted though that the water level surface shown in this figure is representative of the water level surface that was present between 2007 and 2012 due to pumping in the South Field extraction wells. As shown in the figure, most of the South Field extraction wells are located east of the SSOD; groundwater infiltrating into the aquifer from the SSOD would migrate to the east. The SSOD erodes through the glacial till just south of where Flume 6 was located; therefore, the potential for infiltration into the aquifer also begins just south of the former location of Flume 6.

Soil and sediment in the SSOD was certified clean prior to 2007. The objective of the infiltration activity was to flush the dissolved uranium plume located beneath the SSOD. As shown in the attached figure, South Field extraction wells are located just east of the SSOD. The ground surface between the extraction wells and the SSOD is too steep to allow for the installation of monitoring wells. Therefore, the closest monitoring wells east of the SSOD are in line for the most part with the extraction wells and are under heavy influence from the extraction wells.

The two closest monitoring wells to the area of potential infiltration (east of the SSOD, and south of former Flume 6) are monitoring wells 2386 and 2387. Time versus uranium concentration graphs for these two monitoring wells are provided in Figures A.2-25 and A.2-17. For the time period 2007 through 2012, the Mann-Kendall statistic test indicates no statistically significant trend was present at either well. It should be noted that Table A.2-19 in the *Fernald Preserve 2012 Site Environmental Report* considers all data collected at monitoring wells, not just the time period between 2007 and 2012. If data prior to 2007 is considered at monitoring well 2387, the Mann-Kendall test indicates a statistically significant upward trend.

Although removing the flumes may help increase infiltration through the SSOD, the data indicate that it is doubtful that the goal of 500 gpm will be achieved. With removal of the former Production Area facilities and roads and restoration of the area to a tall grass prairie, the SSOD drainage basin runoff coefficients have been significantly reduced to conditions similar to what they were before the site infrastructure was constructed in the early 1950s. When pre-site construction aerial photos of the site are reviewed, it is apparent that much of the SSOD was cut out by erosion caused by increased runoff post-site construction. With the return to pre-site construction runoff conditions, it is anticipated that the SSOD will tend toward being a depositional stream rather than erosional stream in the areas where infiltration would be beneficial to the aquifer cleanup. If sediment is deposited in the target infiltration areas then the infiltration rates will be further reduced; therefore, DOE proposed to continue pumping wells (when deemed necessary) to maintain the health of the Lodge Pond, but supplementing flow down the SSOD would no longer be an objective for the groundwater remedy.

A.2.5 Monitoring Well Inspection and Maintenance

All monitoring wells were inspected in 2013 with particular emphasis on those wells that are not actively monitored. All monitoring wells inspected were found to be protective of the subsurface environment and capable of yielding representative groundwater samples. Many inspection findings are corrected immediately (e.g., rust, vegetation removal, number legibility). Those deficiencies that cannot be corrected immediately (e.g., removal of overhanging trees) are corrected as time permits.

A.2.6 References

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DOE (U.S. Department of Energy), 2004. *Groundwater Remedy Evaluation and Field Verification*, 52460-PL-0001, Revision 0, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, October.

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DOE (U.S. Department of Energy), 2013. *Fernald Preserve 2012 Site Environmental Report*, LMS/FER/S09665, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2014. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 7, Office of Legacy Management, January.

Table A.2-1. Geoprobe Location 13369A

Easting '83: 1346420 feet
Northing '83: 481313 feet
Ground Elevation: 558.65 feet above mean sea level (AMSL)
Depth to Water Table: 37 feet below ground surface (BGS)
Water Table Elevation: 521.65 feet AMSL
Work Completed: 6/12/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium[a,b] (ug/L) (FRL=30)	Uranium[c] (ug/L) (FRL=30)	Technetium-99[c] (pCi/L) (FRL=94)	Nitrate/Nitrite (mg/L) (FRL=11)	Manganese[c] (mgL) (FRL=0.90)	Molybdenum[c] (mgL) (FRL=0.1)	Nickel[c] (mgL) (FRL=0.1)	Temperature[a] (^{0}C)	pH[a] (SU)	Specific Conductance[a] (mS/cm)	Turbidity (NTU)	Turbidity[a] (NTU)	Dissolved Oxygen[a] (mg/L)
1	517	42	0 - 10	202	150	0.16	1.02	2.33	0.232	0.0231	20.8	7.19	0.779	>999	>999	7.18
2	507	52	10 - 20	29.3	40.6	-0.944	0.294	1.19	0.0452	0.00943	17.6	7.51	0.698	>999	174	8.25
3	507	52	10 - 20	37.9	42.0	2.18	1.88	1.39	0.0508	0.0120	17.6	7.51	0.698	>999	174	8.25
4	497	62	20 - 30	6.08	5.77	3.67	1.76	0.47	0.0267	0.00811	14.4	7.59	0.684	>999	16.5	10.4

[a]Samples are filtered through a 5 micron filter.
[b]Maximum uranium result reported regardless of laboratory (i.e., onsite versus offsite) analyzing samples.
[c]Samples are filtered through a 0.45 micron filter.

Table A.2-2. Geoprobe Location 13374A

Easting '83: 1346353 feet
Northing '83: 481505 feet
Ground Elevation: 558 feet above mean sea level (AMSL)
Depth to Water Table: 34 feet below ground surface (BGS)
Water Table Elevation: 524 feet AMSL
Work Completed: 6/17/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium[a,b] (ug/L) (FRL=30)	Uranium[c] (ug/L) (FRL=30)	Technetium-99[c] (pCi/L) (FRL=94)	Nitrate/Nitrite (mg/L) (FRL=11)	Manganese[c] (mgL) (FRL=0.90)	Molybdenum[c] (mgL) (FRL=0.1)	Nickel[c] (mgL) (FRL=0.1)	Temperature[a] (^{0}C)	pH[a] (SU)	Specific Conductance[a] (mS/cm)	Turbidity (NTU)	Turbidity[a] (NTU)	Dissolved Oxygen[a] (mg/L)
1	519	39	0 - 10	232	293	514	375	2.49	0.0457	0.0358	21.7	6.96	2.750	>999	>999	6.06
2	509	49	10 - 20	8.59	12.2	0.547	14	0.483	0.0311	0.00756	19.2	7.36	0.879	>999	22.9	6.28
3	509	49	10 - 20	9.6	13.2	2.83	26.9	0.505	0.0344	0.00806	19.2	7.36	0.879	>999	23.0	6.28
4	499	59	20 - 30	1.87	2.05	-2.06	0.502	0.41	0.0237	0.00611	18.5	7.42	0.666	>999	50.0	4.53
5	489	69	30 - 40	6.46	1.93	-2.88	0.0935	0.399	0.0219	0.00636	18.9	7.34	0.697	>999	820	5.95

[a]Samples are filtered through a 5 micron filter.
[b]Maximum uranium result reported regardless of laboratory (i.e., onsite versus offsite) analyzing samples.
[c]Samples are filtered through a 0.45 micron filter.

Table A.2-3. Geoprobe Location 13463

Easting '83: 1346653 feet
Northing '83: 481346 feet
Ground Elevation: 555 feet above mean sea level (AMSL)
Depth to Water Table: 34 feet below ground surface (BGS)
Water Table Elevation: 521 feet AMSL
Work Completed: 6/18/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium[a,b] (ug/L) (FRL=30)	Uranium[c] (ug/L) (FRL=30)	Technetium-99[c] (pCi/L) (FRL=94)	Nitrate/Nitrite (mg/L) (FRL=11)	Manganese[c] (mgL) (FRL=0.90)	Molybdenum[c] (mgL) (FRL=0.1)	Nickel[c] (mgL) (FRL=0.1)	Temperature[a] (^{0}C)	pH[a] (SU)	Specific Conductance[a] (mS/cm)	Turbidity (NTU)	Turbidity[a] (NTU)	Dissolved Oxygen[a] (mg/L)
1	516	39	0 - 10	50.2	49.9	8.73	7.15	0.660	0.313	0.0114	18.2	7.47	0.625	>999	10.9	5.42
2	506	49	10 - 20	32.5	38.1	0.161	2.80	0.644	0.0725	0.0101	16.9	7.36	0.735	>999	618	7.67
3	506	49	10 - 20	33.7	40.2	1.46	3.23	0.829	0.0808	0.0113	16.9	7.36	0.735	>999	618	7.67
4	496	59	20 - 30	7.50	7.72	-0.919	0.588	0.417	0.0154	0.00557	16.2	7.27	0.764	>999	>999	7.83

[a]Samples are filtered through a 5 micron filter.
[b]Maximum uranium result reported regardless of laboratory (i.e., onsite versus offsite) analyzing samples.
[c]Samples are filtered through a 0.45 micron filter.

Table A.2-4. Geoprobe Location 12824B

Easting '83: 1348037 feet
Northing '83: 477918 feet
Ground Elevation: 567 feet above mean sea level (AMSL)
Depth to Water Table: 44 feet below ground surface (BGS)
Water Table Elevation: 523 feet AMSL
Work Completed: 5/23/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	518	49	0 - 10	445	16.5	7.26	0.639	>999	191	8.88
2	508	59	10 - 20	158	15.3	7.55	0.607	>999	22.7	8.05
3	508	59	10 - 20	161	15.3	7.55	0.607	>999	22.7	8.05
4	498	69	20 - 30	21.0	15.1	7.65	0.607	>999	137	8.08
5	488	79	30 - 40	18.7	14.6	7.23	0.652	>999	14.0	7.32

[a]Samples are filtered through a 5 micron filter.

Table A.2-5. Geoprobe Location 13462

Easting '83: 1348359 feet
Northing '83: 478072 feet
Ground Elevation: 579 feet above mean sea level (AMSL)
Depth to Water Table: 60 feet below ground surface (BGS)
Water Table Elevation: 519 feet AMSL
Work Completed: 6/5/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	514	65	0 - 10	190	17.7	6.62	1.73	>999	>999	7.39
2	504	75	10 - 20	13.3	15.9	7.13	0.703	>999	94.7	9.00
3	504	75	10 - 20	16.6	15.9	7.13	0.703	>999	95.0	9.00
4	494	85	20 - 30	10.8	15.8	7.40	0.667	>999	98.1	7.84
5	484	95	30 - 40	8.30	16.4	7.53	0.597	>999	47.2	7.21

[a]Samples are filtered through a 5 micron filter.

Table A.2-6. Geoprobe Location 12842A

Easting '83: 1348644 feet
Northing '83: 477701 feet
Ground Elevation: 575 feet above mean sea level (AMSL)
Depth to Water Table: 57 feet below ground surface (BGS)
Water Table Elevation: 518 feet AMSL
Work Completed: 5/28/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	513	62	0 - 10	65.4	19.7	7.00	0.819	>999	543	7.20
2	503	72	10 - 20	22.1	16.8	7.45	0.607	>999	149	6.37
3	503	72	10 - 20	22.2	16.8	7.45	0.607	>999	149	6.37
4	493	82	20 - 30	5.20	18.0	7.69	0.636	>999	201	7.13

[a]Samples are filtered through a 5 micron filter.

Table A.2-7. Geoprobe Location 12845A

Easting '83: 1348803 feet
Northing '83: 477713 feet
Ground Elevation: 575 feet above mean sea level (AMSL)
Depth to Water Table: 56 feet below ground surface (BGS)
Water Table Elevation: 519 feet AMSL
Work Completed: 5/22/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	514	61	0 - 10	57.3	14.8	6.80	0.682	>999	989	6.12
2	504	71	10 - 20	12.7	14.2	7.30	0.636	>999	15.1	4.55
3	504	71	10 - 20	14.1	14.2	7.30	0.636	>999	15.1	4.55
4	494	81	20 - 30	5.40	14.7	7.28	0.650	>999	47.0	3.75

[a]Samples are filtered through a 5 micron filter.

Table A.2-8. Geoprobe Location 12230B

Easting '83: 1348627 feet
Northing '83: 476759 feet
Ground Elevation: 570 feet above mean sea level (AMSL)
Depth to Water Table: 54 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 5/2/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	59	0 - 10	43.4	21.3	7.24	0.797	>999	24.3	6.15
2	501	69	10 - 20	32.7	20.8	7.30	0.782	>999	14.4	5.64
3	501	69	10 - 20	33.6	20.8	7.30	0.782	>999	14.4	6.30
4	491	79	20 - 30	36.7	20.0	7.33	0.770	>999	45.6	6.30
5	481	89	30 - 40	19.3	20.3	7.24	0.696	>999	999	5.24
6	471	99	40 - 50	9.90	16.8	7.26	0.601	>999	57.3	6.87
7	461	109	50 - 60	15.7	17.4	7.50	0.601	>999	>999	6.54
8	451	119	60 - 70	6.00	17.5	7.40	0.614	>999	434	6.35
9	441	129	70 - 80	5.50	18.0	7.29	0.650	>999	512	6.30

[a]Samples are filtered through a 5 micron filter.

Table A.2-9. Geoprobe Location 12231B

Easting '83: 1348783 feet
Northing '83: 476554 feet
Ground Elevation: 563 feet above mean sea level (AMSL)
Depth to Water Table: 46 feet below ground surface (BGS)
Water Table Elevation: 517 feet AMSL
Work Completed: 6/3/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	51	0 - 10	48.5	20.4	7.32	0.824	>999	22.7	5.96
2	502	61	10 - 20	36.8	18.5	7.50	0.780	>999	12.3	6.53
3	502	61	10 - 20	37.3	18.5	7.50	0.780	>999	12.3	6.53
4	492	71	20 - 30	36.6	18.4	7.61	0.732	>999	22.9	5.60
5	482	81	30 - 40	24.0	18.1	7.31	0.872	>999	10.0	0.53
6	472	91	40 - 50	13.7	18.6	7.43	6.710	>999	15.9	0.702
7	462	101	50 - 60	11.2	18.1	7.38	0.688	>999	6.62	4.54
8	452	111	60 - 70	2.30	17.8	7.26	0.687	>999	15.3	5.47

[a]Samples are filtered through a 5 micron filter.

Table A.2-10. Geoprobe Location 12410A

Easting '83: 1348896 feet
Northing '83: 476735 feet
Ground Elevation: 546 feet above mean sea level (AMSL)
Depth to Water Table: 29 feet below ground surface (BGS)
Water Table Elevation: 517 feet AMSL
Work Completed: 5/15/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	34	0 - 10	1.00	13.3	6.95	0.695	>999	92.2	7.51
2	502	44	10 - 20	1.20	14.3	7.65	0.710	>999	13.5	8.61
3	502	44	10 - 20	1.30	14.3	7.65	0.710	>999	13.5	8.61
4	492	54	20 - 30	50.8	13.3	7.42	0.771	>999	14.2	7.66
5	482	64	30 - 40	56.6	13.2	7.65	0.774	>999	20.5	7.83
6	472	74	40 - 50	36.6	13.9	7.61	0.698	>999	182	7.02
7	462	84	50 - 60	2.20	15.7	7.74	0.665	>999	13.7	6.56

[a]Samples are filtered through a 5 micron filter.

Table A.2-11. Geoprobe Location 12232B

Easting '83: 1349143 feet
Northing '83: 476800 feet
Ground Elevation: 574 feet above mean sea level (AMSL)
Depth to Water Table: 59 feet below ground surface (BGS)
Water Table Elevation: 515 feet AMSL
Work Completed: 5/13/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	64	0 - 10	35.8	15.1	7.33	0.790	>999	21.2	8.57
2	500	74	10 - 20	25.5	13.3	6.88	0.802	>999	16.7	8.69
3	500	74	10 - 20	32.5	13.3	6.88	0.802	>999	16.7	8.69
4	490	84	20 - 30	69.0	13.9	7.07	0.771	>999	138	6.66
5	480	94	30 - 40	54.0	14.0	7.14	0.702	>999	8.52	5.90
6	470	104	40 - 50	20.9	14.0	7.42	0.744	>999	574	4.06
7	460	114	50 - 60	1.90	14.3	7.32	0.635	>999	25.5	6.26

[a]Samples are filtered through a 5 micron filter.

Table A.2-12. Geoprobe Location 13229C

Easting '83: 1348249 feet
Northing '83: 475527 feet
Ground Elevation: 571 feet above mean sea level (AMSL)
Depth to Water Table: 56 feet below ground surface (BGS)
Water Table Elevation: 515 feet AMSL
Work Completed: 4/9/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	61	0 - 10	61.2	15.3	6.69	0.759	>999	>999	10.40
2	500	71	10 - 20	38.8	15.8	7.13	0.770	>999	92.0	6.70
3	500	71	10 - 20	40.8	15.8	7.13	0.770	>999	92.0	6.70
4	490	81	20 - 30	41.2	16.0	7.07	0.748	>999	478	6.29
5	480	91	30 - 40	15.2	16.2	7.09	0.75	>999	16.8	5.30
6	470	101	40 - 50	5.90	17.0	7.63	0.721	>999	28.7	4.77
7	460	111	50 - 60	3.40	16.8	7.71	0.716	>999	105	5.59

[a]Samples are filtered through a 5 micron filter.

Table A.2-13. Geoprobe Location 13238A

Easting '83: 1348082 feet
Northing '83: 475397 feet
Ground Elevation: 537 feet above mean sea level (AMSL)
Depth to Water Table: 21 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 4/15/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	26	0 - 10	51.0	17.4	7.28	0.772	>999	>999	8.35
2	501	36	10 - 20	20.6	15.5	7.31	0.744	>999	NR[b]	8.49
3	501	36	10 - 20	20.7	15.5	7.31	0.744	>999	NR[b]	8.49
4	491	46	20 - 30	15.2	15.5	7.58	0.736	>999	NR[b]	6.22
5	481	56	30 - 40	12.9	14.3	7.41	0.742	>999	NR[b]	3.71
6	471	66	40 - 50	13.3	14.1	7.32	0.685	>999	NR[b]	4.23

[a]Samples are filtered through a 5 micron filter.

[b]NR = Not Recorded

Table A.2-14. Geoprobe Location 13239A

Easting '83: 1348445 feet
Northing '83: 475400 feet
Ground Elevation: 579 feet above mean sea level (AMSL)
Depth to Water Table: 63 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 4/18/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	68	0 - 10	64.0	17.2	6.73	0.786	>999	852	9.46
2	501	78	10 - 20	42.1	17.0	6.55	0.741	>999	>999	7.82
3	501	78	10 - 20	43.5	17.0	6.55	0.741	>999	>999	7.82
4	491	88	20 - 30	25.5	18.0	6.86	0.667	>999	589	6.90
5	481	98	30 - 40	5.70	17.4	7.21	0.690	>999	26.1	6.04
6	471	108	40 - 50	2.00	18.4	7.14	0.653	>999	40.9	5.88

[a]Samples are filtered through a 5 micron filter.

Table A.2-15. Geoprobe Location 13227B

Easting '83: 1348615 feet
Northing '83: 475756 feet
Ground Elevation: 576 feet above mean sea level (AMSL)
Depth to Water Table: 60.5 feet below ground surface (BGS)
Water Table Elevation: 515.5 feet AMSL
Work Completed: 4/12/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	66	0 - 10	45.2	11.4	5.98	0.715	>999	914	8.52
2	501	76	10 - 20	24.6	12.5	7.51	0.698	>999	771	6.68
3	501	76	10 - 20	27.1	12.5	7.51	0.698	>999	771	6.68
4	491	86	20 - 30	25.9	12.0	7.60	0.629	>999	242	8.00
5	481	96	30 - 40	7.00	12.4	7.64	0.633	>999	54.8	4.71

[a]Samples are filtered through a 5 micron filter.

Table A.2-16. Geoprobe Location 13230C

Easting '83: 1348649 feet
Northing '83: 475593 feet
Ground Elevation: 577 feet above mean sea level (AMSL)
Depth to Water Table: 62 feet below ground surface (BGS)
Water Table Elevation: 515 feet AMSL
Work Completed: 4/10/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	67	0 - 10	34.1	15.6	6.94	0.831	>999	594	7.50
2	500	77	10 - 20	43.8	16.3	7.41	0.635	>999	214	5.30
3	500	77	10 - 20	44.7	16.3	7.41	0.635	>999	214	5.30
4	490	87	20 - 30	33.9	16.8	7.34	0.640	>999	23.7	4.44
5	480	97	30 - 40	27.8	16.6	7.27	0.634	>999	130	6.09
6	470	107	40 - 50	4.70	16.7	7.41	0.680	>999	6.90	4.17
7	460	117	50 - 60	3.80	17.4	7.27	0.602	>999	>999	5.62

[a]Samples are filtered through a 5 micron filter.

Table A.2-17. Geoprobe Location 13240C

Easting '83: 1348844 feet
Northing '83: 475400 feet
Ground Elevation: 580 feet above mean sea level (AMSL)
Depth to Water Table: 63.5 feet below ground surface (BGS)
Water Table Elevation: 516.5 feet AMSL
Work Completed: 4/23/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	69	0 - 10	18.7	12.5	6.29	0.879	>999	90.0	8.06
2	502	79	10 - 20	23.5	13.3	6.99	0.724	>999	788	7.61
3	502	79	10 - 20	26.0	13.3	6.99	0.724	>999	788	7.61
4	492	89	20 - 30	29.7	13.7	7.46	0.642	>999	>999	7.89
5	482	99	30 - 40	23.1	14.1	7.33	0.642	>999	>999	8.68
6	472	109	40 - 50	1.40	14.8	7.32	0.664	>999	14.3	5.23
7	462	119	50 - 60	3.30	15.0	7.20	0.678	>999	530	6.74

[a]Samples are filtered through a 5 micron filter.

Table A.2-18. Geoprobe Location 13464

Easting '83: 1348271 feet
Northing '83: 474769 feet
Ground Elevation: 546 feet above mean sea level (AMSL)
Depth to Water Table: 30 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 6/27/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	35	0 - 10	23.4	21.4	7.49	0.783	>999	3.13	8.00
2	501	45	10 - 20	5.50	17.1	7.33	0.751	>999	54.9	4.19
3	501	45	10 - 20	6.10	17.1	7.33	0.751	>999	54.9	4.19
4	491	55	20 - 30	15.5	16.6	7.03	0.765	>999	121	4.73
5	481	65	30 - 40	22.4	15.3	7.06	0.845	>999	86.0	5.00
6	471	75	40 - 50	42.4	15.0	7.08	0.868	>999	555	4.54
7	461	85	50 - 60	40.6	14.4	7.12	0.862	>999	>999	6.40
8	451	95	60 - 70	23.8	15.4	7.09	0.769	>999	>999	7.02

[a]Samples are filtered through a 5 micron filter.

Table A.2-19. Geoprobe Location 13233A

Easting '83: 1348647 feet
Northing '83: 475198 feet
Ground Elevation: 581 feet above mean sea level (AMSL)
Depth to Water Table: 65.5 feet below ground surface (BGS)
Water Table Elevation: 515.5 feet AMSL
Work Completed: 4/30/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	71	0 - 10	44.8	14.4	6.70	0.765	>999	>999	8.72
2	501	81	10 - 20	19.9	15.0	7.06	0.724	>999	13.4	6.18
3	501	81	10 - 20	20.4	15.0	7.06	0.724	>999	13.4	6.18
4	491	91	20 - 30	16.7	16.1	7.51	0.661	>999	159	6.84
5	481	101	30 - 40	10.2	16.0	7.33	0.630	>999	>999	4.44
6	471	111	40 - 50	1.00	14.8	7.00	0.664	>999	123	3.57
7	461	121	50 - 60	1.00	15.3	7.21	0.641	>999	21.3	4.94
8	451	131	60 - 70	3.10	4.8	7.13	0.662	>999	519	5.64

[a]Samples are filtered through a 5 micron filter.

Table A.2-20. Geoprobe Location 13267A

Easting '83: 1348842 feet
Northing '83: 475194 feet
Ground Elevation: 580 feet above mean sea level (AMSL)
Depth to Water Table: 64 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 4/25/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	69	0 - 10	16.3	12.6	6.31	1.072	>999	28.7	7.46
2	501	79	10 - 20	17.4	13.3	6.83	0.710	>999	20.3	6.53
3	501	79	10 - 20	18.8	13.3	6.83	0.710	>999	20.3	6.53
4	491	89	20 - 30	16.8	13.9	7.31	0.688	>999	12.5	4.62
5	481	99	30 - 40	18.2	14.6	7.27	0.683	>999	126	6.37
6	471	109	40 - 50	7.70	14.3	6.99	0.740	>999	681	7.15
7	461	119	50 - 60	1.00	14.1	7.13	0.753	>999	28.3	7.46

[a]Samples are filtered through a 5 micron filter.

Table A.2-21. Geoprobe Location 13234A

Easting '83: 1349045 feet
Northing '83: 475202 feet
Ground Elevation: 581 feet above mean sea level (AMSL)
Depth to Water Table: 66 feet below ground surface (BGS)
Water Table Elevation: 515 feet AMSL
Work Completed: 4/16/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	71	0 - 10	32.8	18.6	7.07	1.056	>999	850	7.14
2	500	81	10 - 20	37.6	16.1	7.11	0.799	>999	193	7.71
3	500	81	10 - 20	37.8	16.1	7.11	0.799	>999	193	7.71
4	490	91	20 - 30	2.70	16.7	7.29	0.722	>999	44.4	7.24

[a]Samples are filtered through a 5 micron filter.

Table A.2-22. Geoprobe Location 13300B

Easting '83: 1348286 feet
Northing '83: 474907 feet
Ground Elevation: 574 feet above mean sea level (AMSL)
Depth to Water Table: 57.5 feet below ground surface (BGS)
Water Table Elevation: 516.5 feet AMSL
Work Completed: 6/19/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	63	0 - 10	46.4	23.6	7.61	0.797	>999	>999	6.66
2	502	73	10 - 20	7.00	17.4	7.20	0.758	>999	408	7.83
3	502	73	10 - 20	7.80	17.4	7.20	0.758	>999	408	7.83
4	492	83	20 - 30	8.40	17.2	7.19	0.783	>999	24.6	4.86
5	482	93	30 - 40	21.3	16.4	6.93	0.805	>999	73.3	5.50
6	472	103	40 - 50	35.4	16.2	6.92	0.863	>999	>999	6.16
7	462	113	50 - 60	46.2	17.4	7.08	0.853	>999	618	8.91
8	452	123	60 - 70	9.30	16.3	6.98	0.862	>999	341	6.32

[a]Samples are filtered through a 5 micron filter.

Table A.2-23. Geoprobe Location 13301B

Easting '83: 1348576 feet
Northing '83: 474902 feet
Ground Elevation: 581 feet above mean sea level (AMSL)
Depth to Water Table: 65 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 6/26/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	70	0 - 10	18.5	15.6	7.30	0.665	>999	>999	7.87
2	501	80	10 - 20	14.7	14.0	7.20	0.631	>999	18.0	5.46
3	501	80	10 - 20	15.3	14.0	7.20	0.631	>999	18.0	5.46
4	491	90	20 - 30	16.1	15.2	7.36	0.664	>999	NR[b]	7.36
5	481	100	30 - 40	9.60	16.0	7.47	0.645	>999	34.0	4.75

[a]Samples are filtered through a 5 micron filter.

[b] NR=Not Recorded

Table A.2-24. Geoprobe Location 13302B

Easting '83: 1348893 feet
Northing '83: 474900 feet
Ground Elevation: 582 feet above mean sea level (AMSL)
Depth to Water Table: 65.5 feet below ground surface (BGS)
Water Table Elevation: 516.5 feet AMSL
Work Completed: 5/29/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^{0}C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	71	0 - 10	7.50	18.3	7.21	1.045	>999	22.5	7.90
2	501.5	81	10 - 20	18.5	17.3	7.47	0.752	>999	3.98	6.73
3	501.5	81	10 - 20	18.9	17.3	7.47	0.752	>999	3.98	6.73
4	491.5	91	20 - 30	13.7	16.3	7.44	0.724	>999	204	6.00
5	481.5	101	30 - 40	1.20	17.2	7.27	0.793	>999	28.9	4.14

[a]Samples are filtered through a 5 micron filter.

Table A.2-25. Geoprobe Location 13306B

Easting '83: 1348310 feet
Northing '83: 474543 feet
Ground Elevation: 534 feet above mean sea level (AMSL)
Depth to Water Table: 17.5 feet below ground surface (BGS)
Water Table Elevation: 516.5 feet AMSL
Work Completed: 5/7/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (°C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	512	23	0 - 10	43.0	17.6	7.26	0.943	>999	>999	13.54
2	502	33	10 - 20	10.4	18.1	7.29	0.742	>999	18.2	6.00
3	502	33	10 - 20	11.8	18.1	7.29	0.742	>999	18.2	6.00
4	492	43	20 - 30	9.80	16.7	6.99	0.710	>999	7.00	4.10
5	482	53	30 - 40	12.5	15.3	7.10	0.697	>999	7.99	4.76
6	472	63	40 - 50	9.60	14.5	7.38	0.633	>999	18.8	4.51

[a]Samples are filtered through a 5 micron filter.

Table A.2-26. Geoprobe Location 13308B

Easting '83: 1348969 feet
Northing '83: 474570 feet
Ground Elevation: 584 feet above mean sea level (AMSL)
Depth to Water Table: 69.5 feet below ground surface (BGS)
Water Table Elevation: 514.5 feet AMSL
Work Completed: 6/20/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (°C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	75	0 - 10	22.0	16.5	7.18	0.771	>999	555	7.43
2	500	85	10 - 20	36.1	16.8	7.27	0.648	>999	279	9.36
3	500	85	10 - 20	38.6	16.8	7.27	0.648	>999	279	9.36
4	490	95	20 - 30	6.00	18.2	7.38	0.621	>999	200	5.40
5	480	105	30 - 40	3.10	17.1	7.09	0.691	>999	185	4.00

[a]Samples are filtered through a 5 micron filter.

Table A.2-27. Geoprobe Location 13461

Easting '83: 1348184 feet
Northing '83: 475200 feet
Ground Elevation: 536 feet above mean sea level (AMSL)
Depth to Water Table: 20 feet below ground surface (BGS)
Water Table Elevation: 516 feet AMSL
Work Completed: 4/15/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (µg/L)	Temperature filtered[a] (°C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	511	25	0 - 10	31.5	13.7	6.77	0.727	>999	52.9	9.33
2	501	35	10 - 20	27.0	15.6	7.55	0.723	>999	899	8.79
3	501	35	10 - 20	30.2	15.6	7.55	0.723	>999	899	8.79
4	491	45	20 - 30	21.8	13.5	7.37	0.571	>999	992	6.66
5	481	55	30 - 40	14.5	12.5	7.57	0.571	>999	348	5.91
6	471	65	40 - 50	13.7	13.4	7.63	0.586	>999	142	5.15

[a]Samples are filtered through a 5 micron filter.

Table A.2-28. Geoprobe Location 13465

Easting '83: 1348768 feet
Northing '83: 474732 feet
Ground Elevation: 581 feet above mean sea level (AMSL)
Depth to Water Table: 66 feet below ground surface (BGS)
Water Table Elevation: 515 feet AMSL
Work Completed: 7/3/2013

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temp filtered[a] (C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	510	71	0 - 10	**26.5**	**16.2**	**6.81**	**0.681**	**>999**	**>999**	**8.34**
2	500	81	10 - 20	**10.2**	**14.1**	**7.06**	**0.664**	**>999**	**112**	**3.77**
3	500	81	10 - 20	**11.2**	**14.1**	**7.06**	**0.664**	**>999**	**112**	**3.77**
4	490	91	20 - 30	**20.5**	**15.5**	**7.17**	**0.668**	**>999**	**31.3**	**4.57**
5	480	101	30 - 40	**16.9**	**15.5**	**7.15**	**0.656**	**>999**	**22.6**	**4.36**

[a]Samples are filtered through a 5 micron filter.

Table A.2-29. Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2013 Results Above FRLs

Well	No. of Samples	Minimum (µg/L)[a,b,c,d]	Maximum (µg/L)[a,b,c,d]	Average (µg/L)[a,b,c,d,e]	Standard Deviation (µg/L)[a,b,c,d,e]	Trend[a,b,c,d,e,f]
2045	68	12.0	462	123	106	Up
2046	67	20	907	153	207	No Trend
2049	53	3	178	76.8	43.0	Down
2060	81	8.4	332	78.0	60.4	Down
2095	66	27	208	101	48	Down
23271	24	34.6	144	77	32	Down
23273	24	114	421	248	82	Down
23274	37	120	384	184	62	Down
23275	23	119	349	173	56	Up
23276	24	60.4	115	84.2	13.9	No Trend
23278	24	44.6	201	94.2	43.9	Down
23280	24	57.2	700	166	146	Down
23281	24	37.5	367	137	80	Down
2385	47	48.5	592	233	110	Down
2387	47	18.1	492	153	84	Up
2389	36	0.899	120	30.0	25.2	Up
2390	46	31.6	163	73.0	30.7	Down
2397	33	135	737	384	130	No Trend
2649	43	6.01	1110	193	305	Up
2880	47	0.4	64.9	18.5	22.8	Up
3069	73	0.5	398	125	95	Down
3095	67	2	94	25.9	17.3	No Trend
3821	40	7.95	136	19.5	22.0	Up
62433	36	52.2	845	327	203	Down
63285	24	74.9	277	202	47	No Trend
63287	24	78.6	316	157	66	Down
6880	34	57.2	145	87.3	22.5	Down
82369_C1	4	12.1	210	135	86	Up
82369_C3	2	24.0	30.6	NA	NA	NA
82372_C1	4	35.7	62.4	47.8	11.1	No Trend
82433_C3	26	45.2	506	206	138	Down
83117_C1	26	440	1620	844	290	Down
83117_C2	13	33.4	330	137	116	Down
83117_C4	13	71.3	111	86.0	12.5	No Trend
83124_C1	39	185	1070	494	209	No Trend
83124_C2	20	27.8	103	53.8	18.5	Down
83124_C4	13	25.4	62.2	39.8	9.9	Up
83124_C5	13	24.4	61.4	50.3	9.1	No Trend
83294_C1	20	98.5	285	184	44	Up
83294_C2	30	188	575	377	84	Down
83294_C3	16	20.5	539	299	161	Down
83295_C2	20	92.3	178	138	30	No Trend
83295_C3	17	66.7	175	129	35	Down
83295_C4	14	41.6	199	103	58	Down
83295_C5	13	42.4	155	79.5	31.9	Down
83295_C6	13	3.4	64.4	32.5	22.1	Up
83296_C1	10	56.7	135	85.1	23.8	No Trend

Table 29 (continued). Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2013 Results Above FRLs

Well	No. of Samples	Minimum (µg/L)[a,b,c,d]	Maximum (µg/L)[a,b,c,d]	Average (µg/L)[a,b,c,d,e]	Standard Deviation (µg/L)[a,b,c,d,e]	Trend[a,b,c,d,e,f]
83337_C1	18	871	2660	1690	590	Up
83337_C2	27	2.67	835	153	198	No Trend
83338_C1	11	454	710	559	79	No Trend
83338_C2	16	15.9	648	151	177	Down
83339_C1	11	6.09	39.6	19.1	11.8	No Trend
83340_C1	12	13.2	44.8	28.2	9.9	Up
83346_C2	11	10.7	70.7	40.4	14.8	Down

[a] Summary statistics and Mann-Kendall test for trend are primarily based on unfiltered samples with some filtered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2013 groundwater data.

[b] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.

[c] Rejected data qualified with either an R were not included in this count, the summary statistics, or Mann-Kendall test for trend.

[d] If the number of samples is greater than or equal to four, then all of the summary statistics and the Mann-Kendall test for trend are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.

[e] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.

[f] Mann-Kendall test for trend is performed using data from third quarter 1998 through 2013.

Table A.2-30. Summary Statistics and Trend Analysis of Extraction Wells for Total Uranium

Well	Number of Samples[a,b]	Minimum (µg/L)[a,b,c]	Maximum (µg/L)[a,b,c]	Average (µg/L)[a,b,c]	Standard Deviation (µg/L)[a,b,c]	Trend[a,b,c]
South Plume Module (August 27, 1993 through December 31, 2013)						
3924	605	1.8	180	29.9	14.9	Down
3925	605	0.5	84	24.1	7.8	Down
3926	595	1.5	42.4	25.2	8.2	Up
3927	599	1.0	17	2.62	1.10	Up
South Plume Optimization Module (August 9, 1998 through December 31, 2013)						
32308	531	18.4	100	53.1	15.8	Down
32309	541	24.5	123	54.0	19.4	Down
South Field Module (July 13, 1998 through December 31, 2013)						
31550	556	16.2	128	50.8	18.5	Down
31560	583	12.1	183	58.3	37.6	Down
31561	556	18.1	114[d]	40.2	10.3	Down
32276	599	20.1	290	98.9	62.8	Down
32446	454	24.5	168	59.5	19.8	Down
32447	474	21.9	302	105	54	Down
33061	354	15.5	98.5	45.5	14.6	Down
33262	312	21.8	110	46.3	13.6	Down
33264	308	15.8	364	80.0	40.8	Down
33265	307	6.5	96.5	21.1	7.7	Down
33266	304	4.3	105	15.2	10.4	Down
33298	263	10.1	76.2	51.2	10.5	Down
33326	213	15.1	62.2	25.4	6.7	Down
Waste Storage Area Module (May 8, 2002 through December 31, 2013)						
32761	347	21.2	161	59.7	32.4	Down
33062	360	10.2	236	67.4	44.4	Down
33334	176	8.5	50	16.3	7.1	Down
33347	171	7.0	126	26.8	19.7	Down

[a] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[b] Rejected data qualified with either an R were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[c] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[d] This result (sampled August 31, 1998) appears to be an outlier. It is suspected that the sample for this well was switched with the sample from extraction well 31562.

Table A.2-31. Uranium Concentration Data from Direct-Push Location 12369 and Monitoring Well 82369

Location 12369 (2001 through 2011)			Multi-channel Well 83269 (2012 and 2013)					
Midpoint Screen Elevation[a] (ft amsl)	Uranium (µg/L)	2011 Uranium (µg/L)	Channel	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)			
					First Half 2012	Second Half 2012	First Half 2013	Second Half 2013
517 to 511	10.3 to 137	67.8	83269_C1	515 to 513[b]	12.1	151	167	210
507 to 501	3.9 to 43	11.5	83269_C2	504	25.1	NA[c]	28.9	NA[c]
497 to 491	3.4 to 20.4	6.2	83269_C3	491	24	NA[c]	30.6	NA[c]

[a] Range based on midpoint screen elevation for direct-push locations.
[b] Range based on saturated portion of well screen at time of sampling.
[c] NA = Not applicable. Channel completed in plume interval with the highest measured concentration is sampled every 6 months; remaining channels are sampled once a year.

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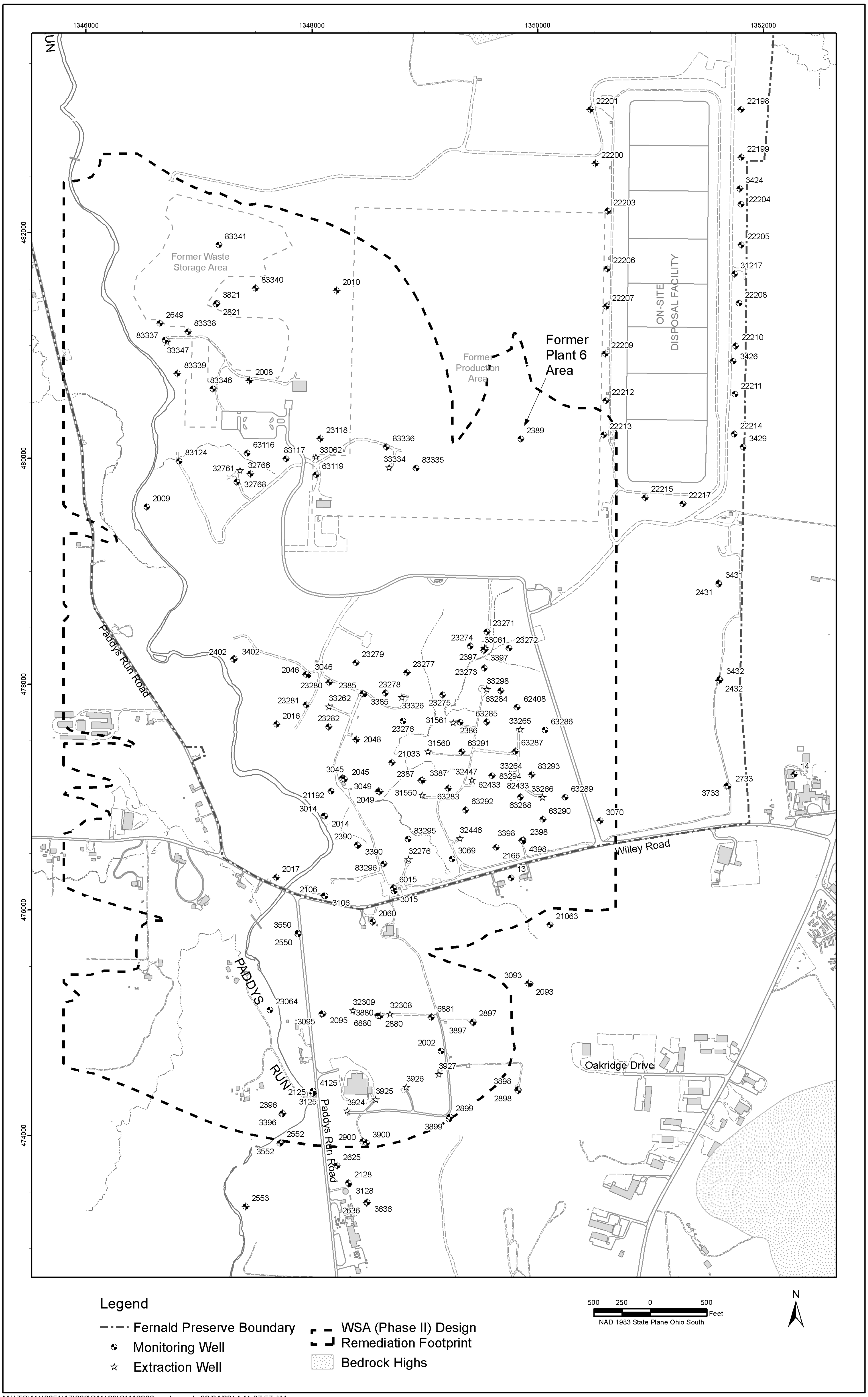

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Figure A.2-1. IEMP Water Quality Monitoring Wells and Extraction Wells

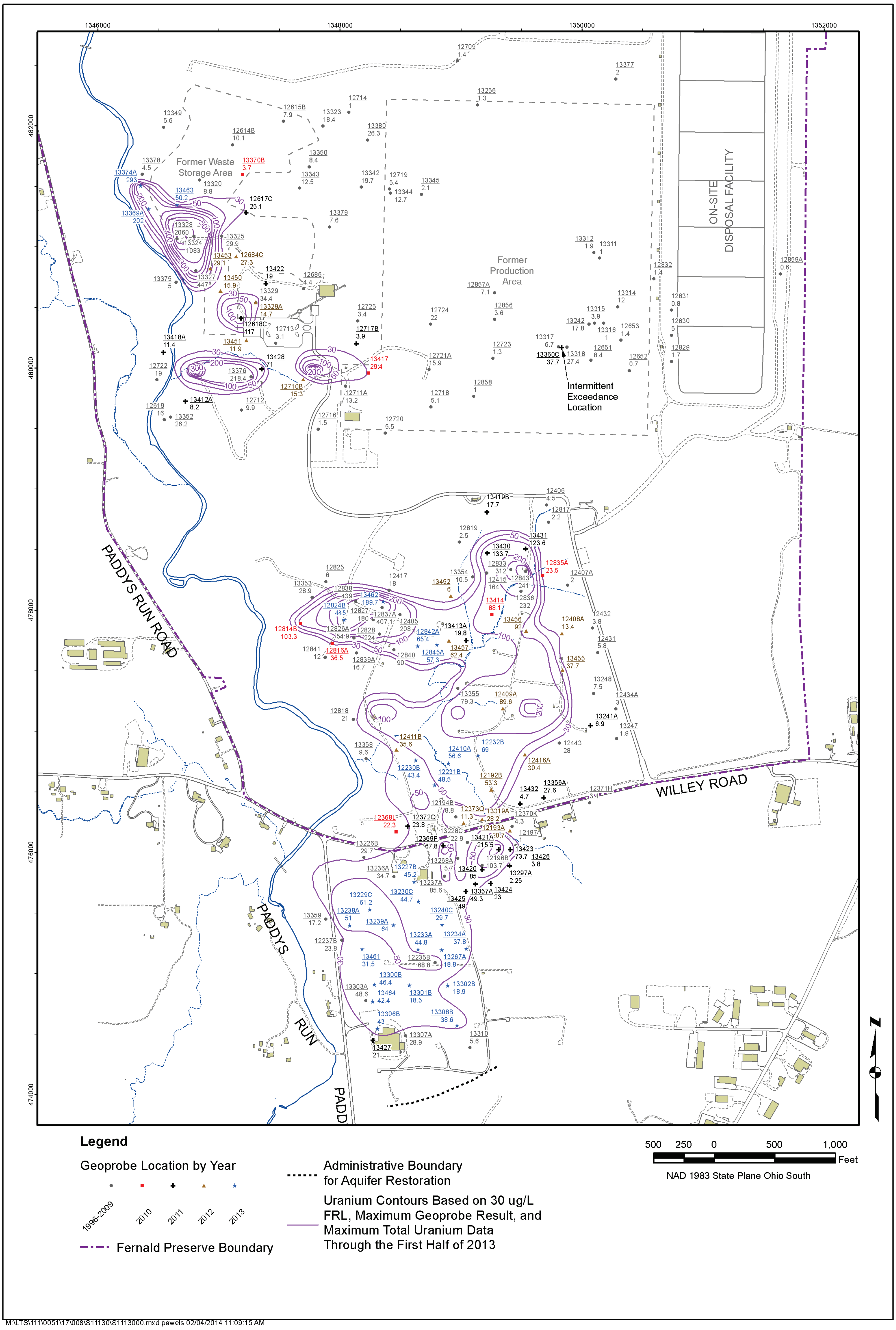

Figure A.2-2A. Direct-Push Data and Maximum Total Uranium Plume Through the First Half of 2013

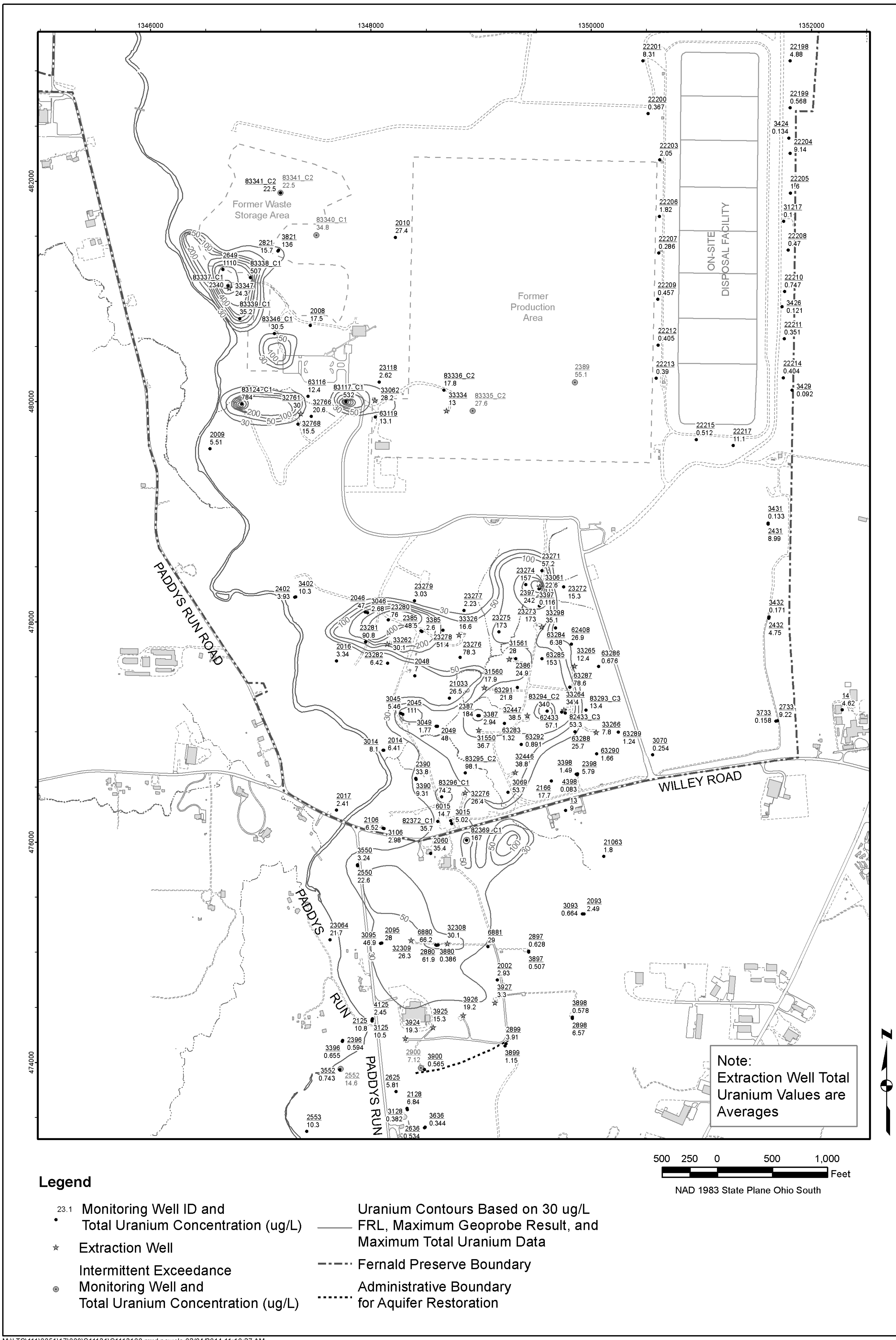

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Figure A.2-2B. Monitoring Well Data and Maximum Total Uranium Plume Through the First Half of 2013

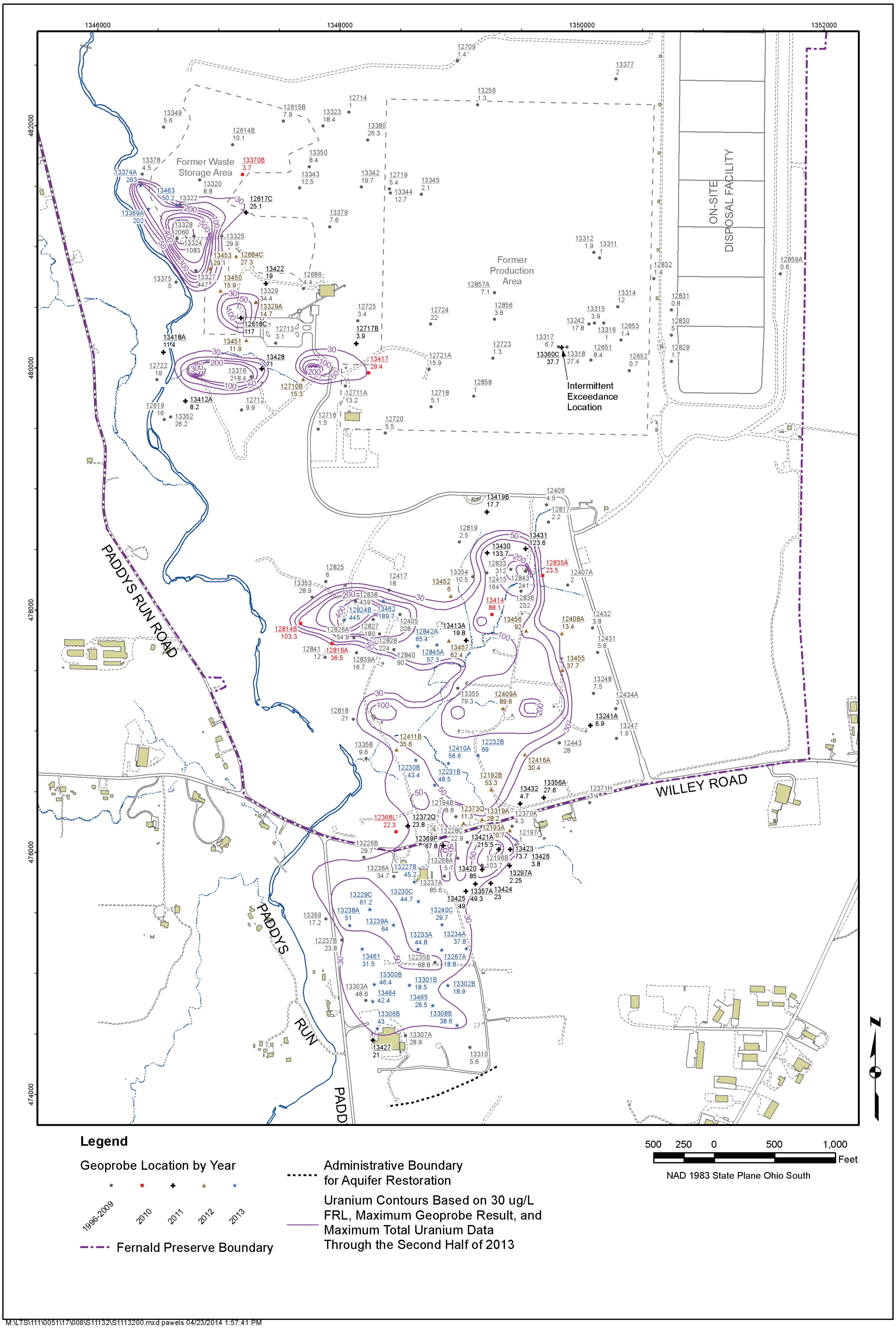

Figure A.2-3A. Direct-Push Data and Maximum Total Uranium Plume Through the Second Half of 2013

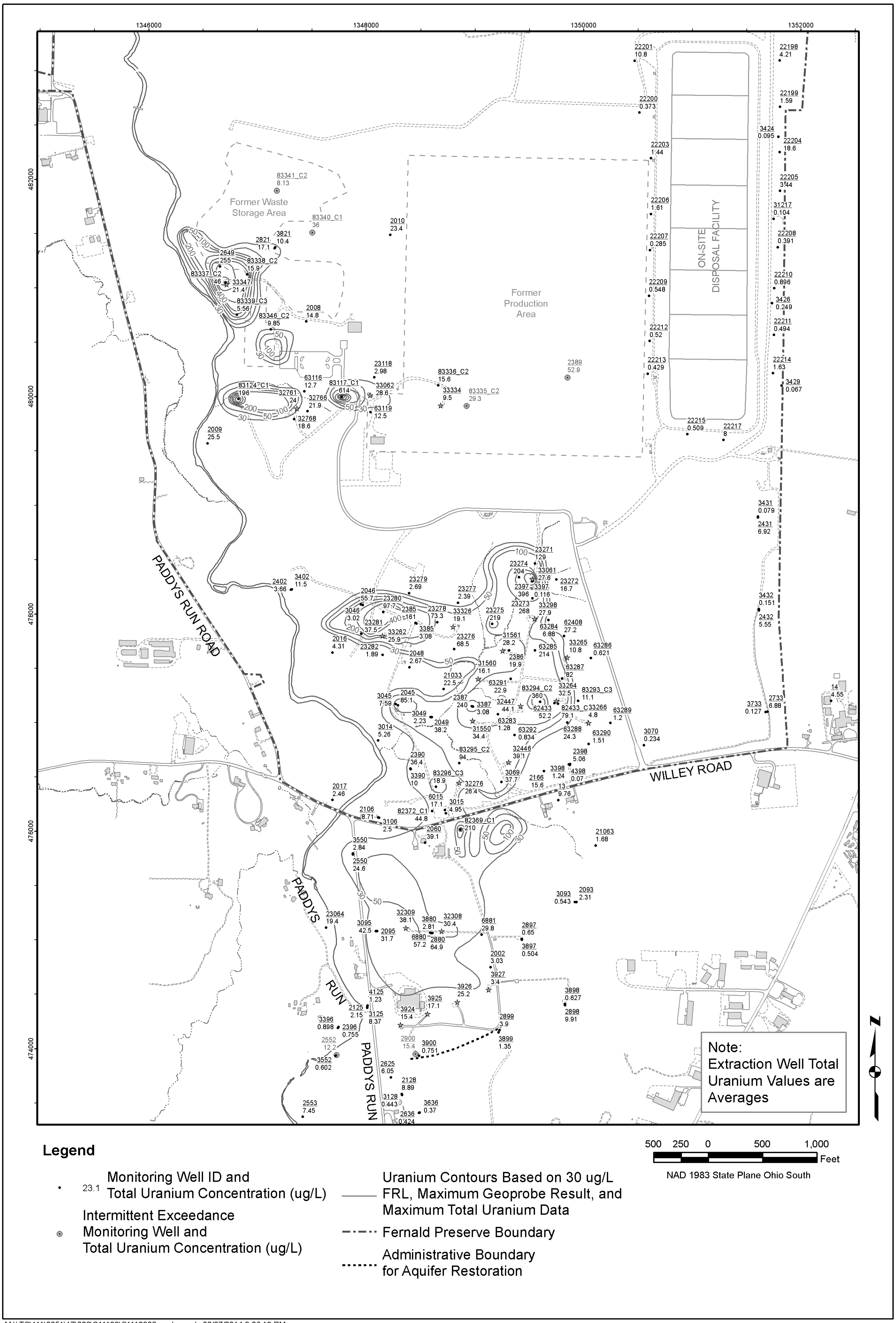

Figure A.2-3B. Monitoring Well Data and Maximum Detected Total Uranium Plume Through the Second Half of 2013

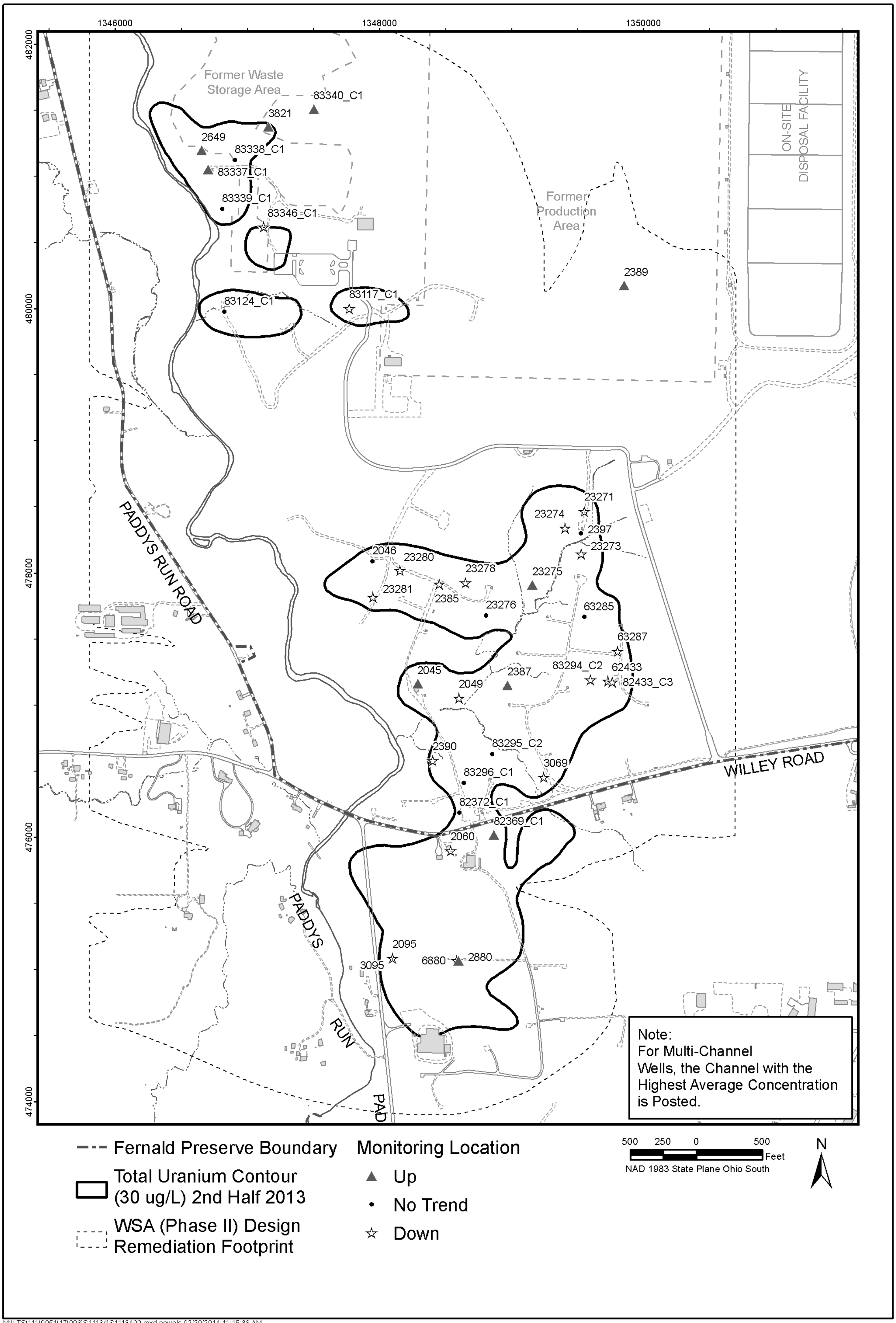

Figure A.2-4. Monitoring Wells with 2013 Exceedances for Total Uranium with Up, Down, or No Significant Trends

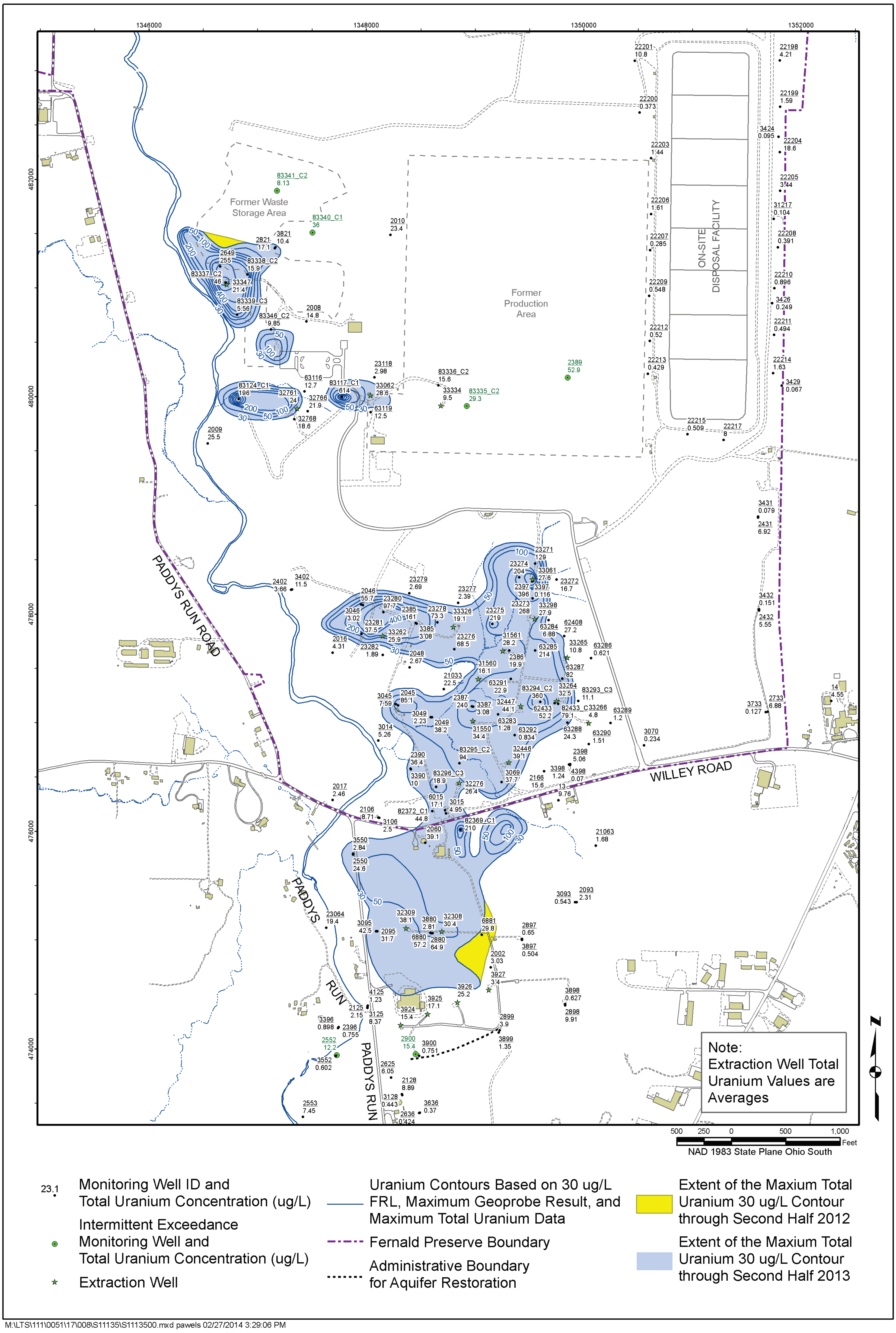

Figure A.2-5. Monitoring Well Data Through the Second Half of 2013 with Maximum Total Uranium Plume Footprint Through the Second Half of 2012 and 2013

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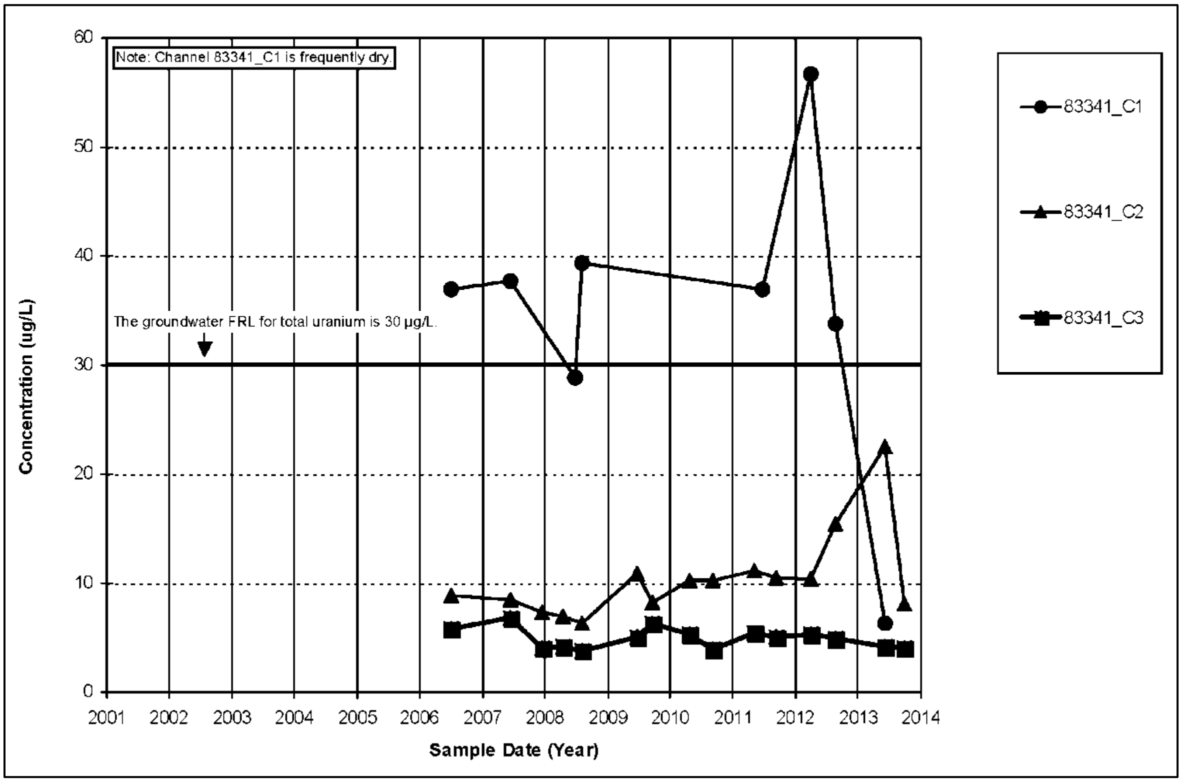

Figure A.2-6. Total Uranium Concentration Versus Time Plot for Monitoring Well 83341

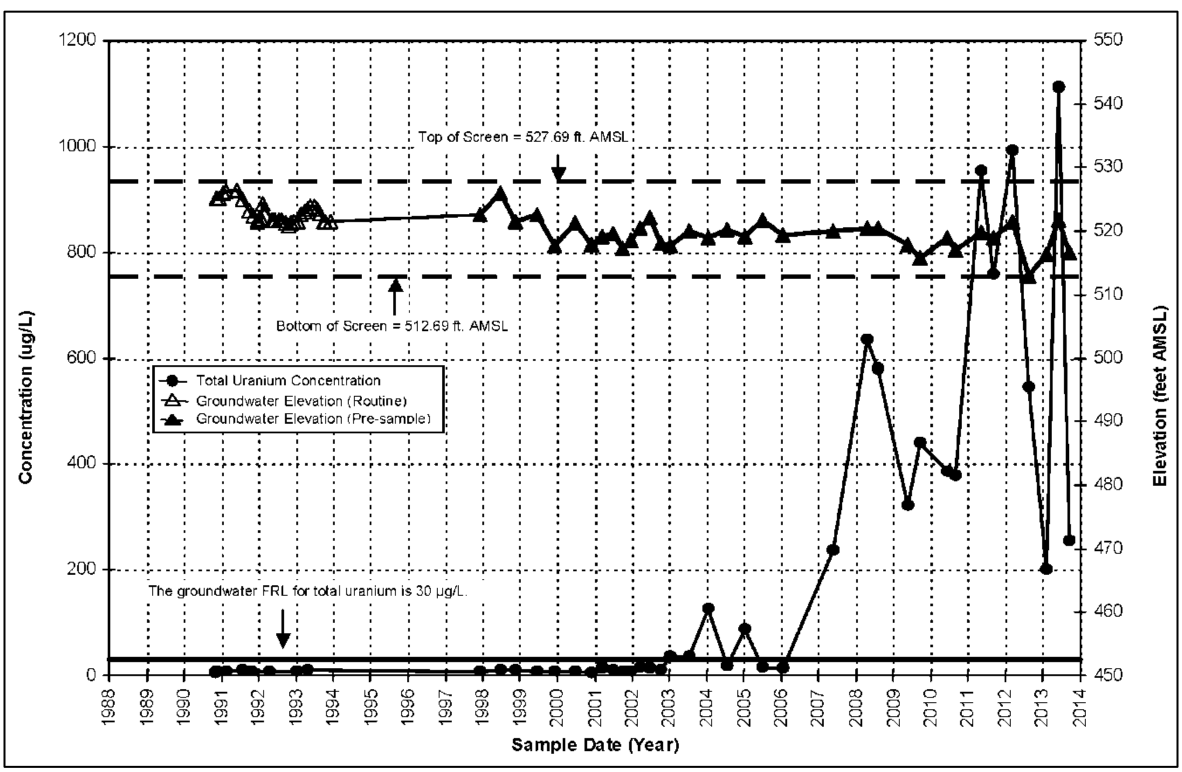

Figure A.2-7. Total Uranium Concentration Versus Time Plot for Monitoring Well 2649

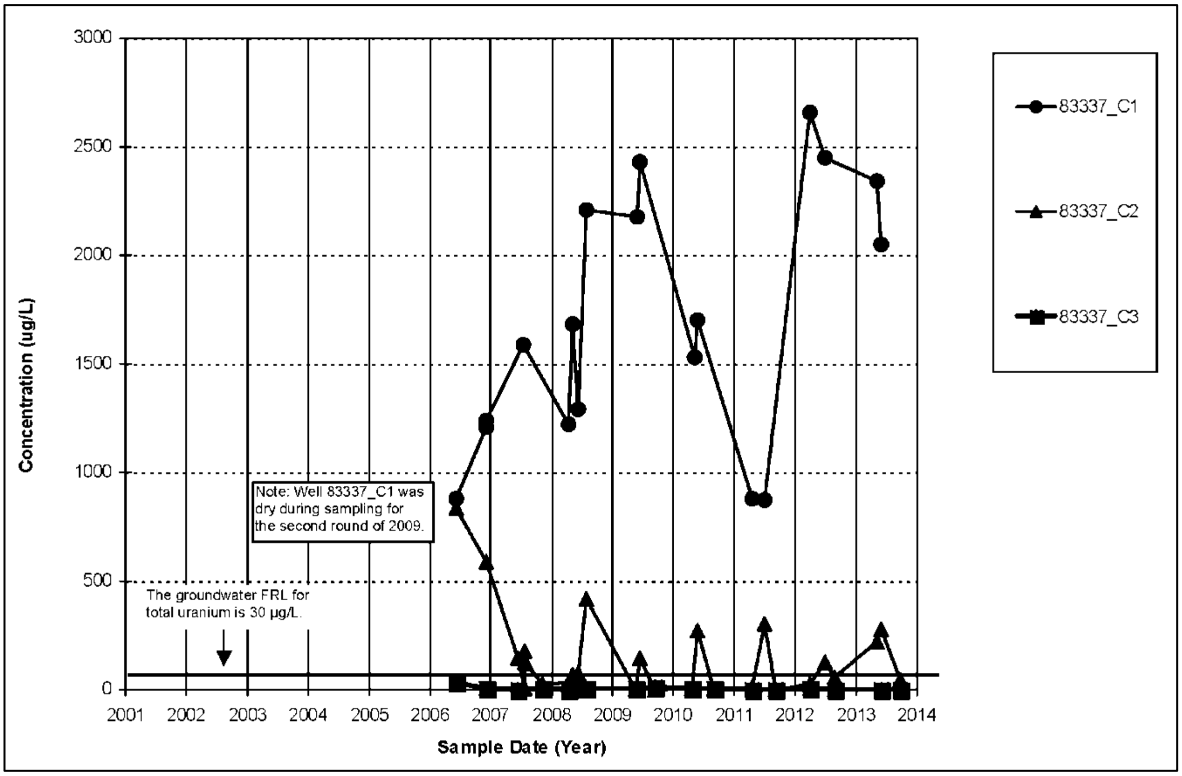

Figure A.2-8. Total Uranium Concentration Versus Time Plot for Monitoring Well 83337

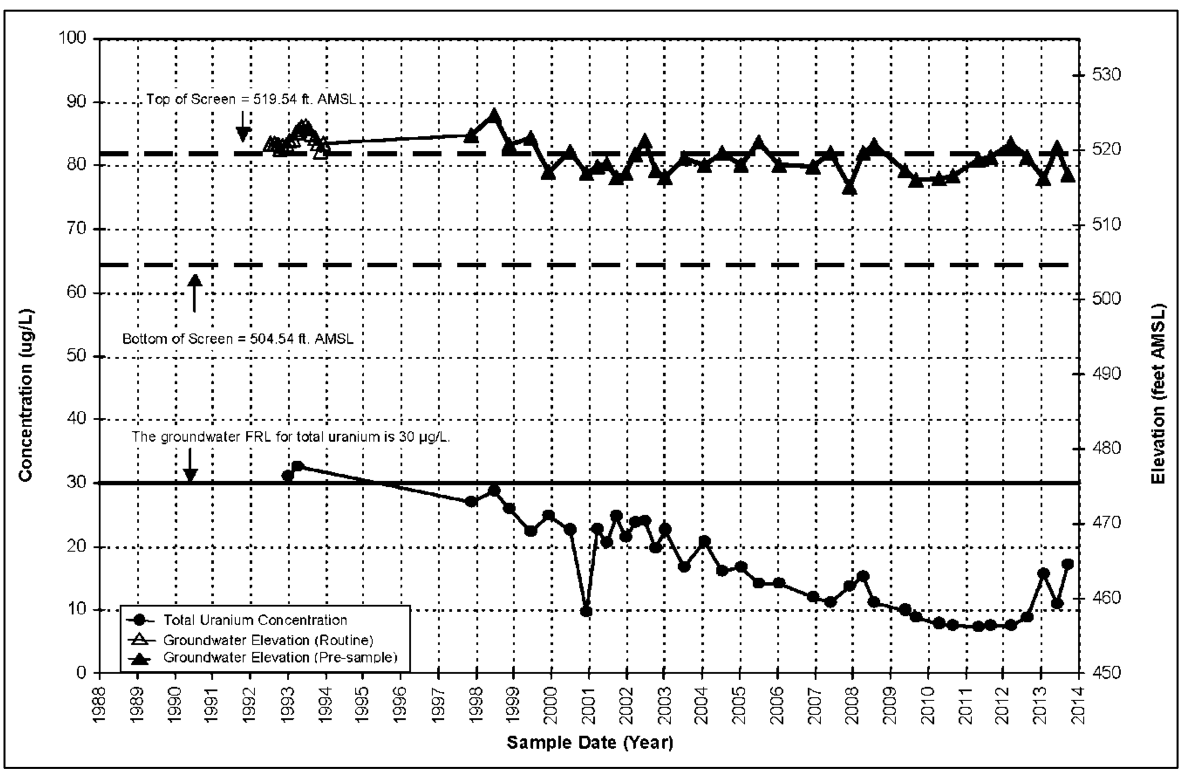

Figure A.2-9. Total Uranium Concentration Versus Time Plot for Monitoring Well 2821

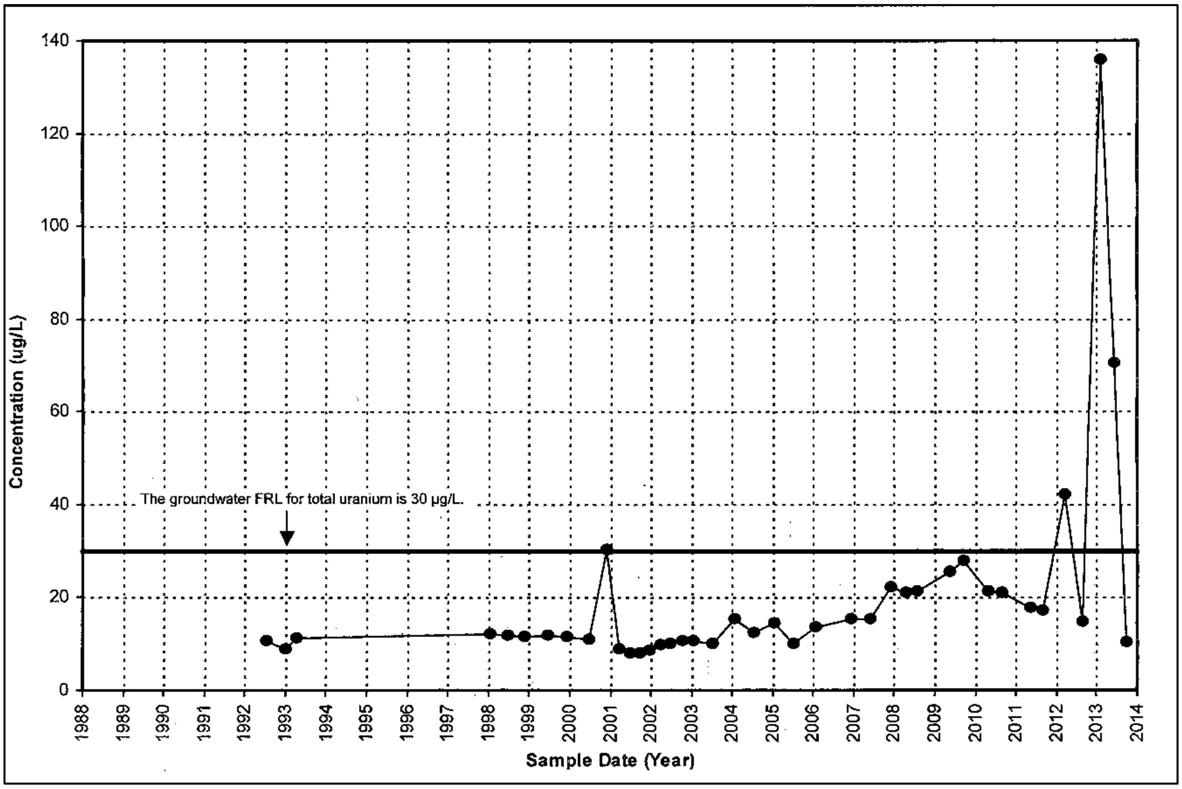

Figure A.2-10. Total Uranium Concentration Versus Time Plot for Monitoring Well 3821

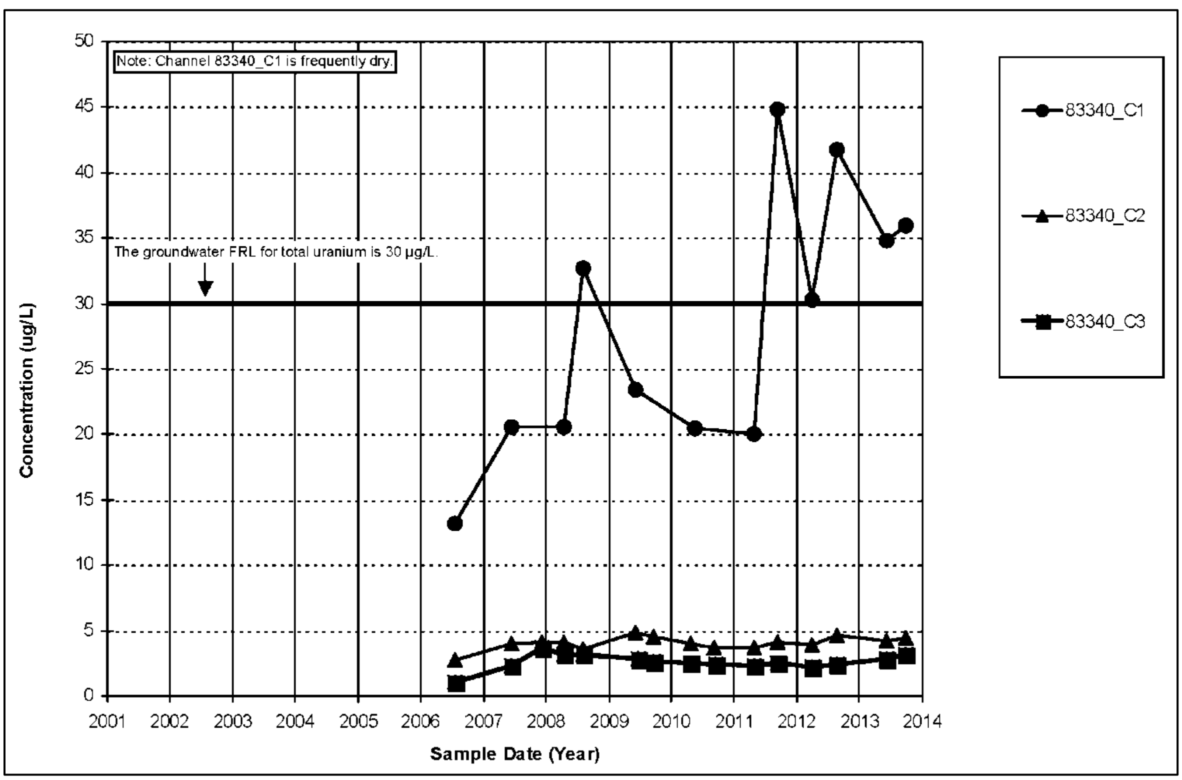

Figure A.2-11. Total Uranium Concentration Versus Time Plot for Monitoring Well 83340

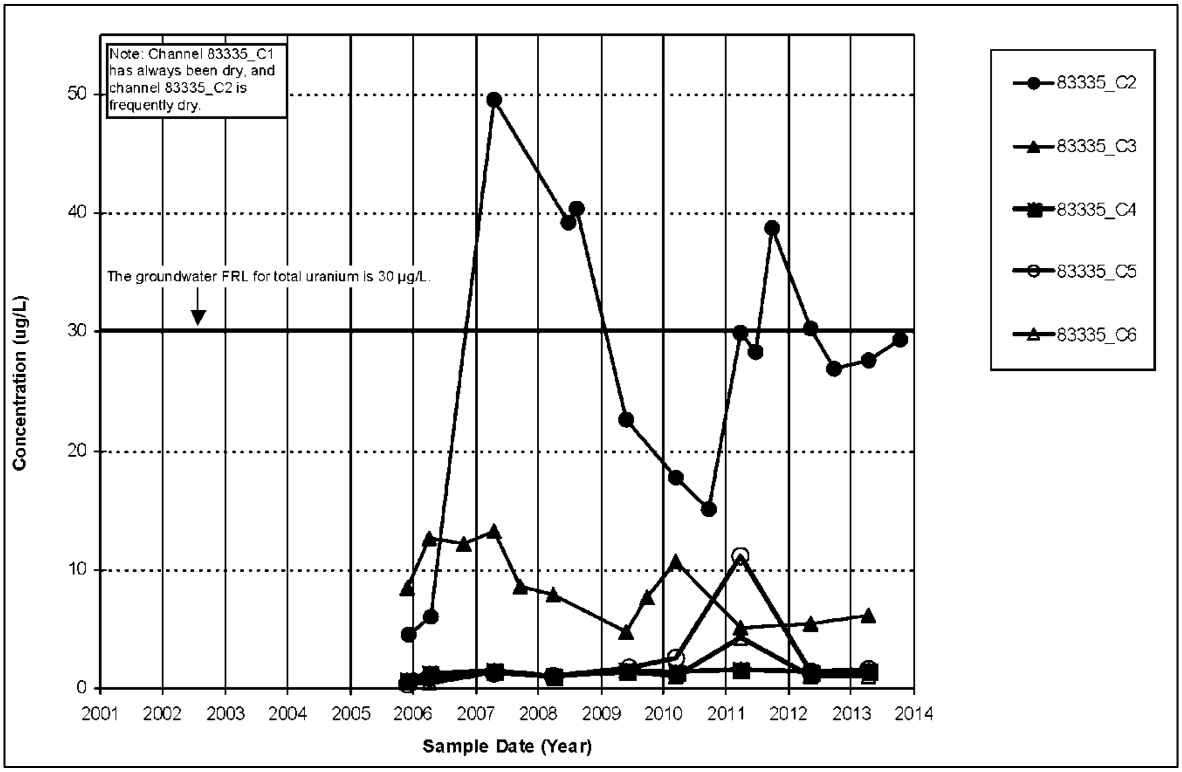

Figure A.2-12. Total Uranium Concentration Versus Time Plot for Monitoring Well 83335

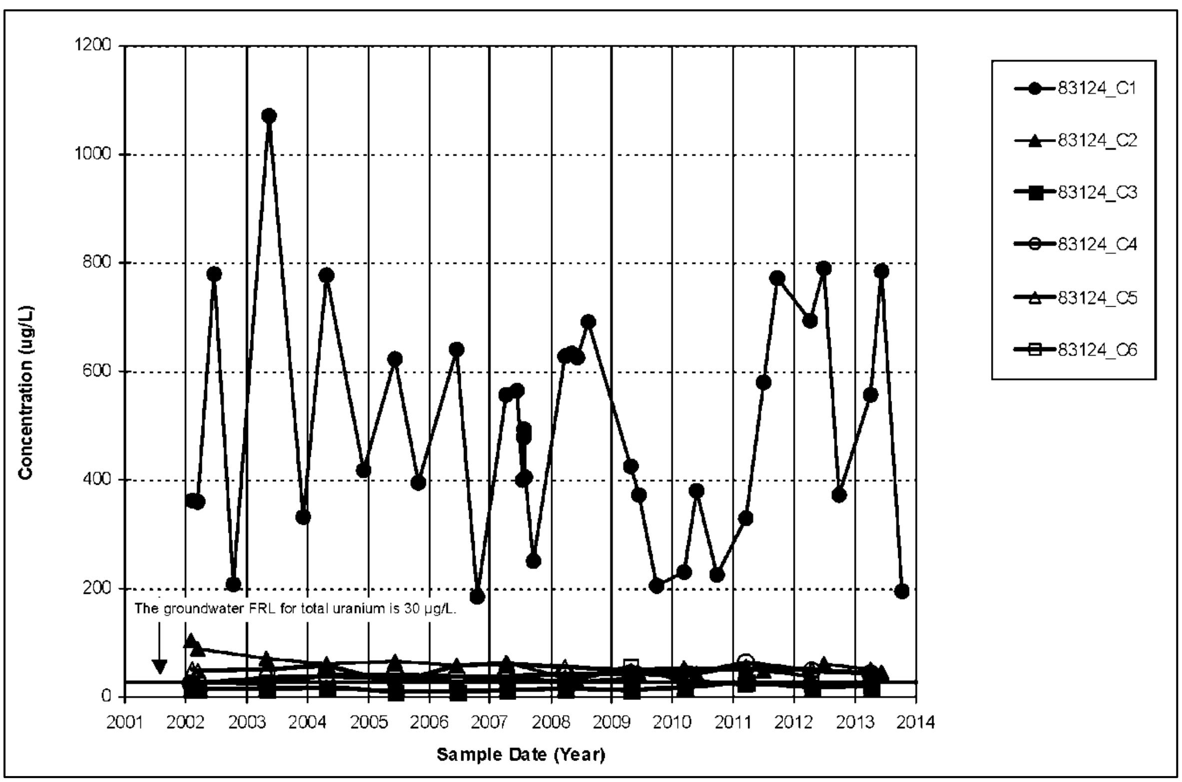

Figure A.2-13. Total Uranium Concentration Versus Time Plot for Monitoring Well 83124

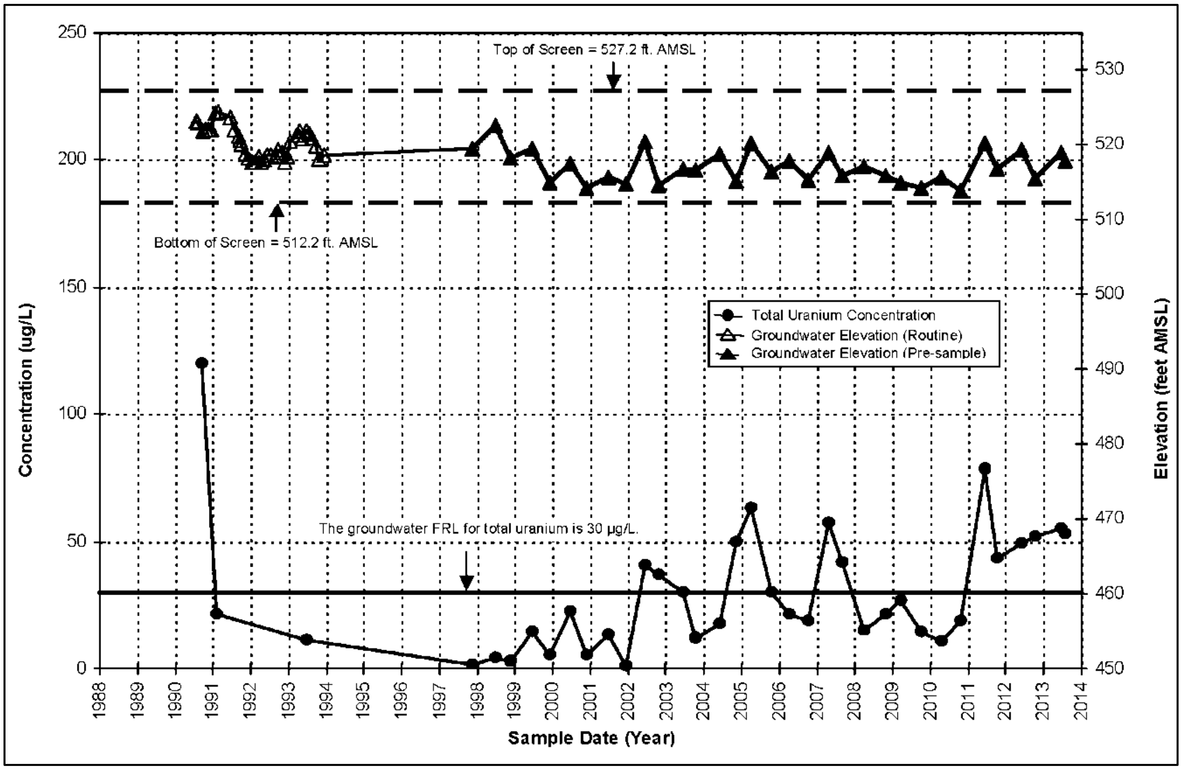

Figure A.2-14. Total Uranium Concentration Versus Time Plot for Monitoring Well 2389

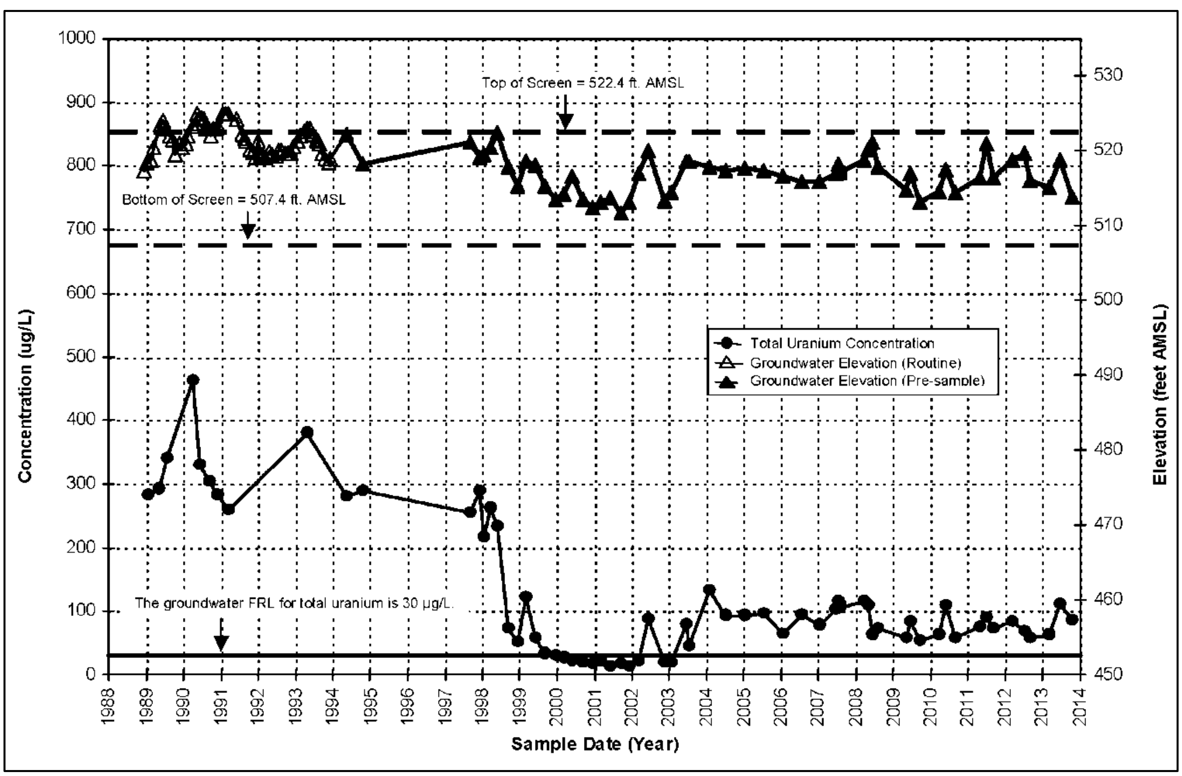

Figure A.2-15. Total Uranium Concentration Versus Time Plot for Monitoring Well 2045

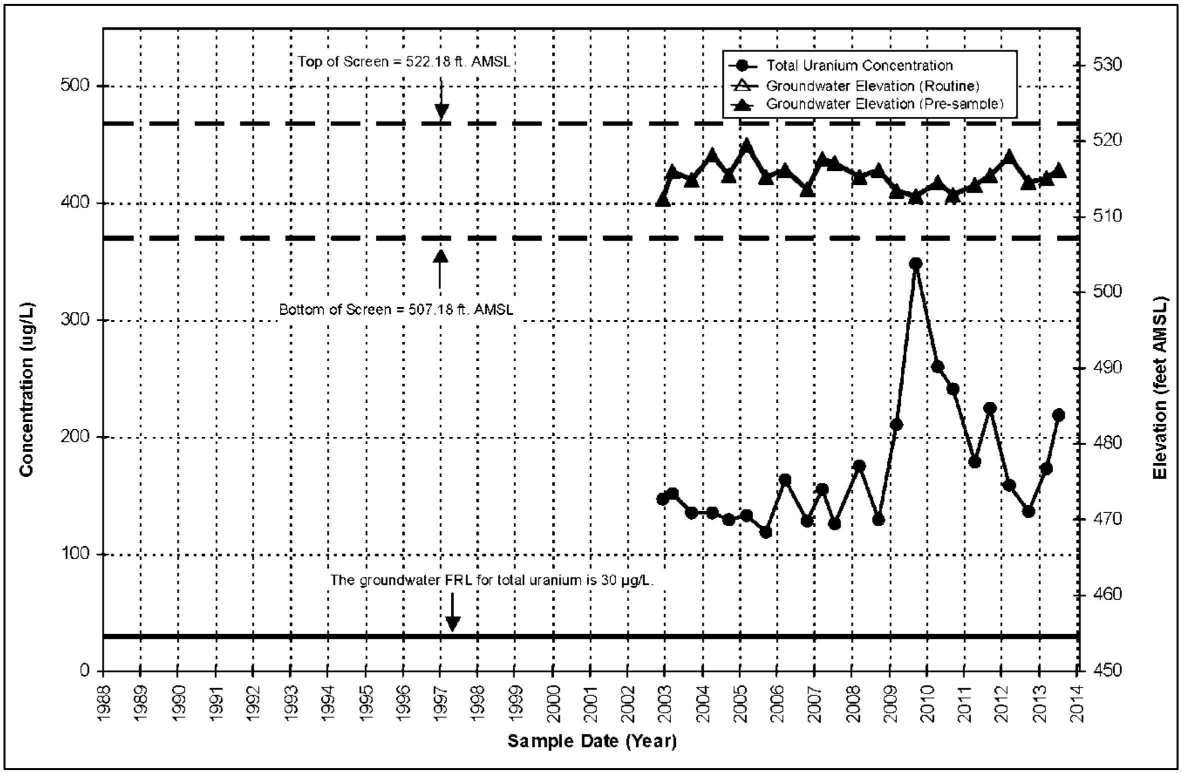

Figure A.2-16. Total Uranium Concentration Versus Time Plot for Monitoring Well 23275

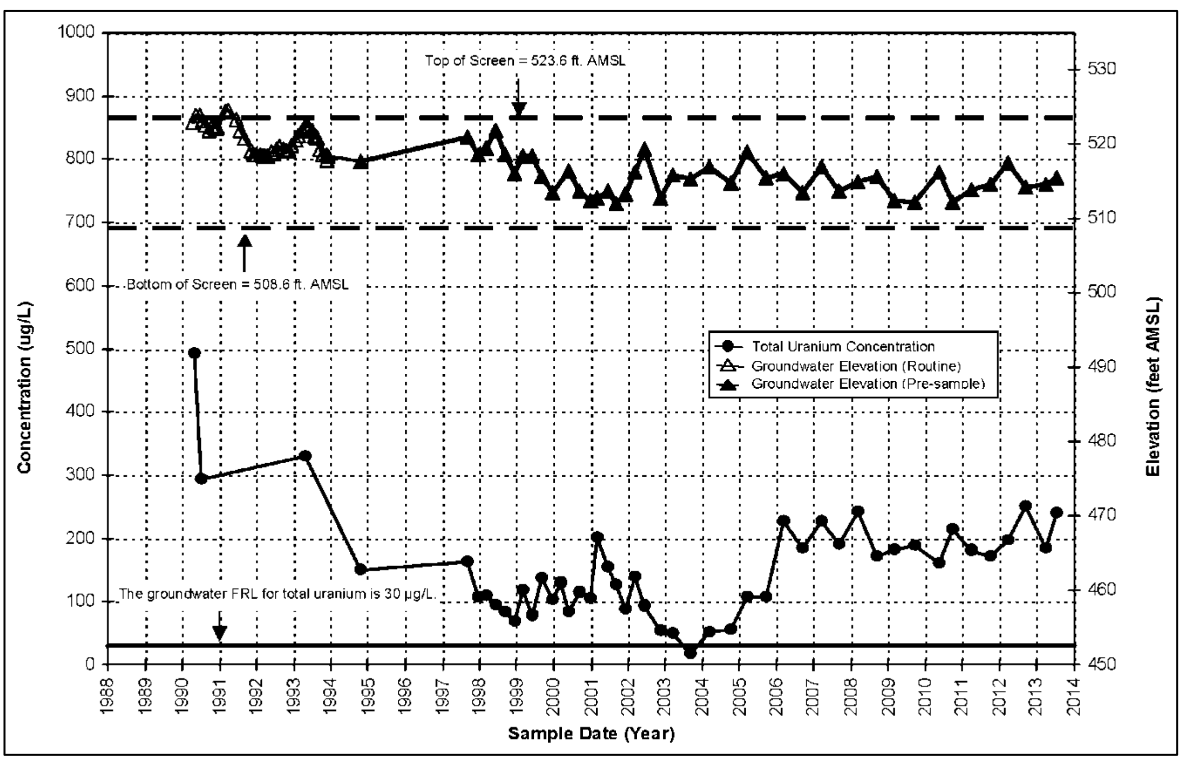

Figure A.2-17. Total Uranium Concentration Versus Time Plot for Monitoring Well 2387

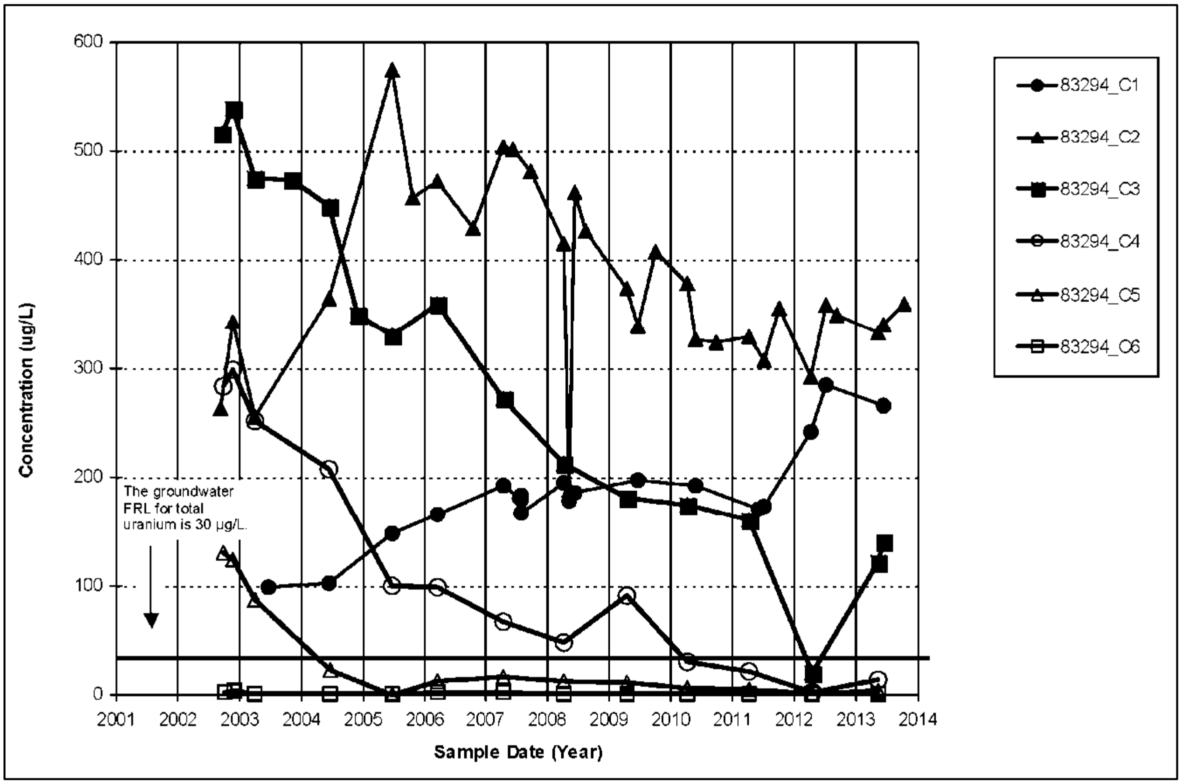

Figure A.2-18. Total Uranium Concentration Versus Time Plot for Monitoring Well 83294

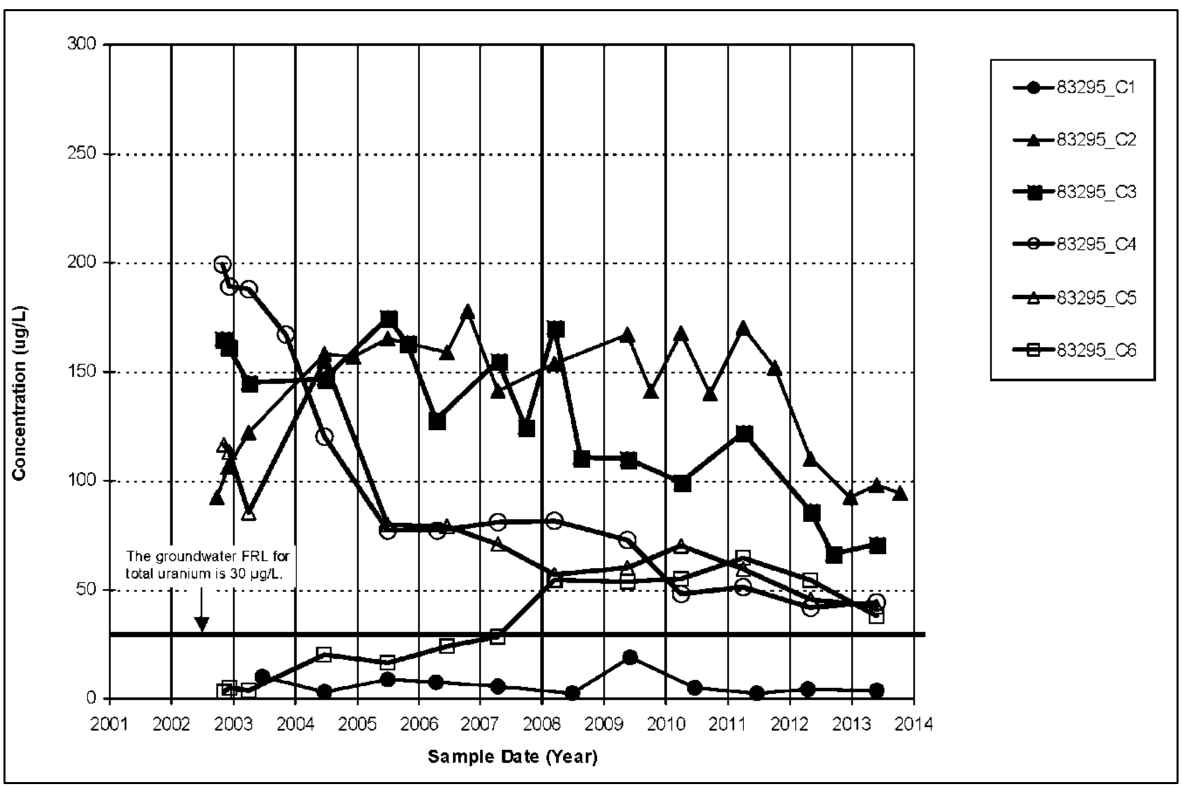

Figure A.2-19. Total Uranium Concentration Versus Time Plot for Monitoring Well 83295

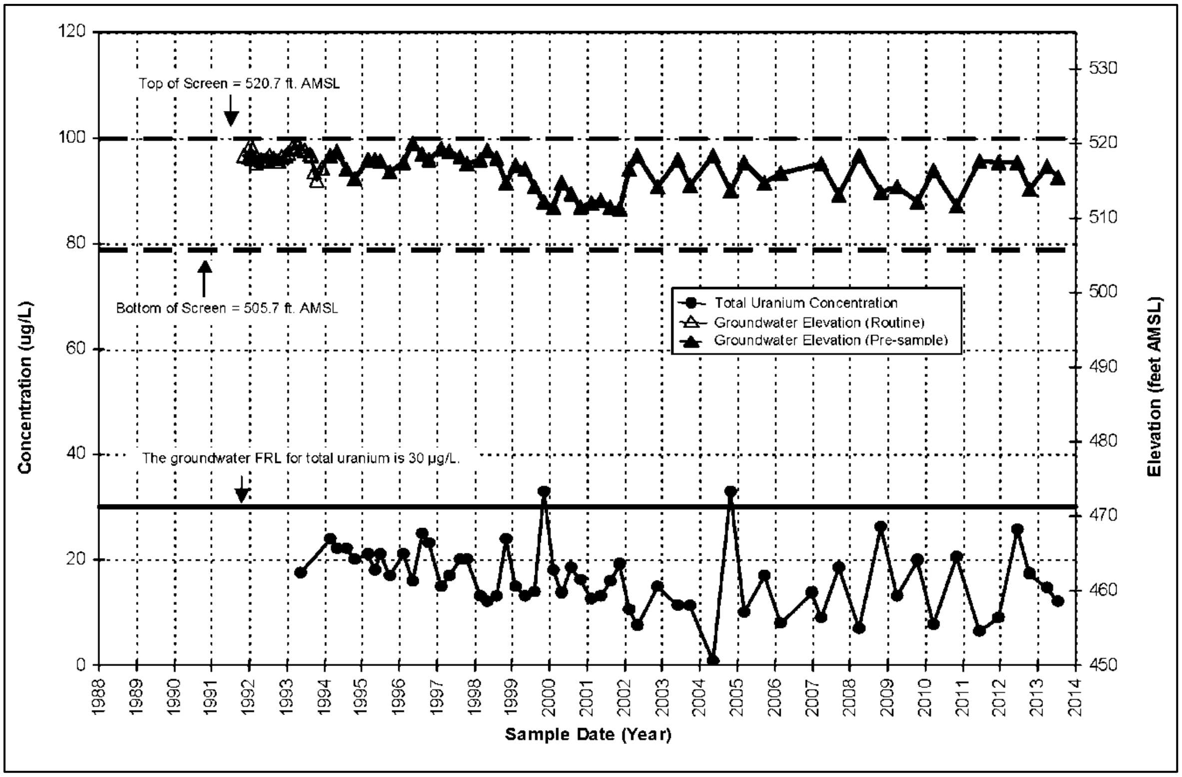

Figure A.2-20. Total Uranium Concentration Versus Time Plot for Monitoring Well 2552

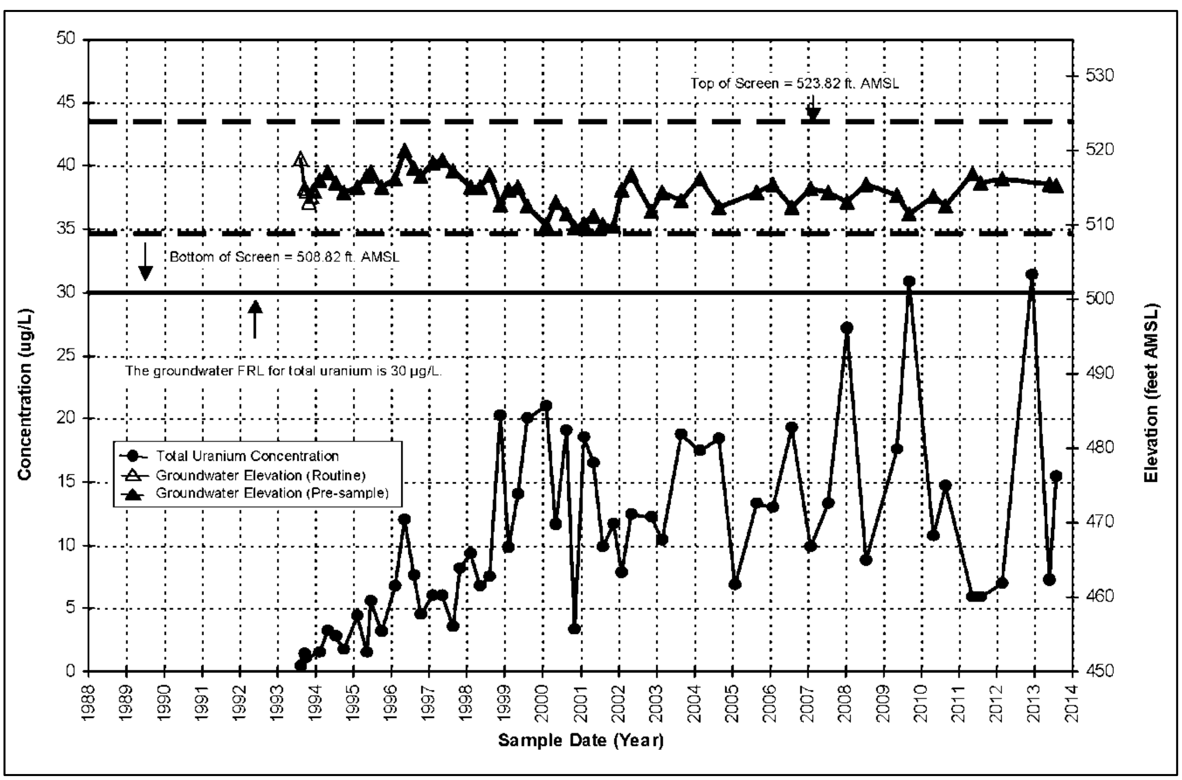

Figure A.2-21. Total Uranium Concentration Versus Time Plot for Monitoring Well 2900

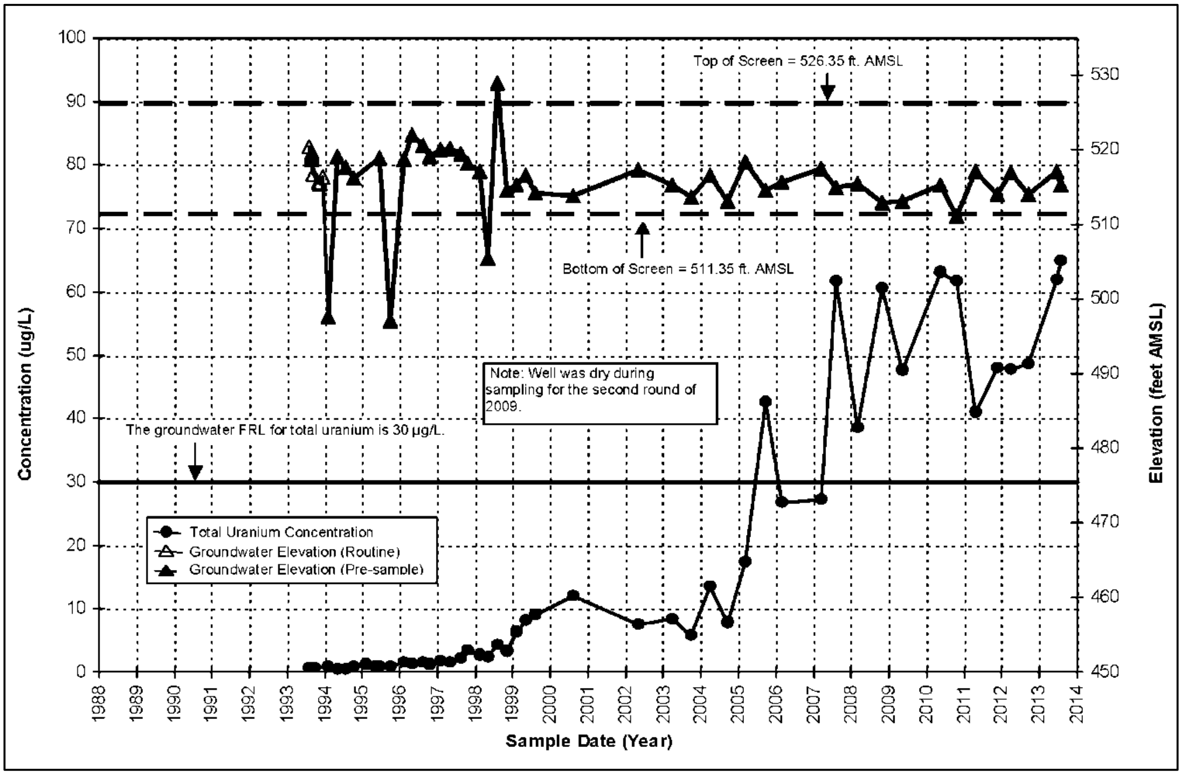

Figure A.2-22. Total Uranium Concentration Versus Time Plot for Monitoring Well 2880

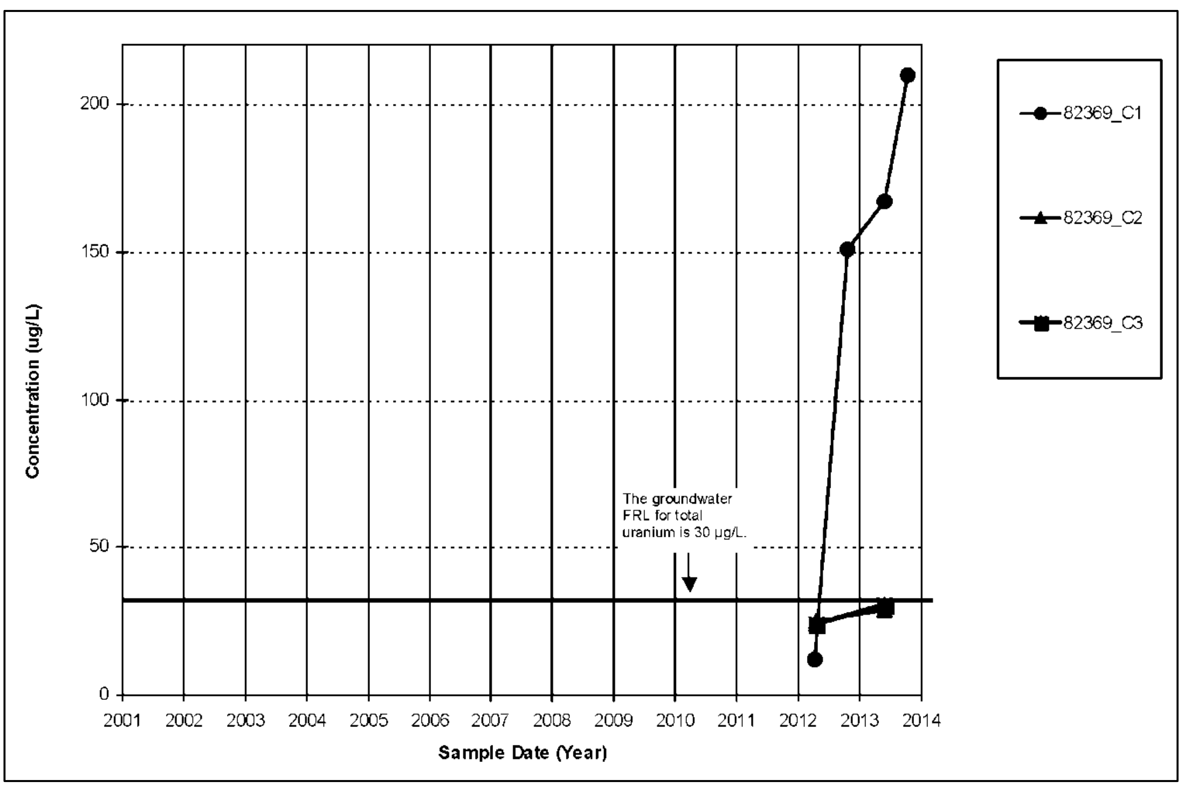

Figure A.2-23. Total Uranium Concentration Versus Time Plot for Monitoring Well 82369

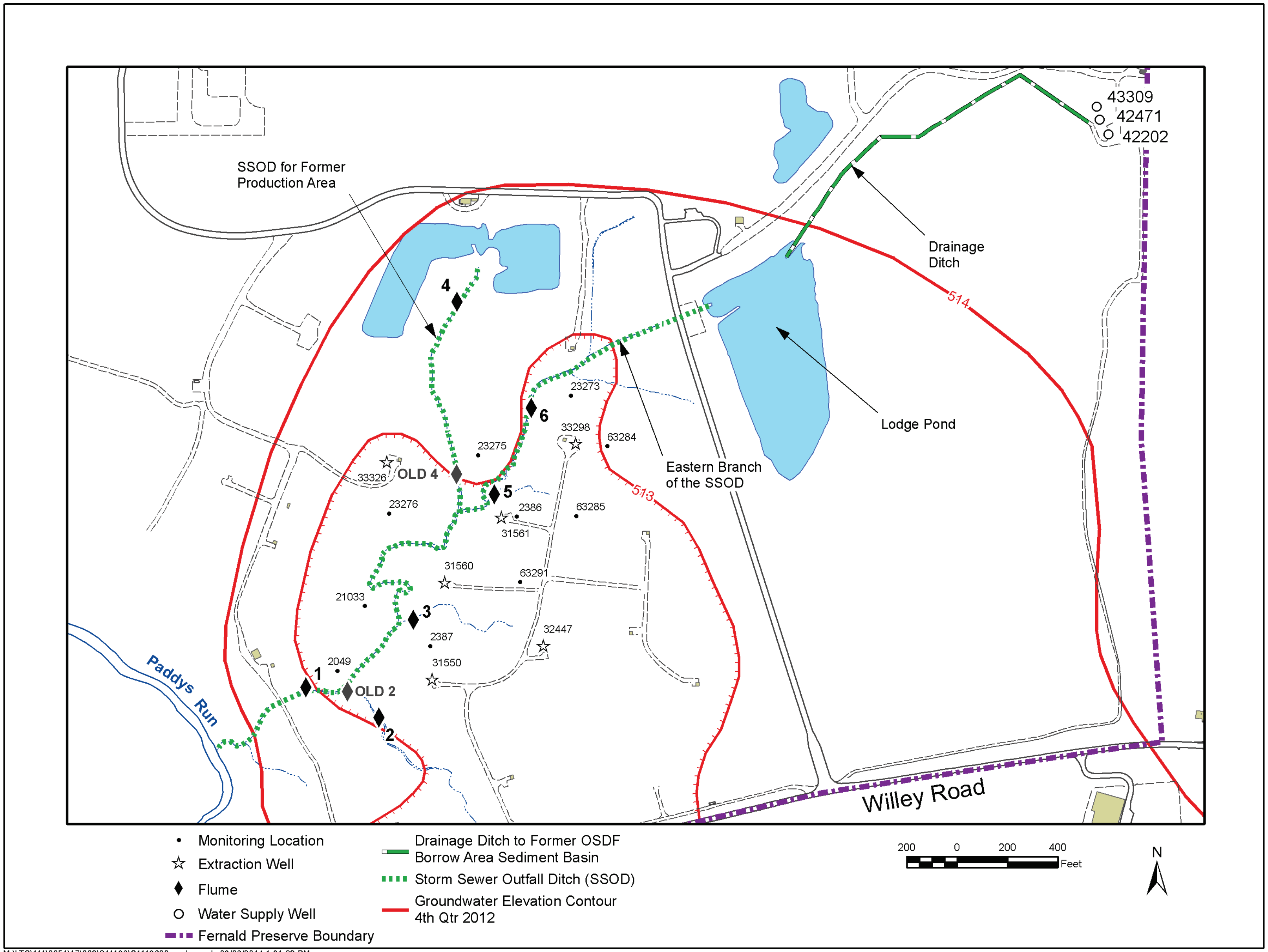

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Figure A.2-24. SSOD Flumes and Water Supply Wells

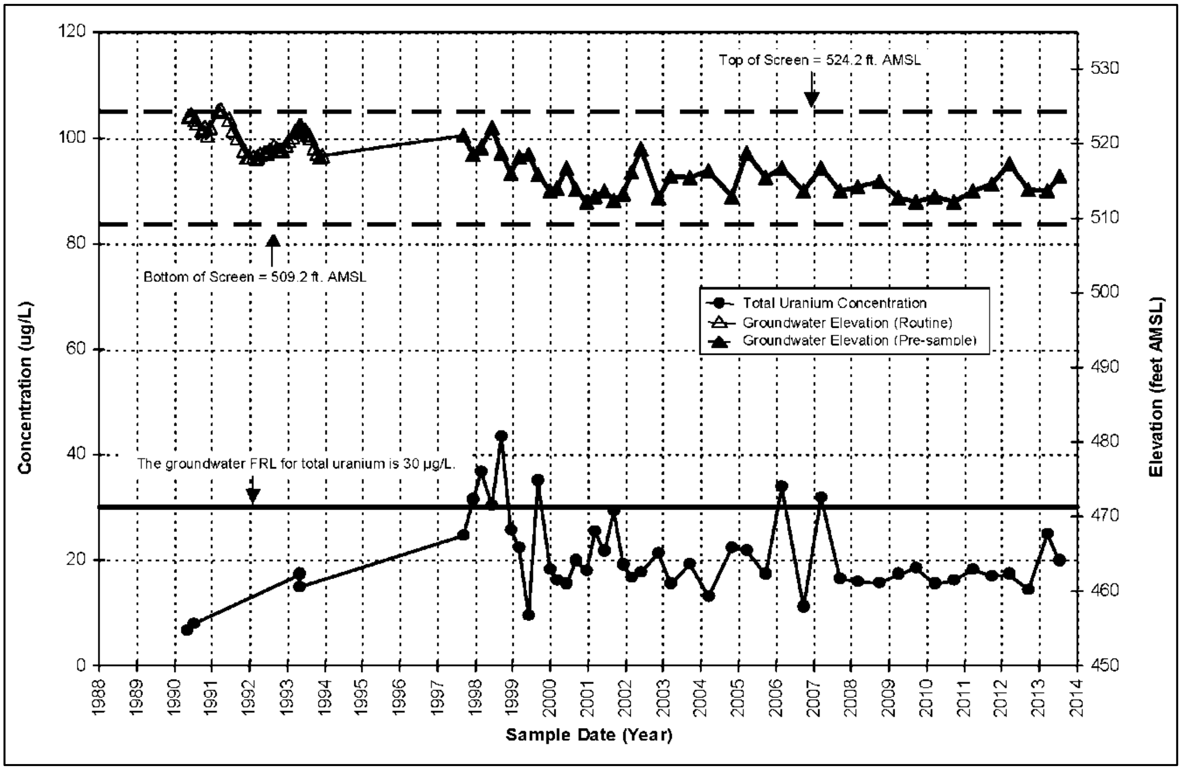

Figure A.2-25. Total Uranium Concentration Versus Time Plot for Monitoring Well 2386

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Attachment A.3

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Contents

Tables

Figures

Abbreviations

IEMP	Integrated Environmental Monitoring Plan
OSDF	On-Site Disposal Facility
VAM 3D	Variable Saturated Analysis Model in 3 Dimensions
WSA	Waste Storage Area

Measurement Abbreviations

ft	feet
µg/L	micrograms per liter

A.3.0 Groundwater Elevations and Capture Assessment

A.3.1 Groundwater Elevations and Capture Assessment

Quarterly groundwater elevation maps for 2013 are provided in Figures A.3-1 through A.3-4. Each groundwater elevation map contains the following quarter-specific information:

- Groundwater elevation data.
- Interpreted water table contours, capture zones, and flow divides.
- Bedrock highs.
- Waste Storage Area (WSA) (Phase II) design particle track defined remediation footprint.
- Extent of the maximum 30 micrograms per liter (µg/L) total uranium plume.
- Module-specific pumping rates during the time period in which the groundwater elevation measurements were collected and the number of wells in each module.

Water levels in 2013 were measured as specified in the Integrated Environmental Monitoring Plan (IEMP) which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (DOE 2013). 179 monitoring wells were available for measurement. During the second quarter of 2013, all 179 wells were targeted for water level measurements. During the other three quarters, 102 of the 179 available wells were targeted for measurement.

Quarter	Measurement Dates (2013)	Number of Days	Average Water Level (ft amsl)
1	January 14 to January 15	2	514.58
2	April 9 to April 11	3	516.53
3	July 1 to July 3	3	517.68
4	October 7 to October 8	2	514.54

ft amsl = feet above mean sea level

Six monitoring wells and the uppermost sampling interval in nine multi-channel monitoring wells were not measured at various times in 2013 because the wells were dry. A summary is provided below.

Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
2014	DRY			DRY
2108	DRY			
2384	DRY			
2544				DRY
2636	DRY			DRY
21192	DRY	DRY	DRY	DRY
82433_C1		DRY		
83293_C1	DRY	DRY		DRY
83294_C1	NS	DRY		
83295_C1	DRY			DRY
83335_C1	DRY	DRY	DRY	DRY
83336_C1	DRY	DRY	DRY	DRY
83337_C1	DRY	DRY		DRY
83341_C1	DRY	DRY		DRY
83346_C1	DRY			DRY

The 2013 quarterly groundwater elevation maps shown in Figures A.3-1 through A.3-4 illustrate capture of the maximum total uranium plume by means of groundwater elevation contours derived from quarterly water level measurements and predicted capture based on WSA (Phase II) design particle track modeling. The pumping rates reported on Figures A.3-1 through A.3-4 are averages of the actual pumping rates during the measurement period.

The WSA (Phase II) design remediation footprint used in this report was constructed using reverse, non-retarded, particle path interpretations from the Variable Saturated Analysis Model in 3 Dimensions (VAM 3D) Zoom Groundwater Model. Figure A.3-5 shows the resulting particle tracks that were used to define the WSA (Phase II) design remediation footprint. Model particles were seeded at each extraction well. The resulting particle tracks represent the individual path that each particle traveled over the time period modeled for the WSA (Phase II) design (2007 to 2023). The limits of most of the particle tracks are truncated because the particles reached the edge of the VAM 3D Zoom Groundwater Model domain.

A groundwater flow divide between Paddys Run Outlet and the New Baltimore Outlet is not readily distinguishable. Groundwater flow diverges around the bedrock high that separates the Paddys Run Outlet from the New Baltimore Outlet, but without additional measurement locations in the New Baltimore Outlet, the location where flow is dividing is not apparent. Additional measurement locations in the New Baltimore Outlet though are not needed for capture assessment purposes.

During 2013, the flow direction in the vicinity of the On-Site Disposal Facility (OSDF) was generally northeast to south/southwest. This flow direction is influenced by active pumping taking place for the groundwater remediation which is predicted to last until 2023 (based on the WSA Phase II design). Prior to the start of pumping for the groundwater remediation, flow in the vicinity of the OSDF was generally west to east. It is anticipated that when pumping stops, flow direction in the vicinity of the OSDF will return to a generally west to east direction.

Figure A.3-6 shows cumulative annual precipitation levels for 2004 through 2013, as recorded at the Butler County Regional Airport. Cumulative precipitation in 2013 was 40.09 inches.

Average annual water table fluctuations and yearly ranges for 2006 through 2013 are as follows:

Year	Average Fluctuation (feet)	Fluctuation Range (feet)
2013	3.45	0.35 to 4.28
2012	4.70	1.1 to 6.79
2011	7.50	7.4 to 14.5
2010	3.78	0.06 to 12.1
2009	2.46	0.1 to 5.5
2008	5.70	1.0 to 10.46
2007	4.45	1.7 to 7.7
2006	3.40	2.0 to 7.1

Quarterly capture zone interpretations coupled with the WSA (Phase II) particle track interpretations and contoured water table gradients indicate that the 30-µg/L total uranium plume was being captured in 2013.

A.3.2 Annual Planned Well Field Shutdown

The entire well field (excluding the South Plume recovery wells) was shut down from May 13 to June 17 as planned to allow water levels to recover to non-pumping elevations. Routine quarterly water level measurements were not collected in 2013 during the planned shutdowns.

Uranium contamination is bound to aquifer sediments in the unsaturated portion of the Great Miami Aquifer beneath former contamination source areas. This contamination will remain bound unless water levels in the aquifer rise and saturate the contaminated sediments, allowing the bound contamination to dissolve into the groundwater.

Planned annual well field shutdowns have been conducted since 2007 to allow water levels in the aquifer to rise as high as possible to saturate aquifer material that is not normally saturated. To achieve the highest water level rise possible, the well field shutdowns are planned to coincide with seasonal high-water levels in the aquifer.

Water Level Results

Pressure transducers were installed in 11 groundwater monitoring wells (2045, 2046, 2649, 23274, 62433, 32763, 23118, 22301, 22302, 22303, and 63119) for the shutdown (Figure A.3-7). Water level measurements were recorded at the top of each hour.

The zero hour transducer readings (midnight) were used to track water level changes in the transducer wells during the shutdown periods. The maximum water level rise, measured during each shutdown period in 2013 (at each transducer), are presented below.

Planned Shutdown: May 13 to June 17

Location	Just Prior to Shutdown 5/13/2013	Just Prior to Restart 6/17/2013	Water Level Rise (feet)
2045	517.36	518.92	1.56
2046	518.09	519.44	1.35
2649	519.65	521.76	2.11
23274	516.63	519.04	2.41
63119	516.87	519.49	2.62
22302	515.71	518.08	2.37
23118	517.29	519.86	2.57
22301	516.39	518.35	1.96
22303	515.83	517.90	2.07
32763	517.77	520.74	2.97
62433	515.13	518.33	3.20

The water level rise measurements indicate that during the shutdown, the water level rise ranged from 1.35 feet (ft) to 3.20 ft.

Figure A.3-8 shows water levels verses precipitation from May 25, 2007, through March 6, 2014. Three wells are shown on the figure: well 2649 (former WSA), well 2046 (west side of South Field Area), and well 62433 (east side of South Field Area). The combination of the shutdown and seasonal water level rise in 2013 resulted in a water level rise of approximately:

- 5.95 ft in the former WSA (monitoring well 2649);
- 5.53 ft in the west side of the South Field (monitoring well 2046); and
- 7.02 ft in the east side of the South Field (monitoring well 62433).

Uranium Concentration Results

Uranium concentrations were measured in six groundwater monitoring wells (2045, 2046, 23274, 83124, 83294, and 83337 [Figure A.3-9]) before, during, and after the 2013 shutdown. The results of the 2013 IEMP first-half uranium sampling are used to represent uranium concentrations in the well before the shutdown. Groundwater samples collected in June represent concentrations during the shutdown. The results of the 2013 IEMP second-half uranium sampling are used to represent uranium concentrations in the well after the shutdown exercise was completed. The two shallowest channels (Channels 1 and 2) of the Type-8 monitoring wells were sampled. Uranium concentration measurements at the six monitoring wells before, during, and after the 2013 shutdown are provided in Table A.3-1.

A comparison of pre-shutdown uranium concentrations to pre-startup uranium concentrations in the monitoring wells yields indicated that concentrations increased in a little over half of the wells. During the second half of the year, the channel with the highest uranium concentration (as measured during the first half of the year) is sampled. Therefore, no sample was collected from 83124_C2 and 83294_C3 during the second half of 2013.

As prescribed in the IEMP, uranium concentrations were also measured at the extraction wells before and daily for 4 days after the wells were restarted. The first water sample was collected after the well had been pumping for approximately 5 minutes. Results for the shutdown are provided in Table A.3-2. Due to a miscommunication in the field, samples from the recovery wells (RW-1, RW-3, and RW-4) were not collected on the June 18, 19, and 20. These wells continued pumping during the shutdown. Samples collected from these wells provide reference data to indicate how concentrations behave at the active wells during the shutdown. While collection of this data is preferred, it is not essential to seeing the change in concentration that occurred at the wells which were shut down. It should also be noted that results from samples collected on June 19 could not be used due to a sample labeling issue that could not be reconciled.

The last column of each table provides the difference between the maximum uranium concentration measured after the wells were restarted and the average uranium concentration measured in the month prior to the shutdown at the extraction well. As the data indicate, uranium concentration changes were mixed. The largest increase in uranium concentration was measured in extraction well EW-26 (10.6 µg/L).

Extraction wells RW-6, RW-7, EW-17a, and EW-21a underwent rehabilitation during the shutdowns (Table A.3-2); therefore, uranium concentration data is not reported. During rehabilitation the well is shut down, liquid acid descalar and hydrochloric acid are placed in the well, and the well is surged to clean the screen and loosen up the formation around the well screen. The objective is to restore pumping efficiency.

A.3.3 Continued Transducer Monitoring

Although not required by the IEMP, pressure transducers installed in 2007 to support the first annual well field shutdown remain in the wells and continue to operate so that daily changes in water levels can be recorded on a continuous, routine basis at key points in the aquifer. The transducers are programmed to record a water level measurement at the top of each hour. Data from three of the six locations (former WSA [2649], east side of the South Field Area [2046], and west side of the South Field Area [62433]) are shown in Figure A.3-7 and are plotted in Figure A.3-8 along with precipitation data collected through March 6, 2013. The transducers will continue to record data to provide a more complete record of seasonal and short-term water table fluctuations and will continue to be used for planning the timing of future well field shutdowns.

A.3.4 References

DOE (U.S. Department of Energy), 2013. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 6, Office of Legacy Management, January.

Table A.3-1. Uranium Concentrations at Monitoring Wells Before, During, and After the 2013 Wellfield Shutdown

Well	Easting	Northing	First Half 2013 Pre-Shutdown Concentrations		Pre-Start-Up Concentrations		Second Half 2013 Post-Shutdown Concentrations[a]	
			Date	Uranium (µg/L)	Date	Uranium (µg/L)	Date	Uranium (µg/L)
2045	1348291	477159	2/27/2013	62.1	6/10/2013	111	10/9/2013	85.1
2046	1347950	478088	3/21/2013	47.0	6/10/2013	37.3	7/15/2013	55.7
23274	1349406	478337	3/19/2013	157	6/10/2013	150	7/11/2013	204
83124_C1	1346826	479977	4/2/2013	556	6/10/2013	784	10/14/2013	196
83124_C2	1346826	479977	4/2/2013	50.1	6/10/2013	45.3	NA	NA
83294_C1	1349599	477190	5/7/2013	DRY	6/11/2013	266	10/7/2013	DRY
83294_C2	1349599	477190	5/7/2013	333	6/11/2013	340	10/14/2013	360
83294_C3	1349599	477190	5/7/2013	122	6/12/2013	141	NA	NA
83337_C1	1346704	481052	5/6/2013	2340	6/4/2013	2050	9/25/2013	DRY
83337_C2	1346704	481052	5/6/2013	219	6/4/2013	281	9/25/2013	46.0

[a] NA = not applicable

Table A.3-2. Uranium Concentration at Extraction Wells During 2013 Well Field Shutdown

Extraction Well ID	May 6 Uranium Concentration (ug/L)	Uranium Concentration (ug/L) After Well Field Re-Start[a,b,c,d]							Maximum Post Re-Start Minus May 6 Concentration[b]
		6/17/2013	6/18/2013	6/19/2013	6/20/2013	Minimum	Maximum	Range	
RW-1	17.3	16.2	NS	NS	NS	NA	16.2	NA	-1.1
RW-2	16.7	17.4	OFFLINE	OFFLINE	OFFLINE	NA	17.4	NA	0.7
RW-3	19.8	21.0	NS	NS	NS	NA	21.0	NA	1.2
RW-4	3.8	3.4	NS	NS	NS	NA	3.4	NA	-0.4
RW-6	31.4	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
RW-7	29.0	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-15A	30.6	37.0	34.2	NS	31.5	31.5	37.0	5.5	6.4
EW-17A	18.2	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-18	38.5	36.2	38.4	NS	35.8	35.8	38.4	2.6	-0.1
EW-19	18.6	19.4	19.8	NS	19.3	19.3	19.8	0.5	1.2
EW-20	28.5	28.9	28.7	NS	25.6	25.6	28.9	3.3	0.4
EW-21A	42.7	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-22	26.0	27.6	30.1	NS	27.9	27.6	30.1	2.5	4.1
EW-23	45.7	32.4	40.7	NS	41.6	32.4	41.6	9.2	-4.1
EW-24	40.8	OFFLINE	OFFLINE	NS	OFFLINE	OFFLINE	OFFLINE	OFFLINE	OFFLINE
EW-25	27.6	OFFLINE	17.3	NS	20.8	17.3	20.8	3.5	-6.8
EW-26	29.5	40.1	36.5	NS	32.3	32.3	40.1	7.8	10.6
EW-27	31.8	OFFLINE	35.9	NS	32.6	32.6	35.9	3.3	4.1
EW-28A	9.3	13.5	10.5	NS	10.3	10.3	13.5	3.2	4.2
EW-30	43.4	38.6	41.7	NS	36.3	36.3	41.7	5.4	-1.7
EW-31	13.2	16.2	16.2	NS	15.1	15.1	16.2	1.1	3
EW-32	4.9	8.1	6.7	NS	6.4	6.4	8.1	1.7	3.2
EW-33	24.8	19.4	25.4	NS	22.5	19.4	25.4	6.0	0.6

Shading indicates uranium concentration after well field re-start is greater than May 6 uranium concentration

[a] NS = Not sampled due to miscommunication or sample labeling issue

[b] OFFLINE = well offline for maintenance (e.g., awaiting adaptors, variable frequency drive, or splice kit; pump removed from well for repairs, etc.).

[c] REHAB = well offline to undergo rehabilitation.

[d] NA = Not applicable

Shutdown began on 5/13/2013 at 9:00 AM and ended on 6/17/2013 at 9:00 AM for a duration of 35 days.

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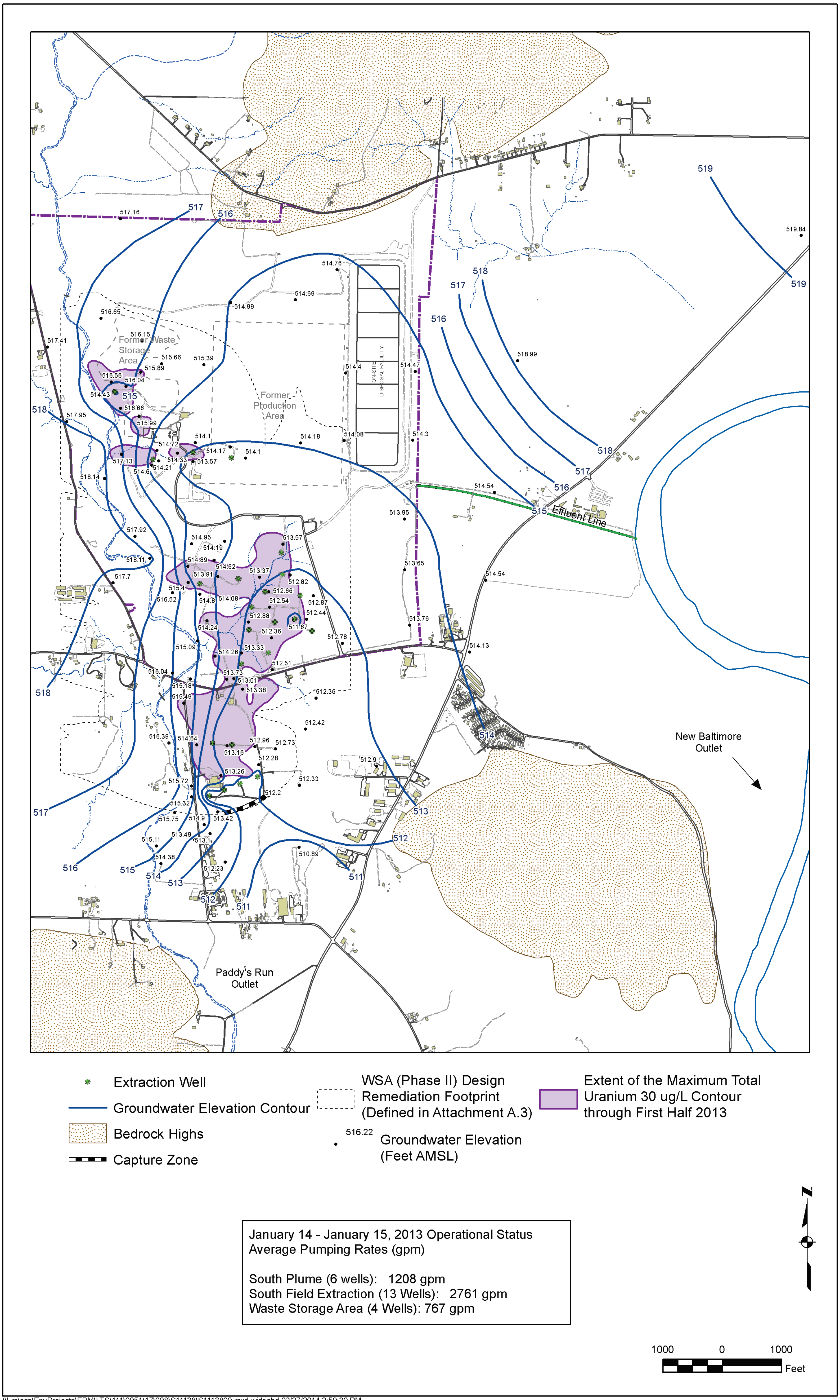

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Figure A.3-1. Routine Groundwater Elevation Map, First Quarter 2013 (January 14 Through January 15, 2013)

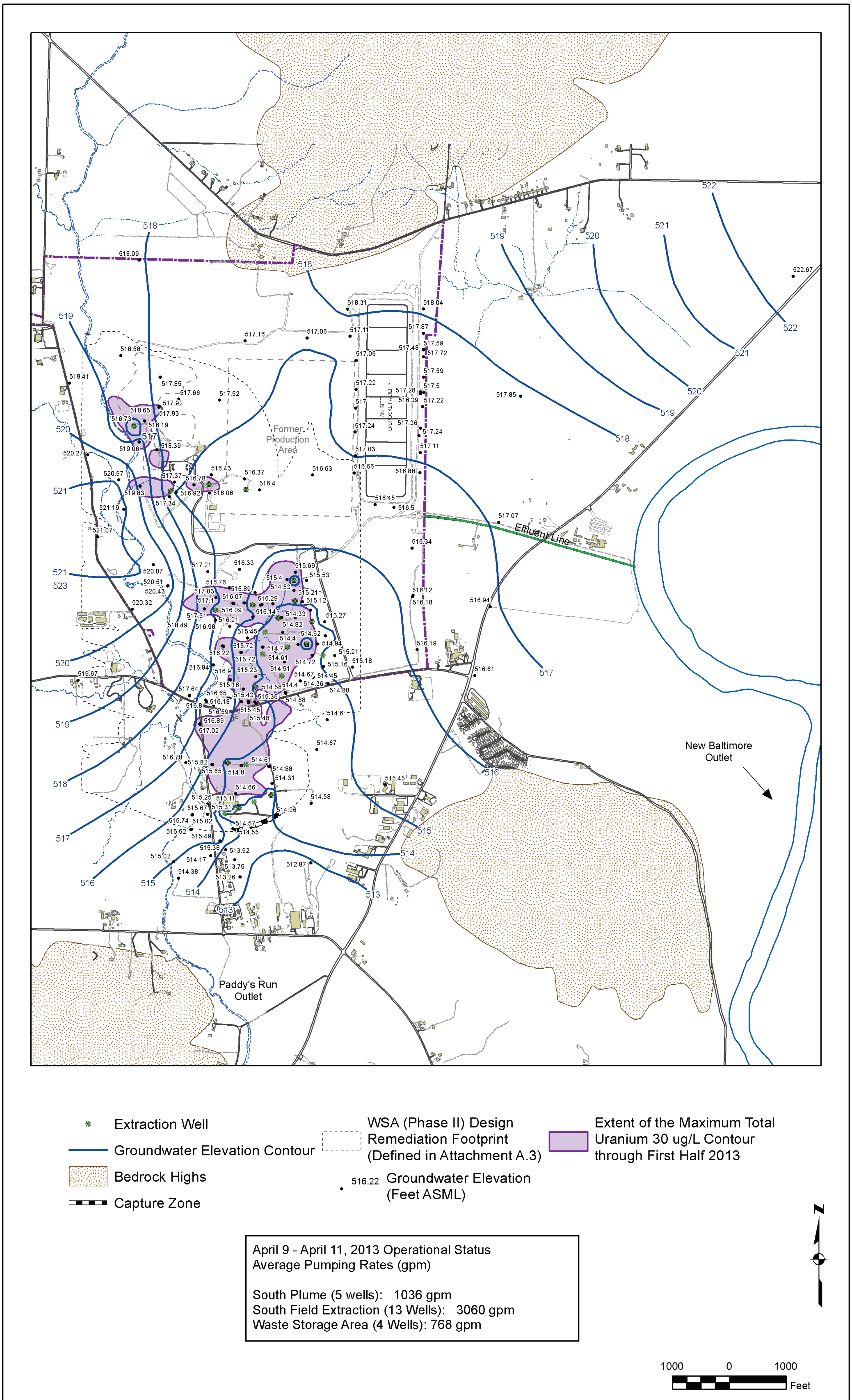

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Figure A.3-2. Routine Groundwater Elevation Map, Second Quarter 2013 (April 9 Through April 11, 2013)

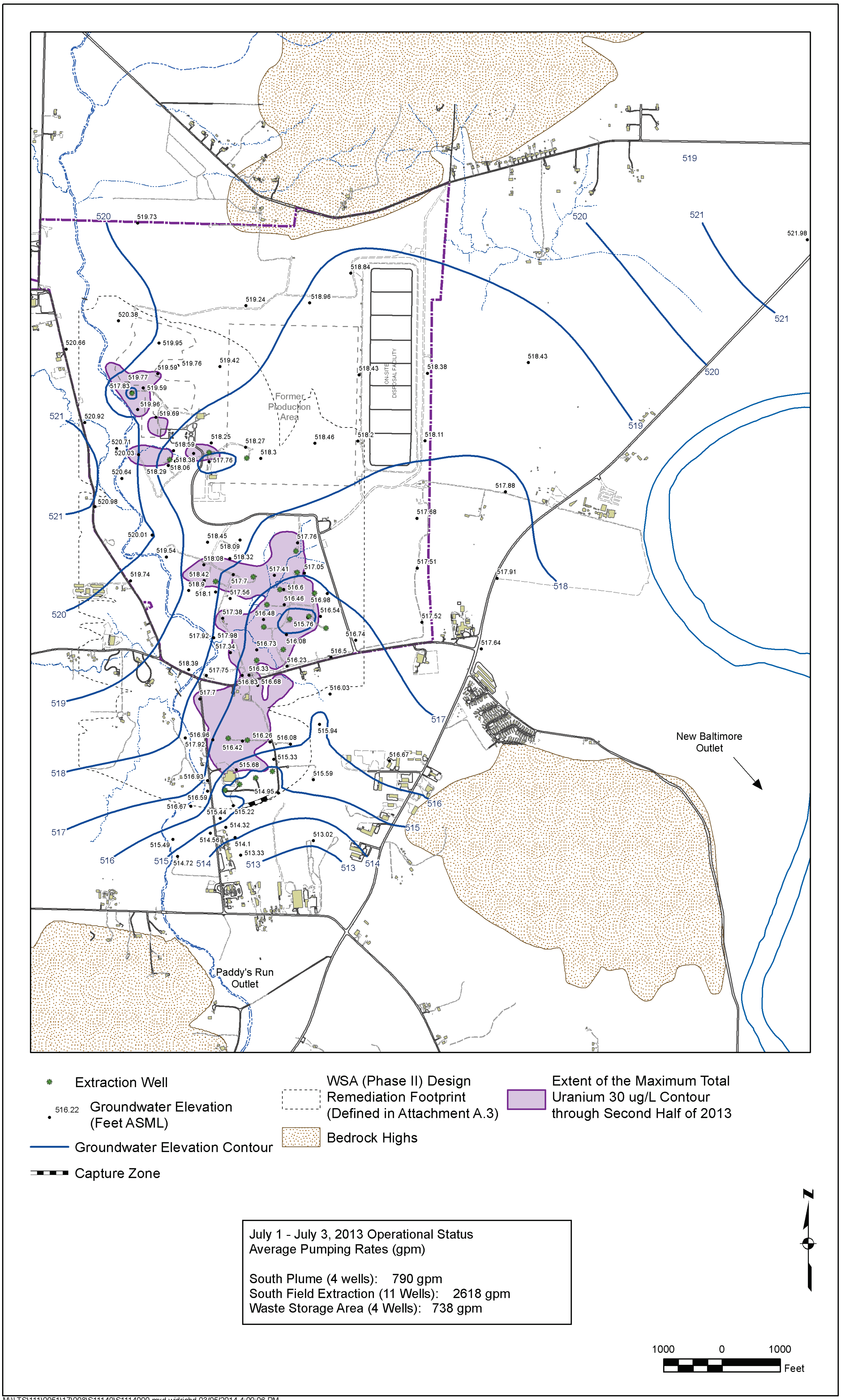

Figure A.3-3. Routine Groundwater Elevation Map, Third Quarter 2013 (July 1 Through July 3, 2013)

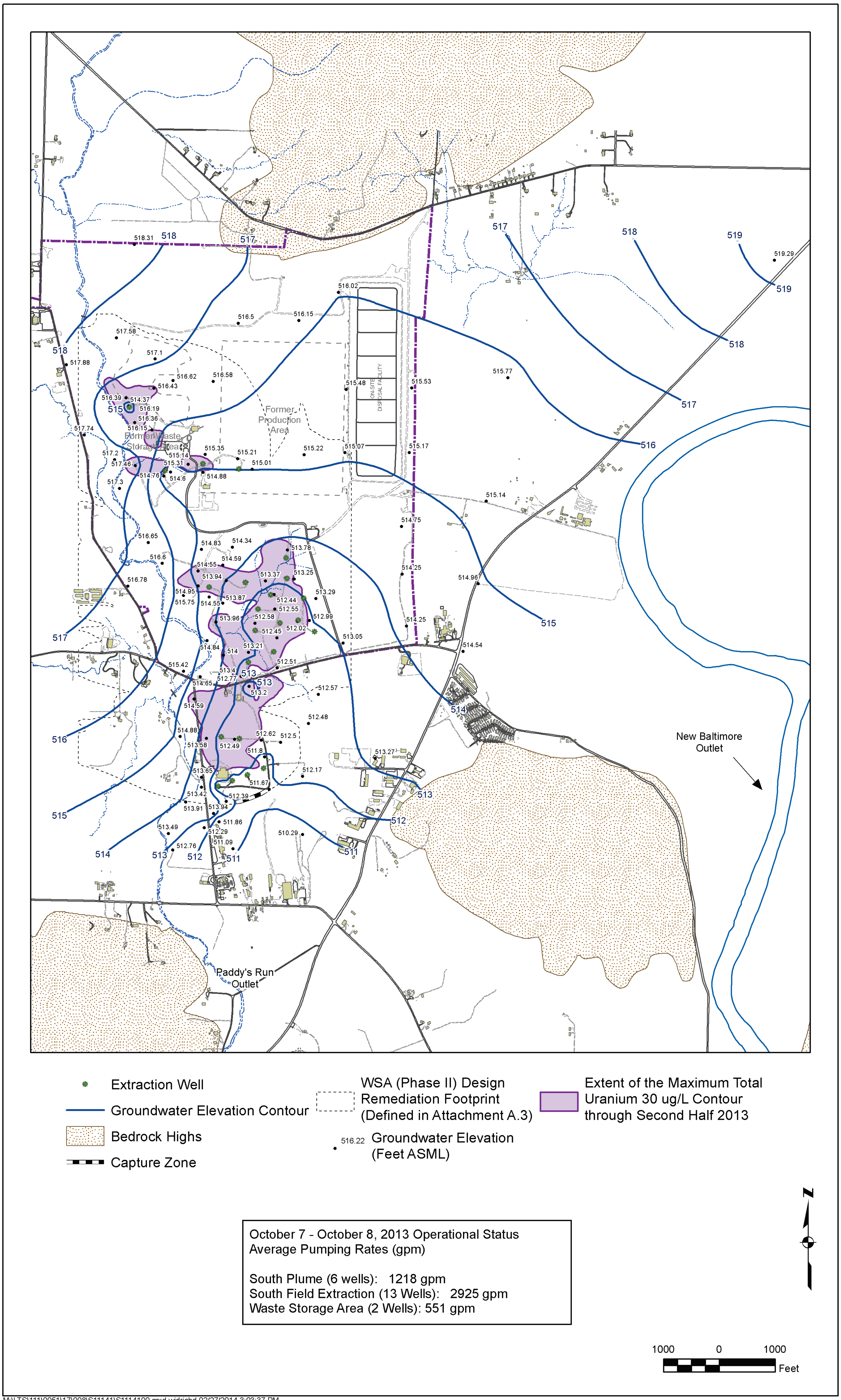

Figure A.3-4. Routine Groundwater Elevation Map, Fourth Quarter 2013 (October 7 and October 8, 2013)

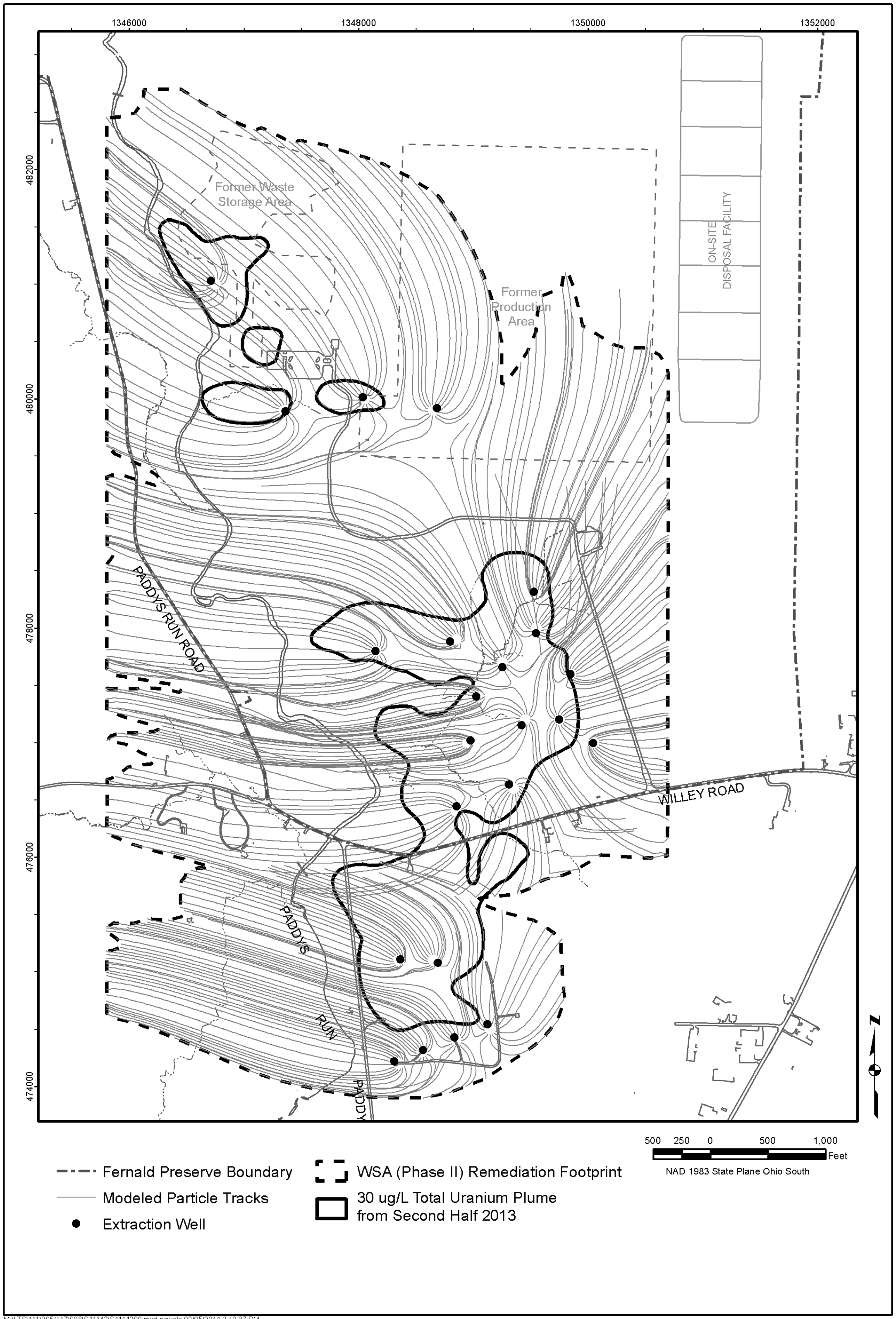

Figure A.3-5. WSA (Phase II) Design Remediation Footprint

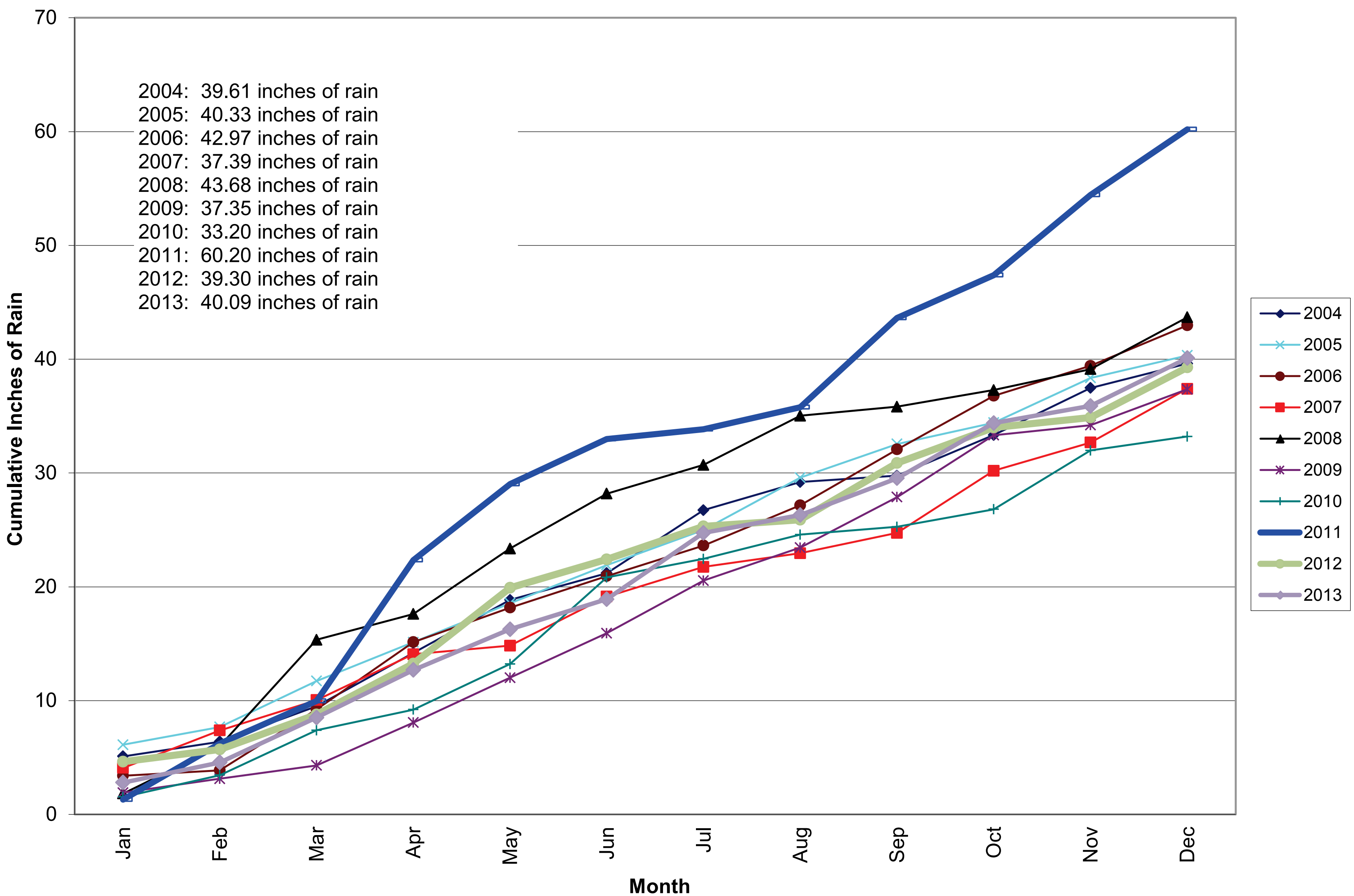

Figure A.3-6. Cumulative Annual Precipitation: 2004 through 2013 as Recorded at the Butler County Regional Airport

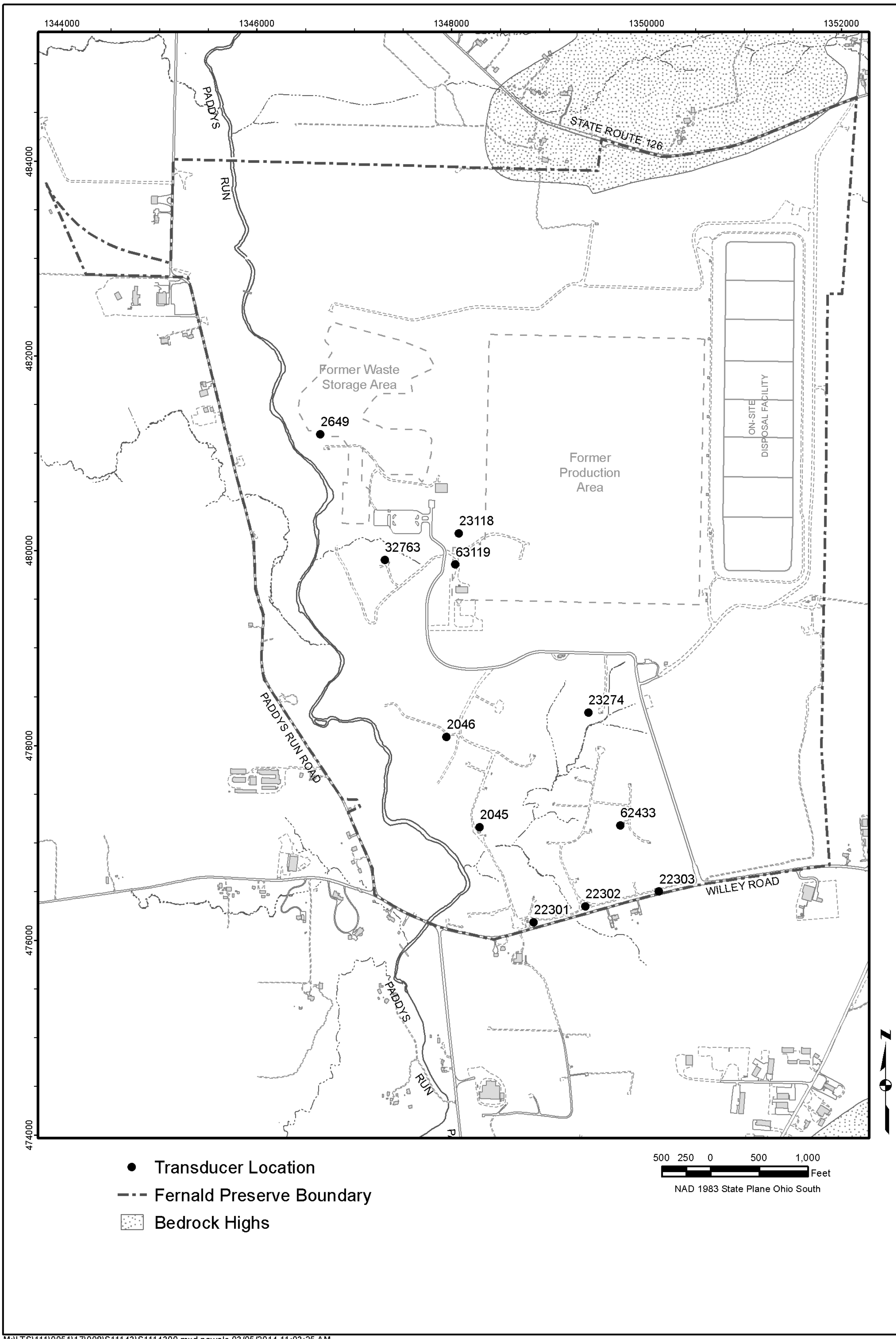

Figure A.3-7. Transducer Locations for the 2013 Operational Shutdown

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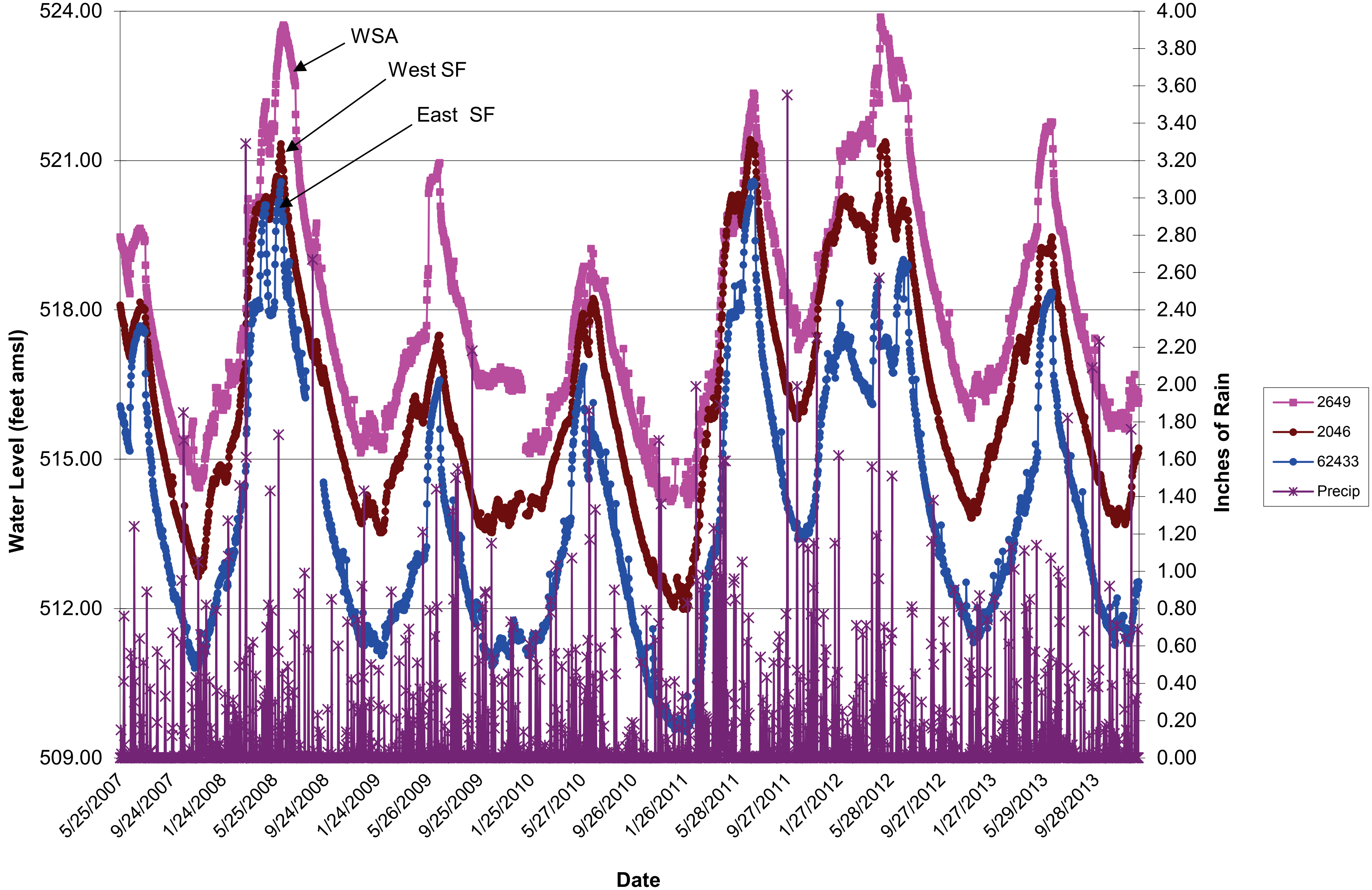

Figure A.3-8. Water Levels Versus Precipitation May 25, 2007 Through March 6, 2014

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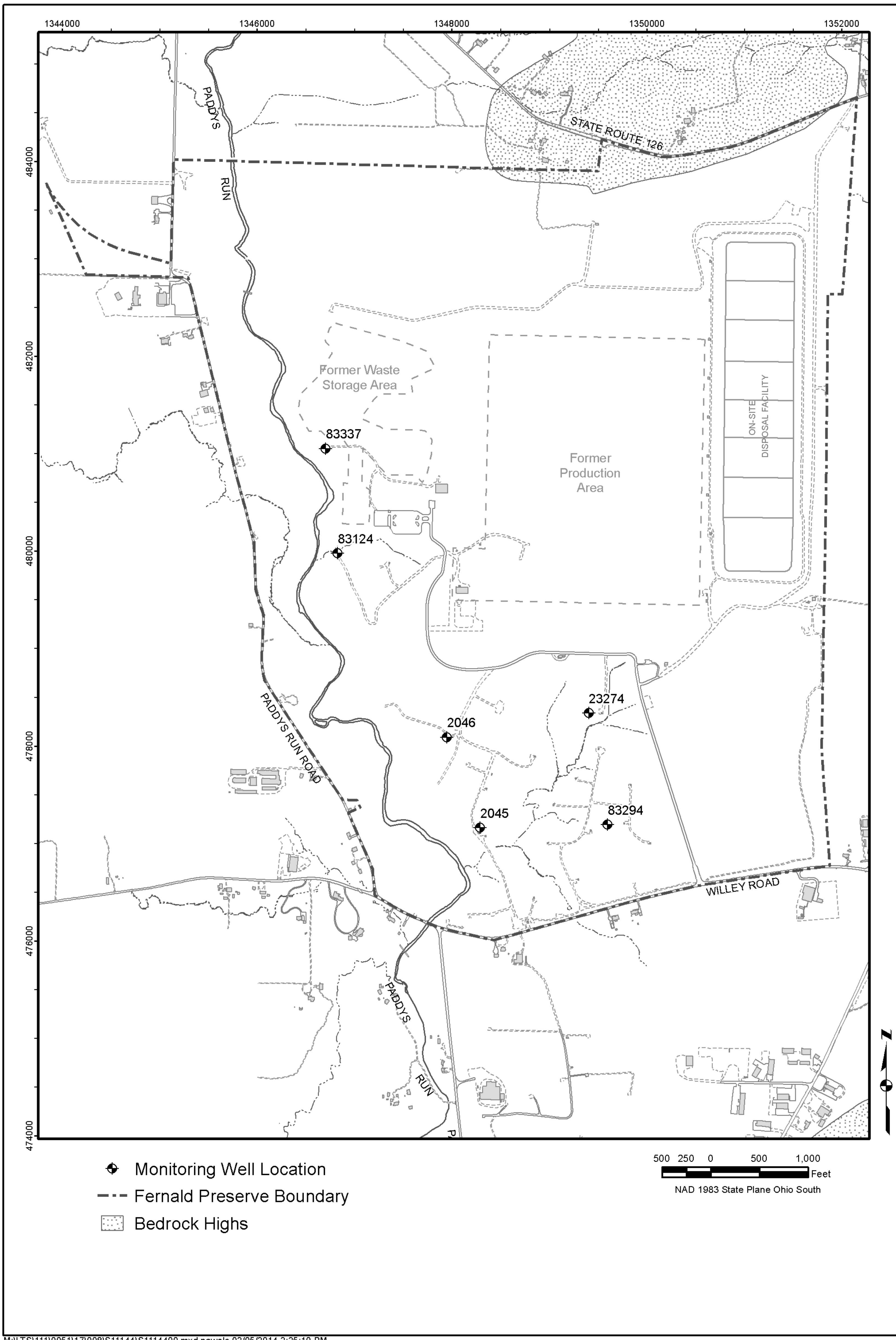

Figure A.3-9. Monitoring Well Locations for the 2013 Operational Shutdowns

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Attachment A.4

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Contents

Tables

Figures

Abbreviations

FRL	final remediation level
GMA	Great Miami Aquifer
IEMP	Integrated Environmental Monitoring Plan
OSDF	On-Site Disposal Facility
PRRS	Paddys Run Road Site
VAM 3D	Variable Saturated Model in 3 Dimensions
WSA	Waste Storage Area

Measurement Abbreviations

mg/L	milligram per liter

A.4.0 Non-Uranium Final Remediation Level Results

This attachment evaluates non-uranium final remediation level (FRL) results for 2013 collected under the Integrated Environmental Monitoring Plan (IEMP) which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (DOE 2013). The purpose of the evaluation is to:

- Identify 2013 non-uranium FRL exceedances (Section A.4.1).
- Determine the persistence of non-uranium FRL exceedances outside the Waste Storage Area (WSA) (Phase II) design remediation footprint (Section A.4.2).
- Present conclusions (Section A.4.3).

A.4.1 Non-Uranium FRL Exceedances for 2013

Table A.4-1 shows the summary statistics and trend analysis for the 2013 non-uranium FRL exceedances from monitoring wells both inside and outside the WSA (Phase II) design footprint. As indicated in Table A.4-1, seven non-uranium FRL constituents had one or more FRL exceedances during 2013. Figure A.4-1 identifies the location of these FRL exceedances.

Figure A.4-1 shows that the non-uranium FRL exceedances in 2013 for monitoring wells were located in the former WSA, along the eastern edge of the site, and in the Paddys Run Road Site (PRRS) area. Those in the former WSA were within the WSA (Phase II) design remediation footprint. Those along the eastern property boundary and in the PRRS area were located outside the WSA (Phase II) design remediation footprint. Specific discussion regarding exceedances and persistence outside the footprint is provided in Section A.4.2.

Table A.4-2 identifies all the locations and constituents that had non-uranium FRL exceedances between 1997 and 2013. The first column in Table A.4-2 lists the groundwater FRL constituents monitored in 2013. The second column identifies the wells monitored that have had an exceedance since 1997 for each constituent. The third column identifies the associated aquifer zone monitored. The fourth column identifies the associated monitoring program for each well/constituent. The remaining columns show monitoring years that reflect a semiannual sampling frequency; a "1" denotes an exceedance for one of the two quarters and a "2" denotes an exceedance for both quarters. Table A.4-2 also indicates whether exceedances occurred inside or outside of the remediation footprint (shading indicates the well is located outside the footprint).

As specified in the IEMP, there were 13 non-uranium constituents monitored in 2013; 7 had exceedances. The following table summarizes the 2013 non-uranium monitoring information:

Constituent	Monitoring Program	2013 Monitoring Summary
Antimony	Property/Plume Boundary for PRRS Constituents	No exceedances
Arsenic	Property/Plume Boundary for PRRS Constituents	No exceedances
Boron	South Field	No exceedances
Carbon Disulfide	Waste Storage Area	No exceedances
Fluoride	Property/Plume Boundary	No exceedances
Lead	Property/Plume Boundary	Exceedance in the PRRS area
Manganese	Property/Plume Boundary, Waste Storage Area	Exceedances in former WSA wells, along the eastern site boundary, and in the PRRS area
Molybdenum	Waste Storage Area	Exceedances in former WSA wells
Nickel	Waste Storage Area	No exceedances
Nitrate/Nitrite	Waste Storage Area	Exceedances in former WSA wells
Technetium-99	Waste Storage Area	Exceedances in former WSA wells
Trichloroethene	Waste Storage Area	Exceedance in former WSA wells
Zinc	Property/Plume Boundary	Exceedances along the eastern site boundary and in the PRRS area

A.4.1.1 Direct-Push Sampling Results for 2013

In 2013, three direct-push sampling locations in the former WSA were sampled for non-uranium constituents specified in the IEMP for the former WSA (locations 13369A, 13374A, and 13463). These locations are identified in Attachment A.2 in Figure A.2-5. Direct-push sampling results for 2013 are provided for locations 13369A, 13374A, and 13463 in Tables A.2-1, A.2-2, and A.2-3, respectively. Non-uranium results are discussed below.

Location 13369A

This direct-push location was originally sampled in 2007 (location 13369). Direct-push sampling results for location 13369A are provided in Table A.2-1. The location is identified on Figure A.2-3A. Non-uranium concentrations from both sampling dates are provided below. The data indicates that in 2013, FRL exceedances were detected for manganese and molybdenum.

Constituent (Units)	Groundwater FRL	13369 (2007)	13369A (2013)
Technetium-99 (pCi/L)	94	1.91	3.67
Nitrate/Nitrite (mg/L)	11	2.72	1.88
Manganese (mg/L)	0.9	**1.3**	**2.33**
Molybdenum (mg/L)	0.1	0.02	**0.232**
Nickel (mg/L	0.1	0.01	0.0231

Bold indicates concentrations above FRL.
mg/L = milligrams per liter
pCi/L = picocuries per liter

Location 13374A

This direct-push location was originally sampled in 2008 (location 13374). When sampled in 2008, the samples were only analyzed for total uranium. Direct-push sampling results for location 13374A are provided in Table A.2-2. The location is identified on Figure A.2-3A. Non-uranium concentrations from both sampling dates are provided below.

Constituent (Units)	Groundwater FRL	13374A (2013)
Technetium-99 (pCi/L)	94	**514**
Nitrate/Nitrite (mg/L)	11	**375**
Manganese (mg/L)	0.90	**2.49**
Molybdenum (mg/L)	0.10	0.0457
Nickel (mg/L	0.10	0.0358

Bold indicates concentrations above FRL.
mg/L = milligrams per liter
pCi/L = picocuries per liter

The data indicates that in 2013, FRL exceedances were detected for technetium-99, nitrate/nitrite, and manganese. As discussed in Section A.2, the U.S. Department of Energy plans to conduct additional direct-push sampling in this area in 2014.

Location 13463

This direct-push location was originally sampled in 2005 (location 13322). When re-sampled in 2013, the location had to be moved more than 50 feet, so was assigned a new identification number: 13464. Direct-push sampling results for location 13463 are provided in Table A.2-3. The location is identified on Figure A.2-3A. Non-uranium concentrations from both sampling dates are provided below.

Constituent (Units)	Groundwater FRL	13322 (2005)	13463 (2013)
Technetium-99 (pCi/L)	94	**6280**	8.73
Nitrate/Nitrite (mg/L)	11	**11.3**	7.15
Manganese (mg/L)	0.90	**1.35**	0.829
Molybdenum (mg/L)	0.10	**0.547**	**0.313**
Nickel (mg/L	0.10	0.03	0.0114

Bold indicates concentrations above FRL.
mg/L = milligrams per liter
pCi/L = picocuries per liter

The data indicates that in 2005, FRL exceedances were detected for technetium-99, nitrate/nitrite, manganese, and molybdenum. In 2013, only one FRL exceedance was measured: molybdenum.

All of the direct-push sample results discussed above are located within the Former WSA, and within capture of the groundwater remediation system.

A.4.2 Evaluation of 2013 Non-Uranium FRL Exceedances Outside the WSA (Phase II) Design Remediation Footprint

This section presents an evaluation of the persistence of non-uranium FRL exceedances outside the WSA (Phase II) design remediation footprint.

A.4.2.1 Background

The *Restoration Area Verification Sampling Program Summary Report* (DOE 1998) states that any FRL exceedance detected at the property boundary during routine monitoring outside the 10-year uranium-based restoration footprint (DOE 1997a) would also be evaluated for persistence. The evaluation would be performed using the same conservative data evaluation method approved in the *Restoration Area Verification Sampling Program Project-Specific Plan* (DOE 1997b) to determine if a change in the aquifer restoration remedy is required. This evaluation was expanded beginning with the *2000 Integrated Site Environmental Report* (DOE 2001) to include all non-uranium FRL exceedances detected outside of the 10-year uranium-based restoration footprint, not just those detected at the property boundary. In the *2003 Site Environmental Report* (DOE 2004), the 10-year uranium-based restoration footprint was replaced with a 10-year time-of-travel remediation footprint based on 2003 target pumping rates and using the Variable Saturated Model in 3 Dimensions (VAM 3D) Zoom Groundwater Model. The footprint was updated in 2005 to reflect capture during the time period modeled for the WSA (Phase II) remediation design. The footprint is shown in Figure A.4-1.

Analytical data from samples collected immediately following an FRL exceedance are evaluated to determine if the exceedance is persistent. In accordance with the approved Restoration Area Verification Sampling method, if two or more consecutive sampling events following an FRL exceedance indicate that the concentration has decreased below the groundwater FRL, then the exceedance is not considered persistent. If an FRL exceedance outside the WSA (Phase II) design remediation footprint is determined to not be persistent, then no additional action is required beyond the routine groundwater monitoring specified in the current IEMP. If an FRL exceedance is determined to be persistent, then the cause of the persistent exceedance will be identified and its effect on the aquifer remedy design assessed. Ultimately, the cause needs to be addressed either through a modification of the aquifer remedy or by other means.

A.4.2.2 Evaluation and Discussion

As reported last year, four possible persistent FRL exceedances were identified in 2012 requiring additional data to be collected through routine monitoring in 2013. The exceedances were for antimony in well 2636; lead in well 2625; and zinc in wells 2625 and 22212. The non-uranium FRL exceedances for 2013 along with the possible persistent exceedances identified in 2012 are addressed below.

Figure A.4-1 and the shaded portion of Table A.4-1 identify the 2013 non-uranium FRL exceedances outside the WSA (Phase II) design remediation footprint. In 2013, three constituents had one or more FRL exceedance at six wells located outside the WSA (Phase II) design remediation footprint:

- Lead at monitoring well 2625.
- Manganese at monitoring wells 22201, 22204, 22217, 2625, and 2733.
- Zinc at monitoring wells 22200, 2625, and 2733.

Table A.4-3 addresses possible persistent FRL exceedances that occur outside the WSA (Phase II) design remediation footprint. It includes the exceedances for 2013 listed in the bullets above, as well as those still being evaluated or deemed persistent from 2012. If the results of two or more sampling events immediately following an FRL exceedance indicate that the concentration decreased below the FRL, then the exceedance is identified as not persistent in Table A.4-3. As shown in Table A.4-3, FRL exceedances for manganese at monitoring well 22204 and the exceedance for zinc at monitoring well 2625 were identified as being persistent in 2013. The persistent manganese exceedance at monitoring well 22204 has been identified since 2004.

The following is a summary of results presented in Table A.4-3:

- The antimony FRL exceedance in monitoring well 2636 in the second half of 2011 was found to be not persistent.
- The lead FRL exceedance in monitoring well 2625 requires that additional data be collected through routine monitoring in 2014 to determine the persistence of the exceedance.
- The manganese FRL exceedance at monitoring well 22201 in the first half of 2013 was found to be not persistent.
- The manganese FRL exceedance at monitoring well 22204 found to be persistent in 2012 remains persistent.
- The manganese FRL exceedance at monitoring well 22217 found to be persistent in 2012 was found to be not persistent in 2013.
- The manganese FRL exceedances at monitoring wells 2625 and 2733 require that additional data be collected through routine monitoring in 2014 to determine the persistence of the exceedances.
- The zinc FRL exceedance at monitoring well 2625 was found to be persistent.
- The zinc FRL exceedance at monitoring well 2733 requires that additional data be collected through routine monitoring in 2014 to determine the persistence of the exceedance.
- The zinc FRL exceedances at monitoring wells 22212 and 22200 were found to be not persistent.

Figures A.4-2 through A.4-12 present individual graphs of time versus concentration for the wells listed on Table A.4-3. Quarterly sampling results from On-Site Disposal Facility (OSDF) monitoring activities are included in the evaluation of property boundary wells. Therefore, some wells were sampled more than semi-annually as reflected in Table A.4-3 and Figures A.4-2 through A.4-12.

The evaluation for persistence of non-uranium FRL exceedances in wells located outside the WSA (Phase II) design remediation footprint in 2013 marks 17 years that an evaluation has been conducted as part of the IEMP. In the past, many exceedances identified as persistent became non-persistent in later years. To date, the only persistent exceedance outside the remediation footprint appears to be isolated to manganese in monitoring well 22204 and zinc in monitoring well 2625.

Manganese was a process chemical used in the former production area. The manganese groundwater FRL is 0.90 milligram per liter (mg/L) and is based on background values in the aquifer. Additional manganese data were collected from the Great Miami Aquifer (GMA) near the OSDF in 2008. Results were reported in the *Fernald Preserve 2008 Site Environmental*

Report (DOE 2009). The purpose for collecting the additional data was to determine if manganese exceedances in the GMA near the OSDF indicate the presence of a localized plume. The additional data collected in 2008 indicated that the manganese exceedances were likely a background issue. Unconsolidated glacial fluvial aquifers in Ohio have relatively high manganese concentrations. Manganese is an impurity in shale, which is a major component of bedrock in the area. The background value upon which the groundwater FRL is based may not be representative of actual natural aquifer conditions. In past reports, biofouling has also been discussed as a possibility for the persistent manganese exceedance that was only seen at one monitoring well. At this time, no change to the aquifer remedy is planned to address the persistent manganese exceedance at monitoring wells 22204.

Monitoring well 2625 is located in the PRRS area and the contamination is not attributed to the Fernald Preserve.

A.4.3 Conclusions

From the information provided in this attachment, the following conclusions can be made:

- Non-uranium FRL exceedances that are occurring in the former WSA were taken into consideration for the WSA (Phase II) Remediation Module Design, and are within capture of the groundwater remediation system.
- Two persistent non-uranium FRL exceedances outside the WSA (Phase II) design footprint were identified in 2013: manganese at monitoring well 22204 and zinc at monitoring well 2625. The exceedance for manganese is attributed to a background definition issue. The exceedance for zinc is attributed to the PRRS. A change in the design of the aquifer remedy to address either exceedance is not being considered at this time.
- Additional routine data to be collected in 2014 are required to evaluate exceedances for lead, manganese, and zinc, as identified in Table A.4-3.

A.4.4 References

DOE (U.S. Department of Energy), 1997a. *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration*, 2505-RP-0003, Revision 0, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 1997b. *Restoration Area Verification Sampling Program Project-Specific Plan*, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

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DOE (U.S. Department of Energy), 2013. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 6, Office of Legacy Management, January.

Table A.4-1. Summary Statistics and Trend Analysis for Non-Uranium Constituents with 2013 Results Above FRLs

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2013[c,d]	Minimum[b,c,d,e,f]	Maximum[b,c,d,e,f]	Average[b,c,d,e,f]	Standard Deviation[b,c,d,e,f]	Trend[b,c,d,e,f,g]
Lead (0.015 (mg/L)	2625	12	3	1	0.00015	0.0425	0.00886	0.0123	Up
Manganese (0.90 mg/L)	2010	25	21	3	0.525	6.74	2.50	1.85	No Trend
	22201	21	8	1	0.0322	2.06	0.790	0.670	No Trend
	22204	41	36	6	0.418	3.01	1.42	0.49	Up
	22217	19	11	2	0.196	1.57	1.00	0.39	No Trend
	2625	12	1	1	0.001	1.05	0.26	0.31	Up
	2733	36	1	1	0.00585	0.919	0.110	0.150	No Trend
	83341_C2	14	4	1	0.127	2.16	0.690	0.640	No Trend
Molybdenum (0.10 mg/L)	2649	27	27	3	0.178	1.26	0.530	0.250	Up
Nitrate + Nitrite as N (11 mg/L)[h]	2649	35	26	1	0.805	102	38.5	29.0	Down
	2821	37	20	3	1.38	120	28.6	31.2	Up
	83338_C1	10	5	1	0.404	73.8	30.2	30.0	Up
	83338_C2	15	9	2	1.98	109	25.5	28.4	No Trend
	83338_C3	15	8	1	2.42	105	28.3	31.3	No Trend
	83340_C1	11	10	1	9.5	58.2	28.8	17.1	Down
	83340_C2	14	14	2	12.5	86.7	51.3	26.8	No Trend
	83340_C3	14	13	2	1.13	133	55.6	39.6	Down
	83341_C1	7	4	1	0.265	26.2	10.1	8.79	No Trend

Table A.4-1 (continued). Summary Statistics and Trend Analysis for Non-Uranium Constituents with 2013 Results Above FRLs

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2013[c,d]	Minimum[b,c,d,e,f,]	Maximum[b,c,d,e,f]	Average[b,c,d,e,f]	Standard Deviation[b,c,d,e,f]	Trend[b,c,d,e,f,g]
Zinc (0.021 mg/L)					(mg/L)	(mg/L)	(mg/L)	(mg/L)	
	22200	19	3	1	0.00165	0.0377	0.0140	0.0090	No Trend
	2625	11	7	2	0.00325	0.199	0.0480	0.0570	Up
	2733	36	2	1	0.001	0.0513	0.0070	0.0100	No Trend
Technetium-99					(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	
(94 pCi/L)	2649	35	35	3	101	1660	626	455	No Trend
	2821	37	24	3	0.253	651	157	155	Up
	83338_C1	10	5	1	10.1	270	107	104	Up
	83338_C2	15	10	2	7.12	587	156	148	No Trend
	83338_C3	15	9	2	0.059	313	124	98	No Trend
	83340_C1	11	11	2	186	817	312	182	No Trend
Trichloroethene					(µg/L)	(µg/L)	(µg/L)	(µg/L)	
(5.0 µg/L)	2649	27	21	2	0.125	120	37.9	33.2	Down
	2821	29	13	2	0.125	11.5	4.22	3.87	Up

Notes: Shading indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.
µg/L = micrograms per liter
pCi/L = picocuries per liter

[a] From *Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996), Table 9-4.
[b] Based on samples from August 1997 through 2013.
[c] If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[d] Rejected data qualified with either an R were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e] If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.
[f] For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g] Mann-Kendall test for trend is performed using data from third quarter 1998 through 2013.
[h] FRL based upon nitrate from *Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996), Table 9–4.

Table A.4-2. Groundwater FRL Exceedances From 1997 Through 2013 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
				2[c]	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Antimony																																				
	22198	0	OSDF																									1	1							
	22199	0	OSDF																									1								
	22204	0	OSDF																									1								
	22205	0	OSDF																									1								
	22208	0	OSDF													1												1								
	2398	2	P/PB																				1													
	2431	0	P/PB													1												1								
	2432	0	P/PB																				1					1								
	2636	4	PRRS														1		1				1						1			1				
	2733	0	P/PB																				1													
	3070	2	P/PB																				1					1								
	31217	0	P/PB																									1								
	3398	2	P/PB																				1													
	3424	0	P/PB																				1					1								
	3426	0	P/PB																				1													
	3431	0	P/PB																									1								
	3432	0	P/PB																				1					1								
	4398	2	P/PB																				1					1								
Arsenic																																				
	2625	4	PRRS						1																											
	2636	4	PRRS	1	1		2						1				1												1							
	2898	4	PRRS						1																											
	2900	4	PRRS						1																											
Boron																																				
	2045	2	SF				1	1	1																											
	2049	2	SF	2		2	2	2	2	1				1																						
Carbon disulfide																																				
	2649	1	WSA			1																														
	3821	1	WSA					1										1																		
Fluoride																																				
	2431	0	P/PB			1																														
Lead																																				
	22198	0	P/PB																										1							
	2431	0	P/PB						1																											
	2625	4	PRRS																													1	1		1	
	3733	0	P/PB	1						1																										

Table A.4-2 (continued). Groundwater FRL Exceedances From 1997 Through 2013 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
				2[c]	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Manganese																																				
	2010	1	WSA						1		1				1	1	1	1		1	1	1	1	1	1	1		1			1	1	1	1	2	1
	22198	0	OSDF											1																						
	22201	0	OSDF																							1		1	1	1	2		1		1	
	22204	0	OSDF												1			1	1	1	1	1	1	1	1	1	2	2	2	1	1	2	2	2	2	2
	22205	0	OSDF																	1										1						
	22212	3	OSDF																													1				
	22214	0	OSDF																													1				
	22215	3	OSDF																												1	1				
	22217	3	OSDF																								1		1	2		1	2	2	2	
	2431	0	P/PB		2																															
	2432	0	P/PB							1		2	1		1																					
	2625	4	PRRS																																1	
	2648	1	WSA	1		1		1	1		1		1					1	1		1															
	2733	0	P/PB																																1	
	2898	4	PRRS										1				1																			
	2899	4	PRRS							1																										
	2900	4	PRRS							1																										
	3093	4	P/PB																								1									
	3821	1	WSA					1	1		1		1		1	1	1			1	1		1	1	1	1	1	1	1	1	1	1	1	1		
	83337_C1	1	WSA																						1	1										
	83337_C2	1	WSA																							1										
	83337_C3	1	WSA																							1		1								
	83338_C2	1	WSA																				1		1		1						1			
	83339_C1	1	WSA																				1		1	1										
	83339_C2	1	WSA																								1									
	83339_C3	1	WSA																						1							1				
	83341_C1	1	WSA																				1		1	1							1			
	83341_C2	1	WSA																				1	1							1				1	
	83346_C1	1	WSA																				1		1	1	1									
	83346_C2	1	WSA																				1	1		1	1									
Molybdenum																																				
	2649	1	WSA	1		1		1	1		1		1		1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	2	1
Nickel																																				
	22198	0	OSDF					1																												
	2398	2	P/PB	1	2	2		2																												
	4398	2	P/PB				1																													
	83346_C1	1	WSA																							1										
	83346_C2	1	WSA																							1	1									

Table A.4−2 (continued). Groundwater FRL Exceedances From 1997 Through 2013 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
				2[c]	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Nitrate/Nitrite																																				
	2648	1	WSA		1			1	1		1					1	1	1			1															
	2649	1	WSA	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1		1	1		1		1	1					1		1		1	
	2821	1	WSA					1							1				1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
	3821	1	WSA							1										1				1			1	1	1	1	1	1				
	83338_C1	1	WSA																										1		1	1	1		1	
	83338_C2	1	WSA																					1				1	1	1	1		1	1	1	1
	83338_C3	1	WSA																					1			1	1	1	1	1	1				1
	83340_C1	1	WSA																				1		1	1	1		1		1	1	1	1	1	
	83340_C2	1	WSA																				1	1	1	1	1	1	1	1	1	1	1	1	1	1
	83340_C3	1	WSA																				1	1	1	1	1	1	1	1	1	1		1	1	1
	83341_C1	1	WSA																				1										1	1	1	
	83341_C2	1	WSA																							1								1		
	83341_C3	1	WSA																				1			1										
Technetium-99																																				
	2648	1	WSA					1			2				1																					
	2649	1	WSA	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	2	1
	2821	1	WSA					1						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	2	1
	83338_C1	1																											1		1	1	1		1	
	83338_C2	1	WSA																					1				1	1	1	1	1	1	1	1	1
	83338_C3	1	WSA																					1			1	1	1	1	1			1	1	1
	83340_C1	1	WSA																				1		1	1	1		1		1	1	1	1	1	1
	83340_C2	1	WSA																				1	1	1	1	1	1								
	83340_C3	1	WSA																				1	1	1	1	1	1				1		1		
Trichloroethene																																				
	2649	1	WSA			1		1	1		1		1		1	1	1	1	1	1	1		1			1	1				1	1	1	1	1	1
	2821	1	WSA																				1	1		1	1	1	1	1	1	1	1	1	2	

Table A.4-2 (continued). Groundwater FRL Exceedances From 1997 Through 2013 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
				2[c]	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Zinc																																				
	22198	0	OSDF																										1							
	22199	0	OSDF												1																					
	22200	0	OSDF																										1		1					1
	22204	0	OSDF												1										1				1							
	22210	0	OSDF																1		1						1									
	22212	3	OSDF																											1				1		
	22213	3	OSDF																											1						
	2398	2	P/PB		1																															
	2431	0	P/PB			2			1																											
	2432	0	P/PB				1		1	1																										
	2625	4	PRRS																						1	1					1	1	1		1	1
	2636	4	PRRS																						1	1										
	2733	0	P/PB				1																												1	
	2900	4	PRRS							1							1							1												
	3128	4	PRRS																1																	
	3426	0	P/PB				1	1																												
	3429	0	P/PB				2																													
	3431	0	P/PB										1																							
	3733	0	P/PB												1																					
	3899	4	PRRS								1																									

Notes: Shading indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.
[a] A "1" denotes an exceedance for one of the two quarters and a "2" denotes an exceedance for both quarters.
[b] WSA = Waste Storage Area; SF = South Field; P/PB = Property/Plume Boundary for FRL Exceedances; PRRS = Property/Plume Boundary for Paddys Run Road Site; OSDF = Property/Plume Boundary for On-Site Disposal Facility.
[c] Sampling for the IEMP was initiated in August 1997.

Table A.4-3. Summary of Persistence Evaluation of Non-Uranium FRL Exceedances Outside the Waste Storage Area (Phase-II) Design Remediation Footprint

Constituent	Monitoring Well	Pertinent 2012 Results[a]	2013 FRL Exceedance		Evaluation Results for 2013	Figure Number
			First Half	Second Half		
Antimony	2636	Additional Routine Data Required	No	No	Not Persistent	A.4-2
Lead	2625	Additional Routine Data Required	Yes	No	Additional Routine Data Required	A.4-3
Manganese	22201[b]	NA	Yes/No	No/No	Not Persistent	A.4-4
	22204[b]	**Persistent**	Yes/Yes	Yes/Yes	**Persistent**	A.4-5
	22217[b]	**Persistent**	Yes/Yes	No/No	Not Persistent	A.4-6
	2625	NA	Yes	No	Additional Routine Data Required	A.4-7
	2733	NA	Yes	No	Additional Routine Data Required	A.4-8
Zinc	2625	Additional Routine Data Required	Yes	Yes	**Persistent**	A.4-9
	2733	NA	Yes	No	Additional Routine Data Required	A.4-10
	22212[b]	Additional Routine Data Required	No/No	No/No	Not Persistent	A.4-11
	22200[b]	NA	No/Yes	No/No	Not Persistent	A.4-12

[a] NA = not applicable
[b] Sampled more than twice in 2013 because it is also sampled for OSDF monitoring program.

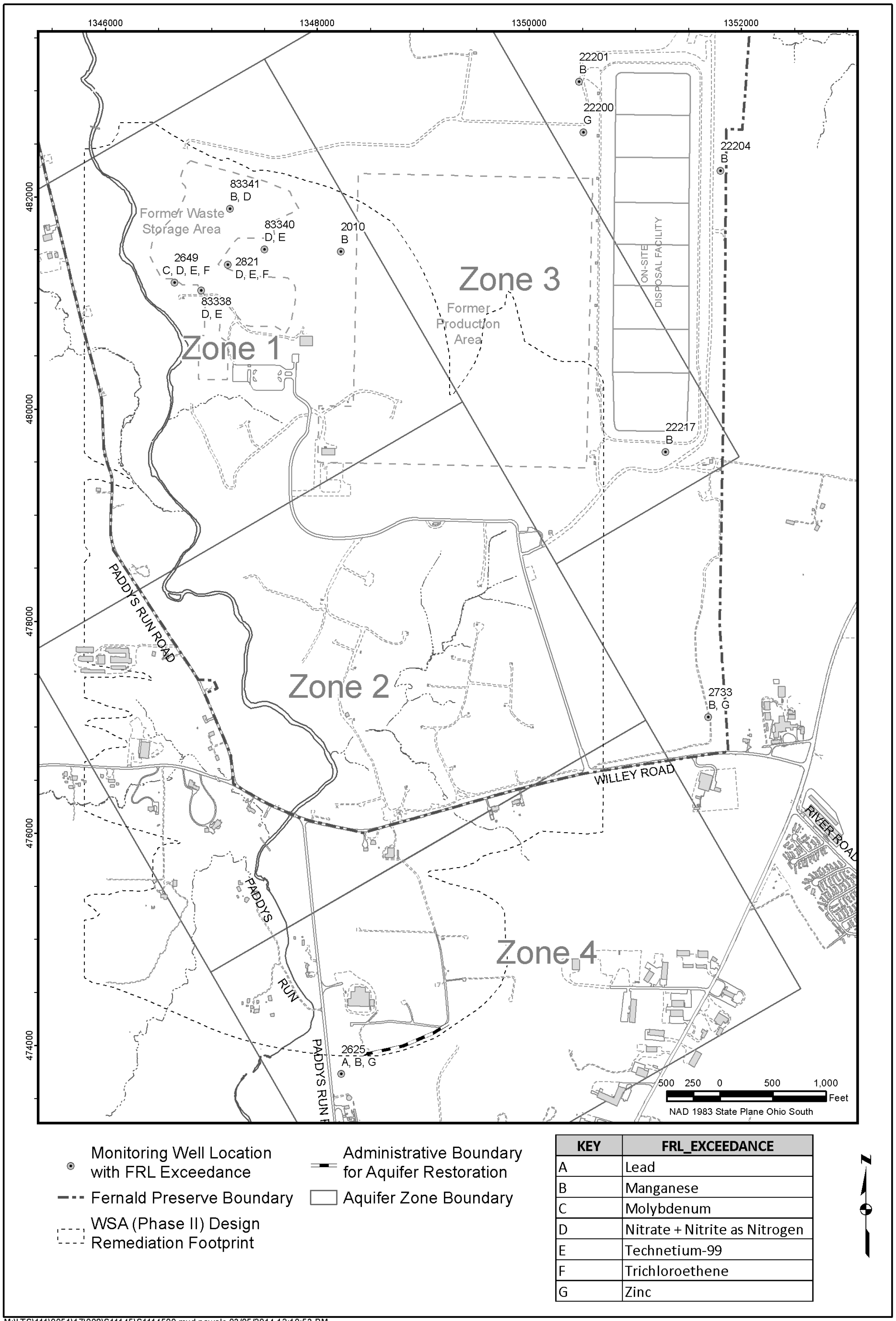

Figure A.4-1. Non-Uranium Constituents with 2013 Results Above FRLs

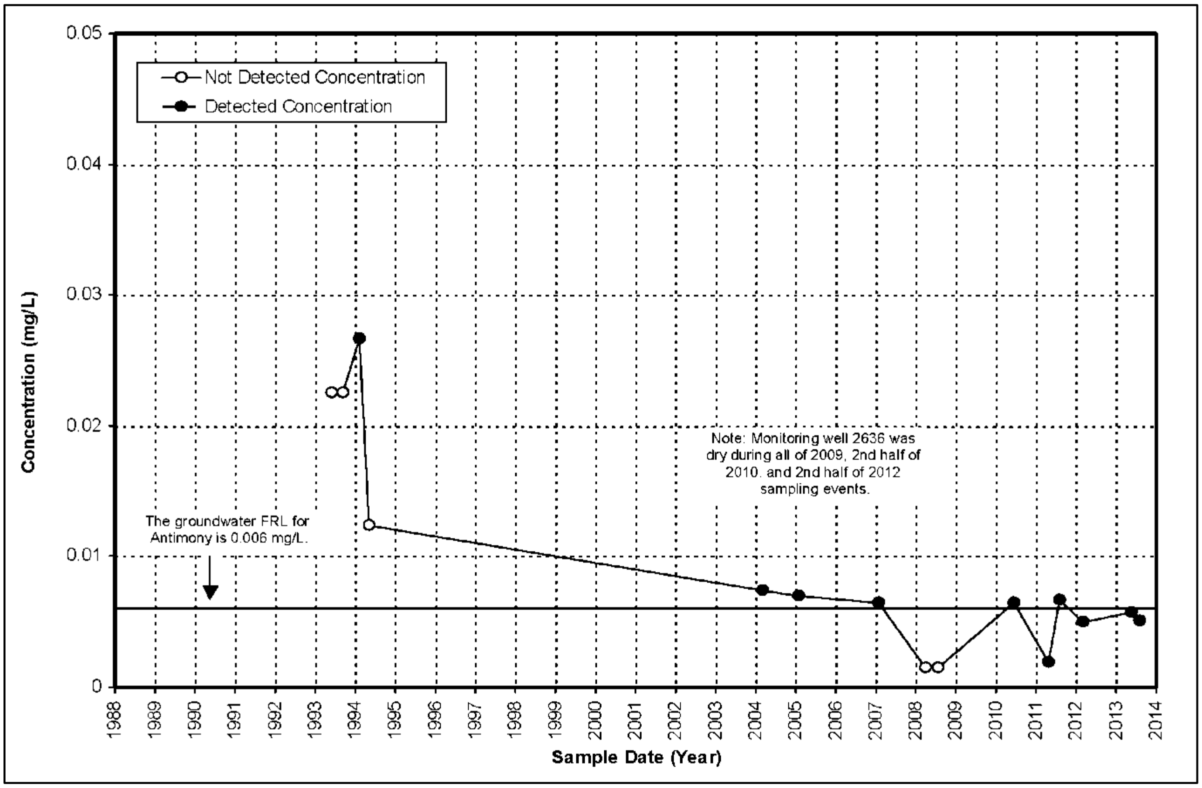

Figure A.4-2. Antimony Concentration Versus Time Plot for Monitoring Well 2636

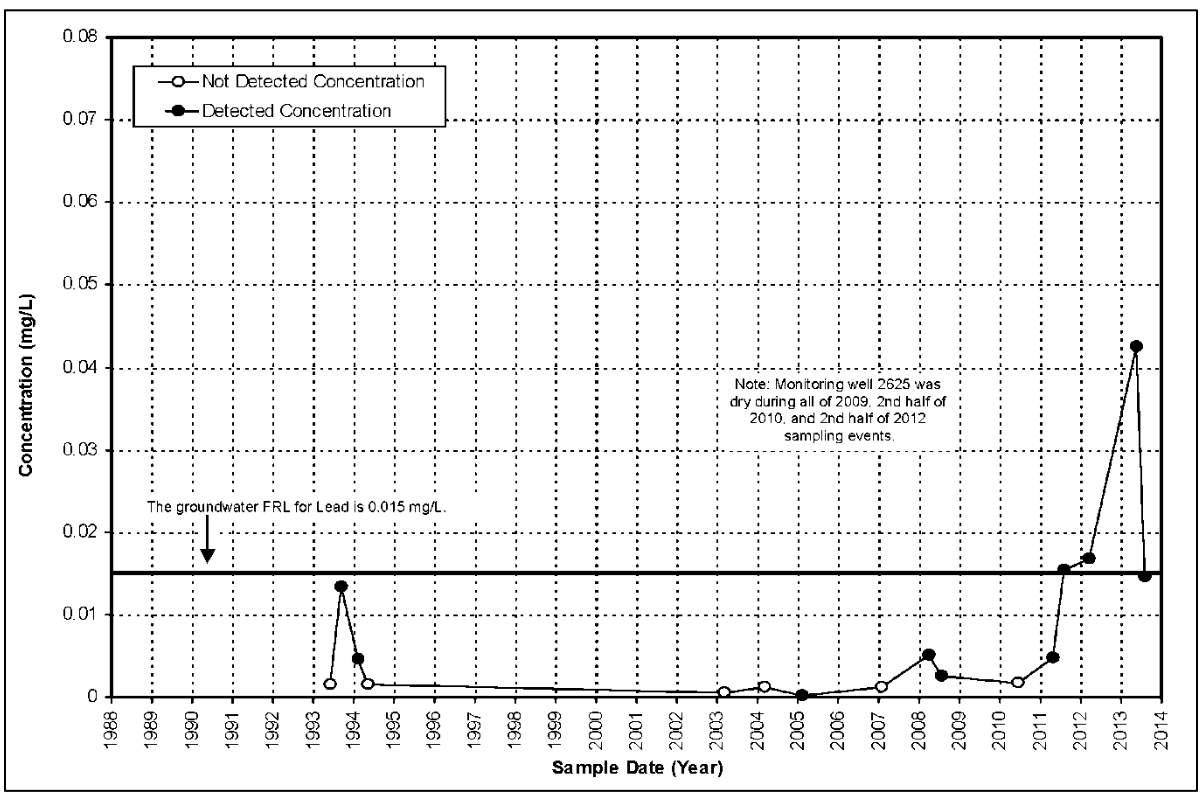

Figure A.4-3. Lead Concentration Versus Time Plot for Monitoring Well 2625

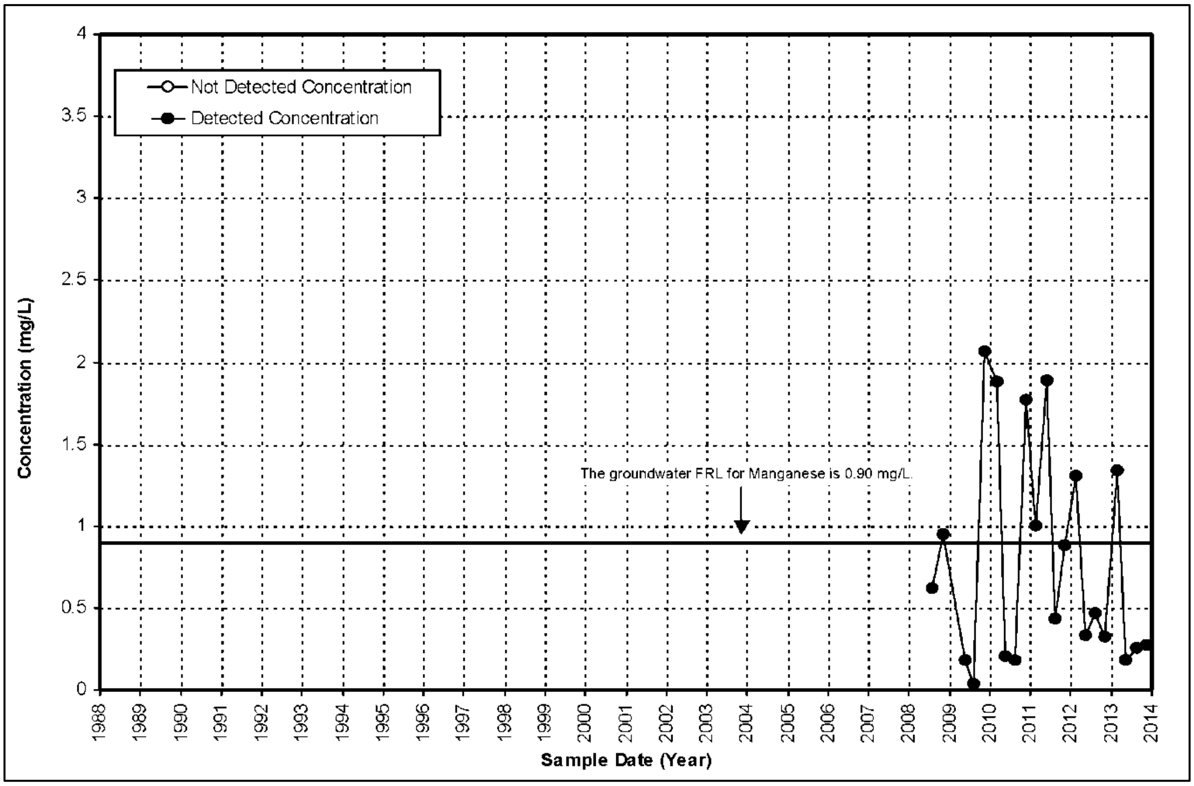

Figure A.4-4. Manganese Concentration Versus Time Plot for Monitoring Well 22201

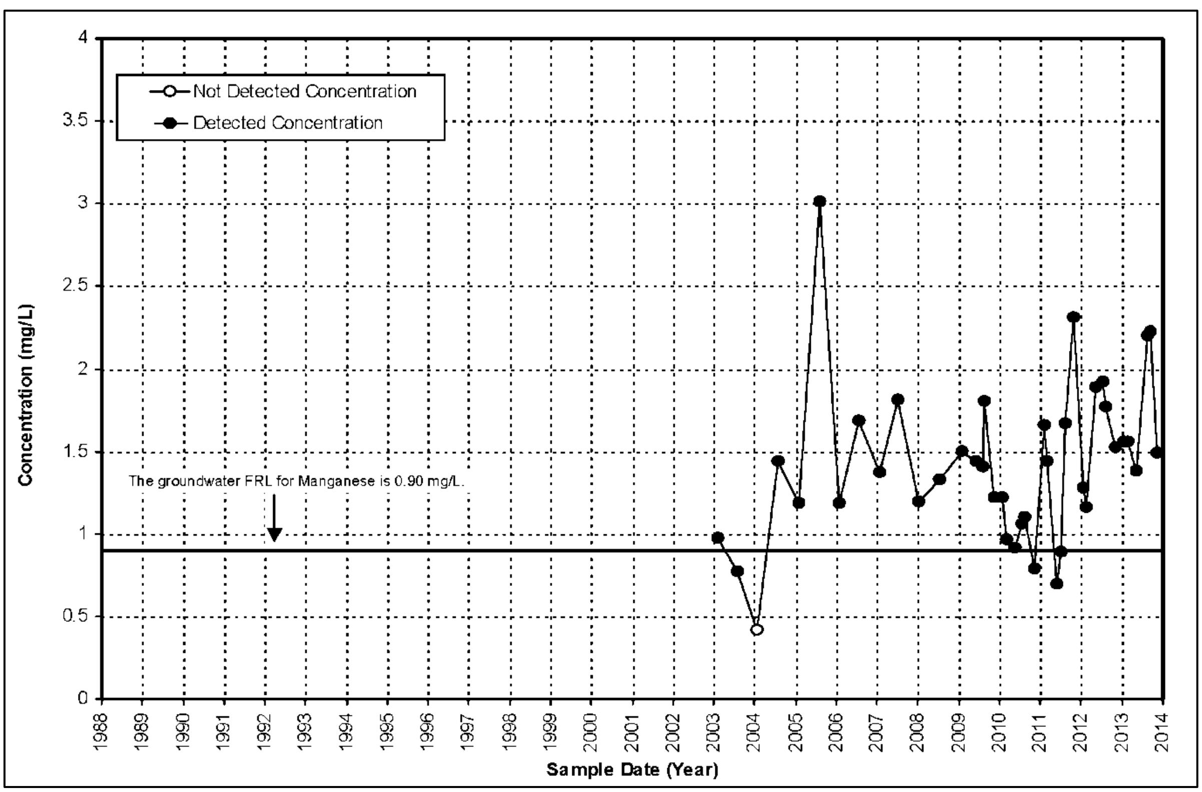

Figure A.4-5. Manganese Concentration Versus Time Plot for Monitoring Well 22204

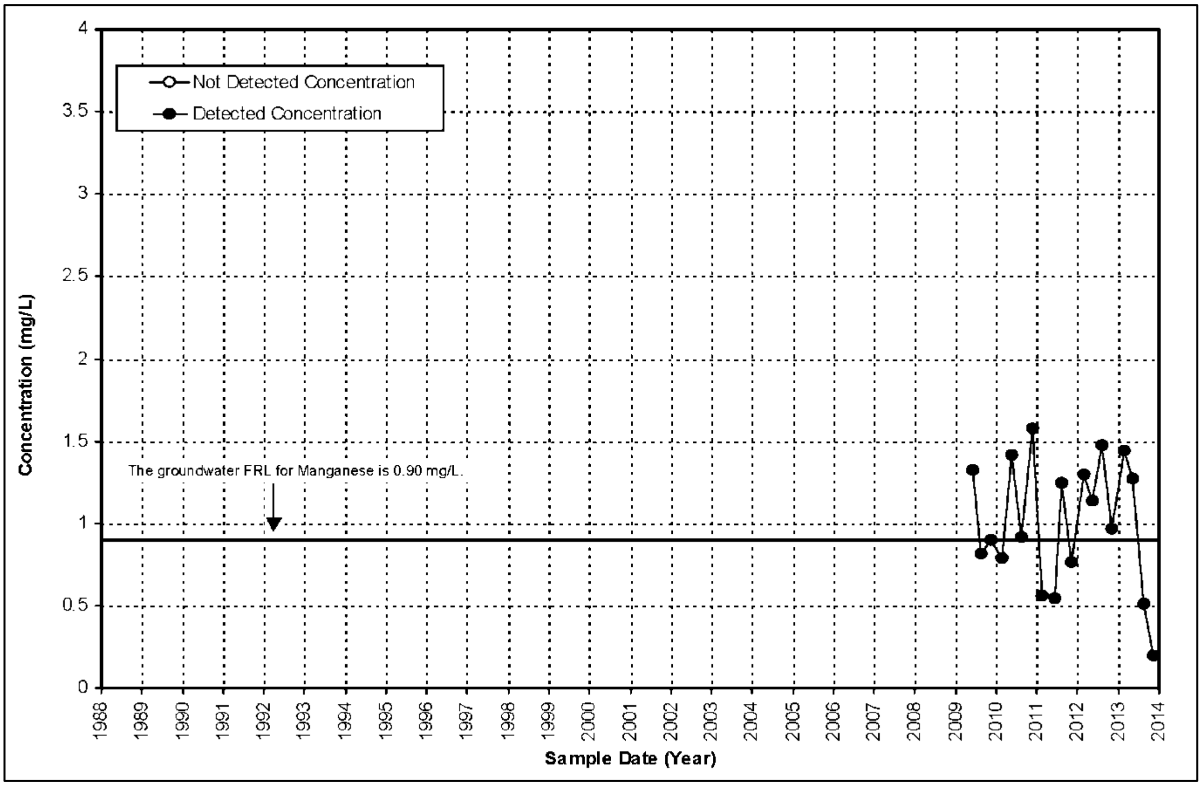

Figure A.4-6. Manganese Concentration Versus Time Plot for Monitoring Well 22217

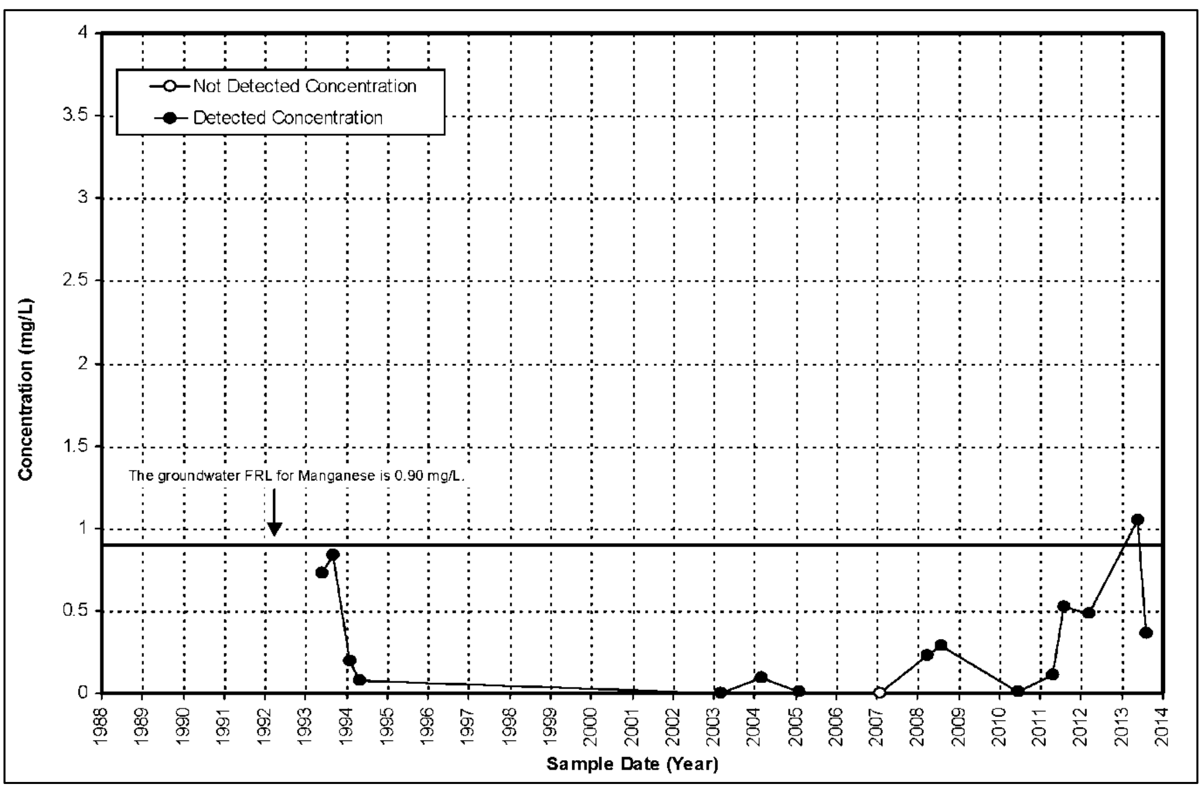

Figure A.4-7. Manganese Concentration Versus Time Plot for Monitoring Well 2625

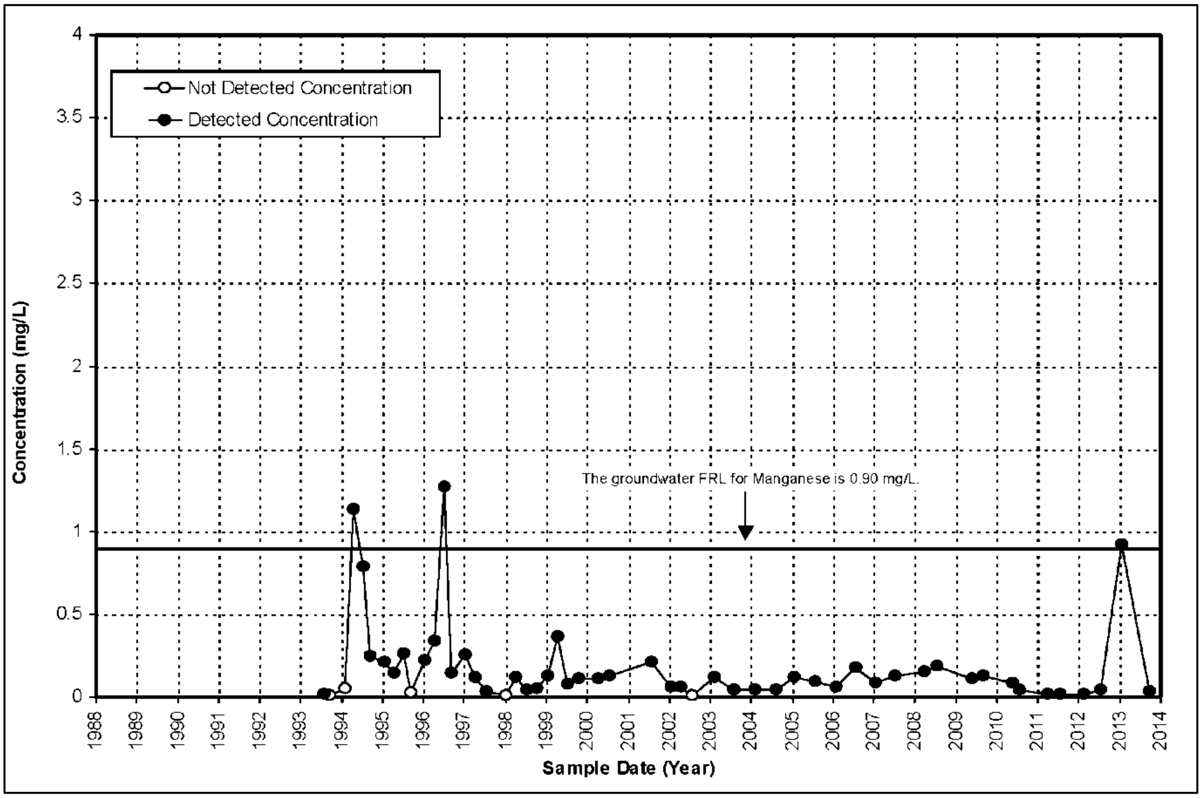

Figure A.4-8. Manganese Concentration Versus Time Plot for Monitoring Well 2733

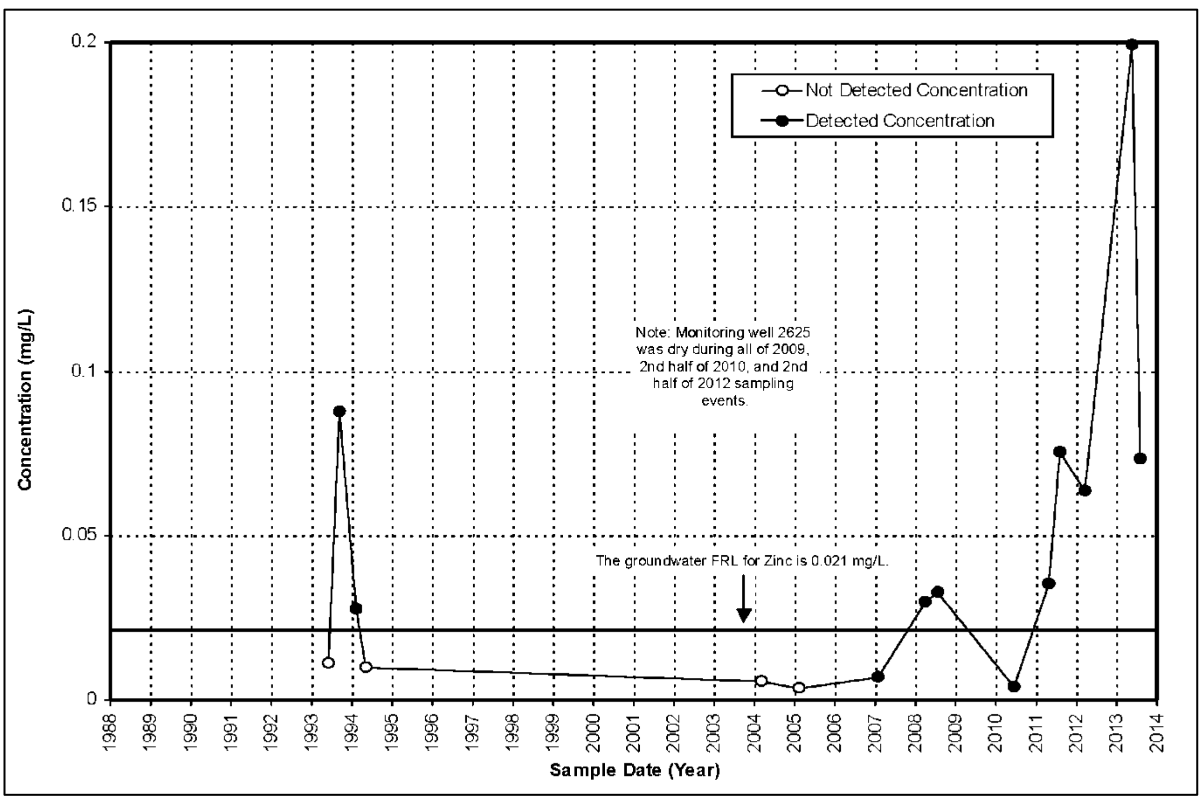

Figure A.4-9. Zinc Concentration Versus Time Plot for Monitoring Well 2625

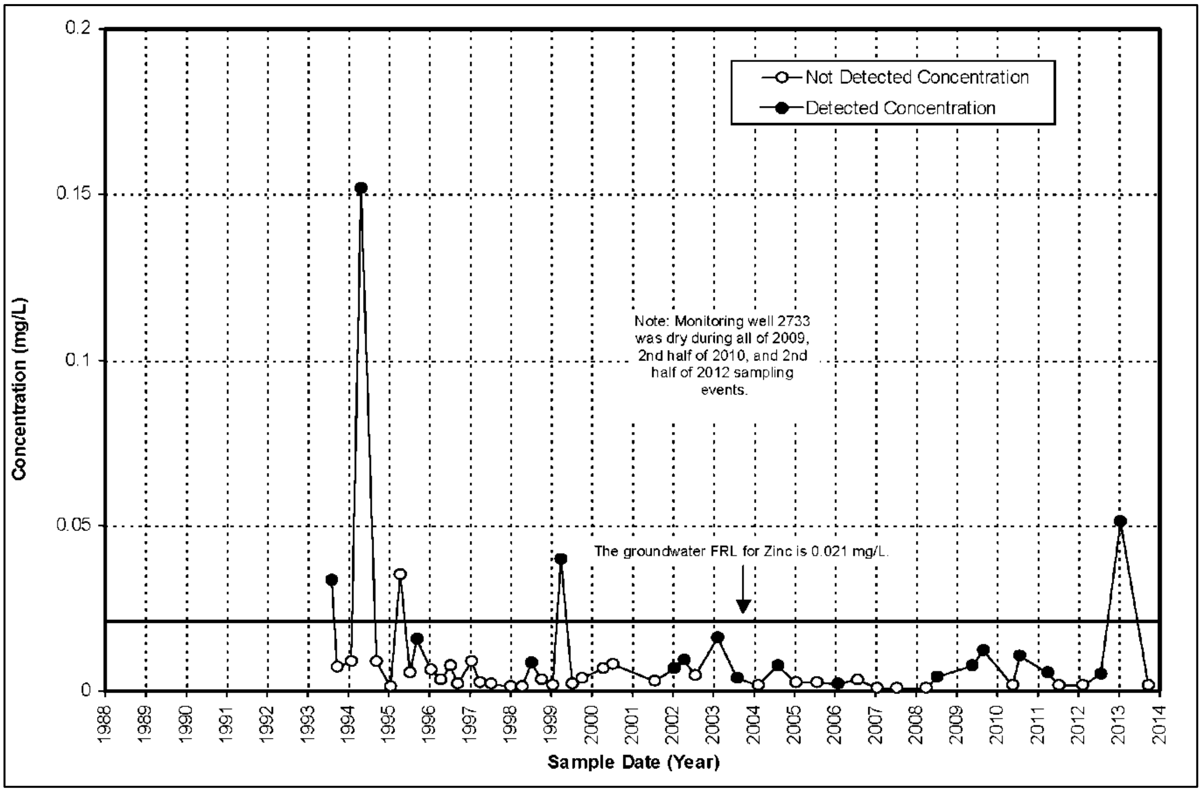

Figure A.4-10. Zinc Concentration Versus Time Plot for Monitoring Well 2733

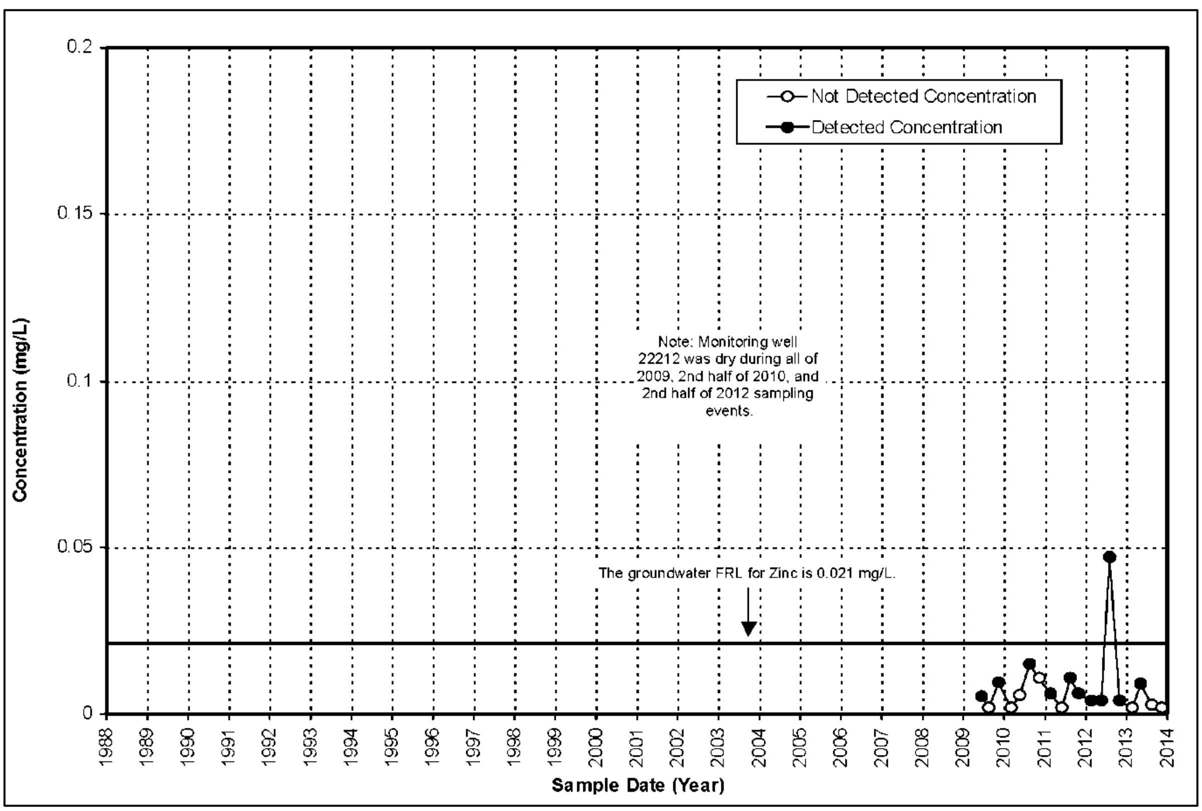

Figure A.4-11. Zinc Concentration Versus Time Plot for Monitoring Well 22212

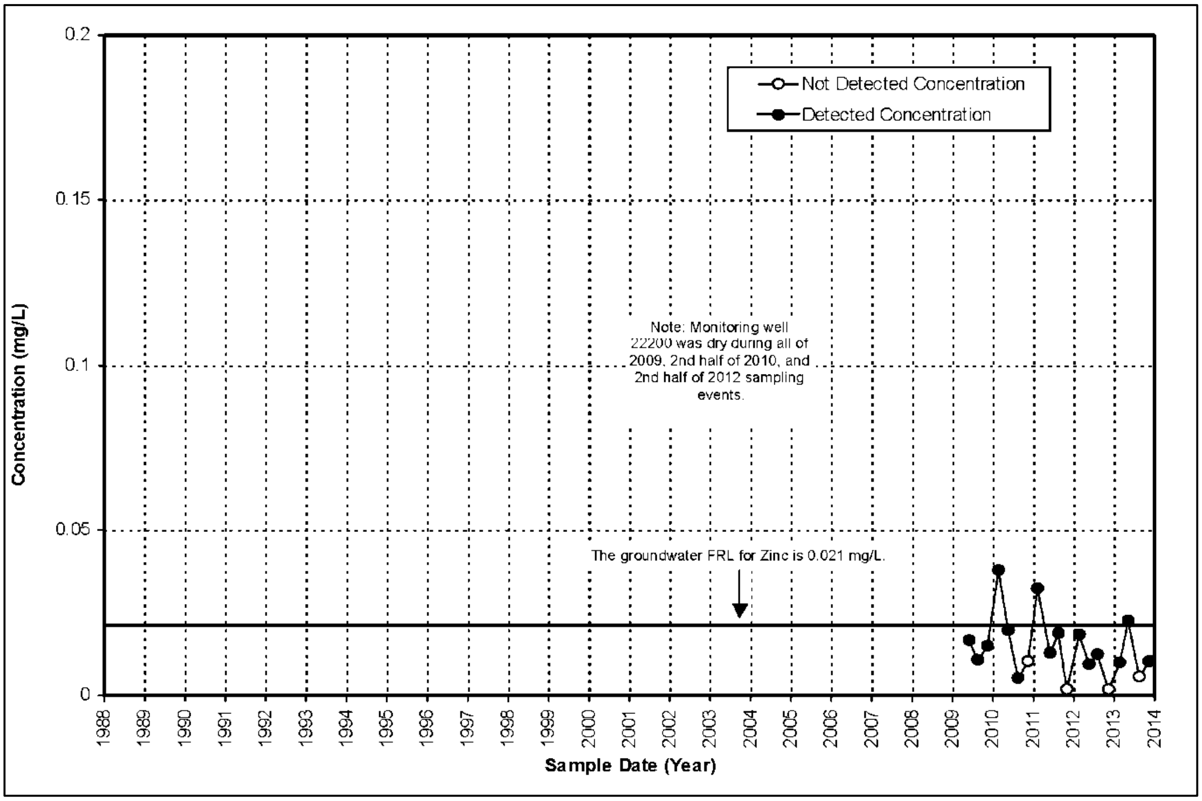

Figure A.4-12. Zinc Concentration Versus Time Plot for Monitoring Well 22200

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Attachment A.5

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Contents

Tables

Figures

Abbreviations

CAWWT	Converted Advanced Wastewater Treatment Facility
CUSUM	Shewhart-cumulative sum
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OAC	Ohio Administrative Code
OSDF	On-Site Disposal Facility
OU5 RI/FS	Operable Unit 5 Remedial Investigation/Feasibility Study
PCB	polychlorinated biphenyls
SCL	Shewhart control limit
TDS	total dissolved solids

Measurement Abbreviations

ft	feet
gpad	gallons per acre per day
pCi/L	picocuries per liter

A.5.0 On-Site Disposal Facility Monitoring Results

This attachment provides results for the On-Site Disposal Facility (OSDF) leak detection and leachate monitoring program for 2013. Monitoring and sampling were conducted in accordance with the *Comprehensive Legacy Management and Institutional Controls Plan*, Attachment C "Groundwater/Leak Detection and Leachate Monitoring Plan" (GWLMP) (DOE 2012a). The objective of the GWLMP is to meet regulatory requirements for groundwater detection monitoring in the Great Miami Aquifer (GMA) and perched groundwater system and to provide leachate monitoring information.

<u>Facility Description</u>

The OSDF is situated in the northeast area of the Fernald Preserve. It has a capacity of 2.96 million cubic yards (2.26 million cubic meters), and a maximum height of approximately 65 feet (ft) (20 meters). A security fence surrounds the OSDF and defines a footprint that occupies approximately 98 acres. The facility consists of eight individual cells. All eight cells were 100 percent full and capped by October 2006.

Protection of the GMA and the overlying perched groundwater system includes the following measures for each of the eight cells (refer to Figure A.5-1 for a cross section of the liner system):

- Leachate collection system (LCS),
- Leak detection system (LDS),
- Multilayer composite liner system, and
- Multilayer composite cap system.

The LCS consists of a gravel layer installed beneath the waste to collect rainwater that came in contact with the waste during cell construction and additional moisture that is draining from the waste following capping. The LDS is located beneath both the LCS and the primary geosynthetic liner system and provides a mechanism for collecting and monitoring leakage through the primary liner layer of the OSDF prior to any releases to the environment. Both systems drain to the west and extend beyond the synthetic liner systems into valve houses, where leachate becomes accessible for monitoring.

The base of each cell liner also slopes toward the centerline of the cell, and the centerline of the base is sloped toward the west. Leachate moving along the top of a liner would first travel toward the centerline and then west along the centerline to be drained from the cell via piping at the penetration box, which is the lowest elevation point of the cell.

Each cell is monitored below the penetration box with a horizontal till well (HTW), which represents the first monitoring point for a release from a cell. HTWs provide monitoring of the perched groundwater quality beneath the point where the LCS and LDS pipes exit the liner system. The GMA is monitored via both an upgradient and a downgradient monitoring well for each cell. Figure A.5-2 identifies the well locations associated with the OSDF. Table A.5-1 identifies specific dates for the following cell activities:

- Sample initiation for each monitoring horizon,
- Waste placement initiation,

- LDS volume measurement initiation,
- Cap geomembrane layer completion, and
- Cap completion (through seeding).

A construction quality assurance/quality control program was executed for each cell of the OSDF. The synthetic liners and caps of each cell were inspected and tested for defects at the time of installation. Given the attention to quality assurance/quality control during the installation of the OSDF liner system, it is doubtful that a breach in the liner would have gone unnoticed, but it is possible that a breach could develop. Such a breach would provide a potential pathway for leachate migration, but adequate hydraulic head is needed to drive leachate through the breach and clay liner into the underlying horizon.

The GWLMP summarizes the principal geologic, hydrogeologic, and subsurface contaminant conditions in the OSDF area that had a direct bearing on the development of the monitoring program for the OSDF facility. As discussed in the GWLMP, the conceptual flow-path/migration pathway for a leak from the facility involves understanding:

- How each cell was constructed and how a cell transmits leachate from the facility;
- The impact of hydraulic head within the facility in the LDS and the design action leakage rate;
- Nature, thickness, and hydraulic conductivity of glacial clay beneath the facility;
- Residual soil contamination beneath the facility and its possible impact to HTW water quality results;
- Groundwater model evaluations of transport times and modeled flow-paths for use in placing monitoring wells for the monitoring network in the GMA; and
- Modeled breakthrough travel times through the glacial clay for uranium (the main contaminant of concern) and for technetium-99 (the most mobile contaminant).

<u>Information Organization</u>

The 2013 OSDF leak detection and leachate monitoring information is organized in the following sections:

- Flow and Hydraulic Performance (Section A.5.1),
- Water Quality: Data Presentations and Evaluations (Section A.5.2),
- Cell Cap Inspections (Section A.5.3),
- Monitoring Changes (Section A.5.4), and
- Summary of Overall Performance/Findings and Recommendations (Section A.5.5).

Sub-attachments A.5.1 through A.5.8 provide cell-specific information for disposal cells 1 through 8.

A.5.1 Flow and Hydraulic Performance

A.5.1.1 Overall LCS Volumes

In 2013, leachate volumes pumped from the LCS tanks were measured by recording readings from capacitance probes installed in each primary containment vessel. The probes are attached through a remote control unit to the Converted Advanced Wastewater Treatment (CAWWT) Facility control room, where water levels are converted automatically to volumes based on the tank manufacturer's design specifications for the tanks.

If communication to CAWWT is not functioning properly, tanks are pumped manually when the level reaches 40 percent full or 0.9 ft of leachate in the tank. Volumes pumped are recorded manually on the leachate round sheet. Volumes in the tank are based on levels in the tank and are calculated using the formula provided by the tank manufacturer.

Leachate volumes have been measured since waste placement began. Figure A.5-3 is a graph showing monthly leachate volumes from October 2006 through December 2013. Figure A.5-4 is a graph that shows the annual leachate volume from 2007 through 2013. The data collected in 2013 indicate that 143,733 gallons of leachate were collected and pumped to the CAWWT Backwash Basin for subsequent treatment at the CAWWT. The total volume measured in 2013 represents a 5 percent decrease from the total volume measured in 2012 (151,343 gallons). The volume of precipitation that fell on the OSDF in 2013 was approximately 58.9 million gallons (40.09 inches of rain over 54.1 acres). The facility cap was designed to inhibit rainwater from infiltrating into the OSDF. Leachate collected in 2013 represents approximately 0.2 percent of the precipitation that fell on the OSDF in 2013, indicating that the cap is performing as designed to reduce infiltration.

The GWLMP identifies that trend analysis of the LCS flow-monitoring measurements will be conducted for capped cells to provide an indication of changes in system performance. Monthly accumulation volumes for Cells 1 through 8 are plotted and provided in Sub-attachments A.5.1 through A.5.8. The semi-log plots indicate that leachate volumes from the capped cells continue to decline over time, but the rate of decline is decreasing. The overall monthly facility leachate flow declined by 1,390 gallons or approximately 2 percent (72,561 gallons for January–June 2013 versus 71,171 gallons for July–December 2013).

A.5.1.2 LDS Accumulation Rates and Volumes

Quantitative measurement of the volumes accumulating in and pumped from the LDS tanks was initiated according to the various dates in Table A.5-1. These measurements were taken using the same methodology as described above for the LCS. These data are used to determine both accumulation rates (in gallons per acre per day [gpad]) and accumulation volumes (in gallons) for each cell's LDS.

The GWLMP states that trend analysis of the LDS flow monitoring measurements will be conducted for capped cells to provide an indication of changes in system performance. Monthly accumulation volumes for Cells 1 through 8 are provided and graphically displayed in Sub-attachments A.5.1 through A.5.8. The graphs indicate that overall LDS flows are declining.

Based on capacitance probe readings, the LDS of Cells 3 and 4 were dry during all four quarters of 2013. The LDS of Cells 1, 2, and 5 were dry during three quarters of 2013. It should be noted that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2013 for the LDS in Cells 1, 3, 4, and 7. From a sampling ability, the LDS in Cells 1, 3, 4 and 7 were considered to be dry all year.

The *On-site Disposal Facility Final Design Calculation Package* (DOE 1997) defines an initial response leakage rate for individual cells of 20 gpad. The 2013 maximum LDS accumulation rates and the percent of the initial response leakage rate for each cell are as follows:

Cell	Maximum LDS Accumulation Rate Capacitance Probe Measurements (gpad)	Percent of Initial Response Leakage Rate
1	0.05	0.3
2	0.02	0.1
3	0.00	0.0
4	0.00	0.0
5	0.02	0.1
6	0.07	0.3
7	0.01	0.1
8	0.02	0.1

These LDS accumulation rates indicate that the liner systems for the cells are performing well within the specifications outlined in the approved OSDF design. The initial response leakage rate of 20 gpad is an administrative criterion for commencing an investigation into the possibility that the cell is not performing as designed. It is 1/10 of the design criterion of 200 gpad. Because all of the cells are closed and capped, it is expected that LDS accumulation rates will continue to diminish over time. Rates will continue to be closely tracked to document that the primary liner systems continue to perform as designed.

A.5.1.3 Liner Efficiencies

Cell-specific apparent liner hydraulic efficiencies are calculated using the following equation:

$$\text{Hydraulic efficiency} = [1-(\text{Volume}_{LDS}/\text{Volume}_{LCS})] \times 100$$

Apparent liner hydraulic efficiency is a measure of how a cell's liner is performing. The above equation considers *all* the LDS volume to be leakage through the primary liner, which is a conservative measure. In the *Report on the 1995 Workshop on Geosynthetic Clay Liners* (EPA 1996), several sources of flow from leak detection layers are identified. These sources include:

- Top liner leakage,
- Construction water and compression water,
- Consolidation water, and
- Water from groundwater infiltration.

Quarterly apparent liner efficiencies were consistently greater than 99 percent for Cells 1 through 8 throughout 2013. Quarterly apparent liner efficiencies (in percentages) are provided for Cells 1 through 8 below.

Apparent Liner Efficiency (percent), Quarterly for 2013

Quarter	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8
First	100	99.98	100	100	99.87	99.48	99.87	99.95
Second	100	99.90	99.98	99.98	99.97	99.45	99.89	99.77
Third	99.74	100	100	100	100	99.06	99.96	99.95
Fourth	99.93	99.94	100	100	100	99.19	99.93	99.92

A.5.1.4 HTW Water Yields

HTW water yields are monitored at each cell to document trends in perched-water purge volumes. In 2013, the HTWs were purged four times (February, May, August, and November). Average purge water yields from the HTWs ranged from 0 gallons beneath Cell 8 to 1,050 gallons beneath Cell 5. The HTW water yields will continue to be tracked and factored into the OSDF leak detection evaluation, where appropriate. The water-yield graphs are provided in each cell's sub-attachment and are updated with purge volume data collected prior to each sampling event.

A.5.2 Water Quality: Data Presentations/Evaluations

The water quality and data presentations/evaluations presented in this report consist of the following:

- Quarterly monitoring summary statistics (Section A.5.2.1)
- Concentration plots (Section A.5.2.2)
  - LCS, LDS, and HTW, of each cell
  - HTW and GMA wells of each cell
- Control charts (Section A.5.2.3)
- Annual LCS monitoring results (Section A.5.2.4)
- Additional LDS Monitoring (Section A.5.2.5)
- Bivariate plots for each cell (Section A.5.2.6)
- Summary of Upward Concentration Trends in the HTW and GMA Wells (Section A.5.2.7)

A.5.2.1 Quarterly Monitoring Summary Statistics

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within each cell is sampled in the LCS and LDS. Water quality beneath each cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present results.

In 2013, 24 parameters were sampled quarterly in the LCS, LDS, and GMA wells of each cell (alkalinity, chloride, chromium, nitrate/nitrite, total dissolved solids [TDS], total organic carbon, total organic halogens, sulfate, arsenic, barium, boron, calcium, cobalt, copper, iron, lithium, magnesium, manganese, nickel, potassium, selenium, sodium, zinc, and uranium). HTWs in all cells were sampled quarterly for arsenic, uranium, sodium, and sulfate. In addition, the LCS, LDS, and GMA wells of Cell 8 were sampled quarterly for technetium-99, and the LCS, LDS, and GMA wells of Cell 5 were sampled quarterly for vanadium. Summary statistics for all of the parameters monitored quarterly are provided in Sub-attachments A.5.1 to A.5.8 (Tables A.5.1-1 through A.5.8-1). The information provided in each summary table is based on a standardized quarterly sampling frequency.

The process used for conducting the summary statistics is illustrated in Figure A.5-5. Table A.5-2 lists the rules that are used to report the data provided in the sub-attachments on Tables A.5.1-1 to A.5.8-1. For results where the concentrations are below the detection limit, the results used in the average, standard deviation, distribution, trend, serial correlation, and outliers are each set at half the detection limit. One objective of conducting the summary statistics is to identify the parameters that meet the requirements for control charts (i.e., greater than eight samples, normal or lognormal distribution, no trend, and no serial correlation).

Data used in the summary statistics were "quarterized" (i.e., normalized to quarterly data). The rationale behind this is that during different time periods, data were collected at varying time intervals. For example, from October 30, 1997, through December 8, 1997, there were 15 uranium measurements taken at HTW 12338. In all of 1998, only four were taken; in 1999 there were seven; in 2000 there were six; and four each were taken in 2001 through 2003. So, in a 5 to 6 week period in 1997, nearly as much data were collected as were collected from 1998 to 2000. Without normalizing the data, the time periods with more sampling activity would carry more weight, and, therefore, with respect to the calculations, be considered more important. Additionally, sampling the same well at too short of an interval (often just one day apart in 1997) also violated the statistical assumption of independence. Well data that are collected too closely in time are serially correlated and can distort the statistics underlying the control charts. Even with quarterly sampling, there is often an issue with serial correlation.

ChemStat, Version 6.3, (a Starpoint Software Program) was used to conduct the statistics. ChemStat is software used to perform the statistical analysis of groundwater monitoring data at Resource Conservation and Recovery Act facilities. The website for the software is www.pointstar.com.

Data set distributions were checked using the Shapiro Wilk Test (95 percent confidence interval) for data sets with less than 50 samples, and the Shapiro-Francia Test (95 percent confidence interval) for data sets with 50 samples or more. The Mann-Kendall test for trend (95 percent confidence interval) was used to determine the presence of either an upward or downward concentration trend over time. The rank Von Neumann test (confidence interval of 99 percent) was used to check for serial correlation.

A.5.2.2 Concentration Plots

Concentration plots for the 24 parameters monitored quarterly in the LCS, LDS, and the four parameters monitored quarterly in the HTW of each cell in 2013 are presented in Sub-attachments A.5.1 to A.5.8. The plots are presented with a common *y*-scale based on the parameter. Outliers identified in Subsections A.5.1 through A.5.8 in Tables A.5.1-1 through A.5.8-1 are not plotted on the concentration plots.

A.5.2.3 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewhart-cumulative sum (CUSUM) control chart works as follows. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a Shewhart control limit (SCL) on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL control limit.

U.S. Environmental Protection Agency (EPA) Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM control limits on the charts. As a "work-a-round," the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

One hundred and twenty seven Shewhart-CUSUM control charts are presented in Sub-attachments A.5.1 through A.5.8 for parameters monitored quarterly in the HTW and GMA wells in 2013 and had data sets that achieved control chart criteria (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation). In 2012, only 78 control charts were prepared.

Of the 127 control charts presented, 124 (98 percent) exhibit "in control" conditions, and 3 (2 percent) exhibit "out of control" conditions. The three "out of control" conditions were in

Cell 4 (zinc in monitoring well 22205), Cell 5 (total dissolved solids in well 22208), and Cell 8 (alkalinity in well 22217).

A.5.2.4 Annual LCS Monitoring Results

Once a year, the LCS of each cell is sampled for Appendix I parameters and polychlorinated biphenols (PCBs) listed in Ohio Administrative Code (OAC) 3745-27-10. A summary of the results for each cell is provided in Sub-attachments A.5.1 thru A.5.8 (Tables A.5.1-2 through A.5.8-2).

- One new Appendix I or PCB parameter (cadmium) was detected in the LCS of Cell 6 in 2013. Detection of cadmium in the LCS of Cell 6 in 2014 will trigger sampling for cadmium in the LDS of Cell 6 during the subsequent next sampling event.

A.5.2.5 Additional LDS Monitoring

As stated in Appendix B of the GWLMP (DOE 2012a) "two consecutive detects in a cell's LCS will trigger sampling in the cell's LDS during the next scheduled sampling round." In Cells 3, 7, and 8 additional sampling is taking place in the LDS. A summary and status of the additional LDS sampling is provided below.

- **Ammonia in Cell 3:** First detected in the LCS of Cell 3 in 2009, a consecutive detect was made in 2010. Ammonia is therefore being sampled for in the LDS of Cell 3. The LDS of Cell 3 was dry in 2011, 2012, and 2013 so no samples could be collected. Ammonia was detected in the LCS of Cell 3 in 2011, 2012, and 2013.
- **1,1-dichloroethene in Cell 7:** First detected in the LCS of Cell 7 in 2009, a consecutive detect was made in 2010. Sampled for twice in the LDS of Cell 7 in 2011, it was not detected. The LDS of Cell 7 was dry in 2012 and 2013. 1,1-dichloroethene was detected in the LCS of Cell 7 in 2011, but not in 2012 or 2013.
- **1,1-dichloroethene in Cell 8:** First detected in the LCS of Cell 8 in 2009, consecutive detect was made in 2010. Sampled for twice in the LDS of Cell 8 in 2011, it was not detected. Sampled for once in the LDS in 2012 (LDS of Cell 8 was dry for three of the four quarters in 2012) it was not detected. It was not detected in the LDS in 2013. 1,1-dichloroethene was detected in the LCS of Cell 8 in 2011, but not in 2012 or 2013.
- **Cadmium in Cell 8:** First detected in the LCS of Cell 8 in 2011, consecutive detect made in 2012. Cadmium was not detected in the LDS of Cell 8 in 2013 and it was not detected in the LCS of Cell 8 in 2013.

A.5.2.6 Bivariate Plots for Each Cell

Bivariate plots are used in an Alternate Source Determination capacity to show that water quality changes observed beneath the facility in HTW and GMA wells are not attributed to facility performance. Sodium and uranium were selected because this combination provides a good distinction between LCS, LDS, and HTW. This combination was discovered during the Common Ion Study (DOE 2008a). Although the sodium-uranium bivariate plot for Cell 8 provides a distinction between the LDS and HTW, the separation shown between the LDS and HTW is not as distinct as it is for the other seven cells; therefore, a sulfate-uranium bivariate plot is also provided for Cell 8. Other combinations may be added, if deemed appropriate.

Bivariate plots for (uranium-sodium) are presented for each cell in Sub-attachments A.5.1 through A.5.8. The bivariate plots illustrate the concentration signatures for uranium-sodium in each monitoring horizon. Distinct clustering of horizon concentrations indicates that the fluids in the different horizons are not mixing. In response to an Ohio EPA comment on the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010) (OEPA Comment Number 35) the closest points between monitoring horizons are dated.

An additional bivariate plot for (uranium–sulfate) is presented for Cell 8 in Sub-attachment A.5.8. The additional uranium-sulfate bivariate plot provides supporting information concerning the water chemistry signatures that are present in the LDS and HTW of Cell 8; specifically that they are separate and distinct.

The bivariate plots for 2013 continue to support the interpretation that chemical signatures for the different monitoring horizons are separate and distinct, indicating that mixing between the horizons is not occurring; therefore, upward concentration trends measured beneath the cells in 2013 (HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.2.7 Upward Concentration Trends in the HTW and GMA Wells

The HTW is located beneath the liner penetration box of each cell by design. This area of the liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration trend in the HTW.

GMA monitoring wells are positioned (and identified) for pre-aquifer-remediation flow conditions defined in the Operable Unit 5 Remedial Investigation/Feasibility Study (OU5 RI/FS) Report. Water level data reported in the OU5 RI/FS Report indicates that prior to the start of pumping for the groundwater remediation, groundwater flow directions in the vicinity of the OSDF were generally from west to east.

Groundwater flow beneath the OSDF is currently being influenced by active pumping taking place for the groundwater remediation southwest of the OSDF. Water beneath the OSDF is generally moving in response to this pumping from northeast to southwest. When pumping for the groundwater remedy stops, groundwater flow in the vicinity of the OSDF should once again return to a direction that is generally from west to east. Up trends are therefore being tracked in all GMA wells at this time. A leak from the OSDF would be indicated by an increasing concentration trend in a GMA monitoring well.

In addition to being caused by a leak from the OSDF facility, increasing concentration trends in the HTW and/or GMA wells could also be caused by fluctuating ambient concentrations beneath the cells not connected to the operation of the facility.

As presented in subsections A.5.1 through A.5.8, several parameter data sets have upward concentration trends beneath the OSDF (i.e., HTW and/or GMA Wells). Bivariate plots (uranium-sodium and uranium-sulfate) indicate separate and distinct chemical signatures for the

LCS, LDS, and HTW of all eight cells. This indicates that water is not mixing from inside the facility to outside the facility, leading to the conclusion that the facility is not leaking. Therefore, concentration increases observed in the GMA wells are attributed to fluctuating ambient concentrations beneath the cells, and not to cell performance. Additional information is provided in Sub-attachments A.5.1 through A.5.8.

A.5.3 Cell Cap Inspections

OSDF cell cap inspections are conducted quarterly. The inspection team typically includes representatives from Ohio EPA, Ohio Department of Health, and The S.M. Stoller Corporation, a wholly owned subsidiary of Huntington Ingalls Industries. Issues identified during inspections typically include small erosion rills, rocks that surface as top soil settles, animal burrows and digging, small areas that require reseeding, and the presence of woody vegetation, thistle, or other noxious species.

The issues are addressed as follows:

- Erosion rills are repaired if they exceed 3 inches wide by 6 inches deep.
- Rocks that surface are removed, especially if they will interfere with mowing activities or may be a source location for erosion.
- Animal burrows and holes are filled in and reseeded, if necessary.
- Areas that require reseeding are seeded and covered with jute matting to help prevent erosion of the seed.
- Woody vegetation is removed and herbicide is applied to the noxious weeds.

Following each inspection, a report is submitted to the agencies documenting the inspection, issues and stating how issues will be addressed. These reports are available to the public on the Fernald Preserve website http://www.lm.doe.gov/fernald/sites.aspx. In 2013, inspections were conducted in March, June, September, and December. In 2013, there were no visual signs that the integrity of the cap had been compromised in any way.

A.5.4 Monitoring Changes

The U.S. Department of Energy (DOE) completed a parameter selection process in 2011 that had been ongoing for several years. Established in consultation with the Ohio EPA in 2005 and 2006, the objective of the process was to identify the Appendix I and PCB parameters detected in the LCS that would provide the most promise for detecting a leak from the facility and therefore warrant more frequent and robust monitoring. A description of the process and the results of the process were documented in the *Fernald Preserve 2011 Site Environmental Report* (DOE 2012b). The process can be briefly described as a statistical screening procedure that was applied to each cell. The 24 parameters selected by the process were parameters that had been most detected in the LCS at concentrations large enough to be measured beneath the facility should a leak in the facility ever occur. Specifically:

- Parameters had been detected at least 25 percent of the time in the LCS, and
- Parameters were shown statistically to have a mean concentration in the LCS that is larger than the mean concentration of the pre-design or background data sets.

Results from the parameter selection process for LCS data from Cells 1, 2, and 3 were reported in the *Fernald Preserve 2007 Site Environmental Report* (DOE 2008b). Six additional parameters were identified for more frequent and robust monitoring (arsenic, cobalt, nickel, selenium, TDS, and zinc). Quarterly sampling for these additional six new parameters in the LCS, LDS, HTW, and GMA wells of each cell began in 2009.

Results from the parameter selection process for LCS data from Cells 4 and 5 were presented in the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010). Eight additional parameters were identified for more frequent and robust monitoring (alkalinity, chloride, nitrate/nitrite, barium, calcium, copper, magnesium, and potassium). Quarterly sampling for these additional eight parameters in the LCS, LDS, HTW, and GMA wells of each cell began in 2011. Vanadium was also identified for quarterly sampling in the LCS, LDS, and GMA wells of Cell 5, and technetium-99 was identified for quarterly sampling in the LCS, LDS, and GMA Wells of Cell 8. As reported in the *Fernald Preserve 2012 Site Environmental Report* (DOE 2013), sampling for vanadium ended in the LCS, LDS, and GMA of Cell 5 beginning in 2013.

Results from the parameter selection process for LCS data from Cell 6 were presented in the *Fernald Preserve 2010 Site Environmental Report* (DOE 2011). No new parameters were identified for quarterly monitoring.

Results from the parameter selection process for Cells 7 and 8 were presented in the *Fernald Preserve 2011 Site Environmental Report* (DOE 2012b). One additional parameter (chromium) was identified for quarterly monitoring. Quarterly monitoring for chromium in the LCS, LDS, and GMA wells of each cell began in 2013.

The resulting quarterly sampling list is as follows:

Quarterly Sampling in the LCS, LDS, and GMA of each Cell

Alkalinity	Barium	Manganese
Chloride	Boron	Nickel
Nitrate + nitrite, as Nitrogen	Calcium	Potassium
Total Dissolved Solids	Cobalt	Selenium
Total Organic Carbon	Copper	Sodium
Total Organic Halogen	Iron	Zinc
Sulfate	Lithium	Uranium
Arsenic	Magnesium	Chromium

- Quarterly sampling for vanadium in the LCS, LDS, and GMA wells of Cell 5.
- Quarterly sampling for technetium-99 in the LCS, LDS, and GMA wells of Cell 8.

Beginning in the second quarter of 2011, DOE implemented the following monitoring changes:

- For one year, tritium was added to the quarterly sampling list for all four horizons of all eight cells.
- The quarterly sampling list for the HTW of each cell was reduced to tritium, uranium, arsenic, and sodium. Sodium was retained to support the preparation of bivariate plots.

These changes stem from an informal proposal made to DOE by Ohio EPA in February 2011 via e-mail.

Tritium sampling was conducted from the second quarter of 2012 to the first quarter of 2013. The results indicate that tritium was only detected in the LCS of Cell 8. The August 4, 2011, sample from the Cell 8 LCS (12345C) had a concentration of 373 picocuries per liter (pCi/L), with a "J" validation qualifier indicating that the concentration was estimated. The February 21, 2012, sample from the Cell 8 LCS (12345C) also had a concentration of 373 pCi/L with a "J" validation qualifier indicating that the concentration was estimated.

Based on the lack of detections made, DOE has discontinued sampling for tritium. Quarterly sampling in the HTW continues for uranium, arsenic, sodium, and sulfate. Arsenic is included at the request of Ohio EPA, and uranium, sodium, and sulfate are included to provide data for bivariate plots.

A.5.4.1 Semiannual Sampling Frequency Began in January 2014

Ohio Solid Waste Regulations (OAC 3745-27-10) allows for a semiannual sampling frequency for detection monitoring after the first year of sampling. At the request of Ohio EPA, sampling had remained on a quarterly frequency through 2013. With EPA and Ohio EPA concurrence, DOE changed from a quarterly sampling frequency to a semiannual sampling frequency at the end of 2013. The supporting argument for the change can be found in the *Fernald Preserve 2012 Site Environmental Report* (DOE 2013).

A.5.4.2 Vanadium Sampling in Cell 5 Conducted from 2010 Through 2013

In 2009, vanadium was identified for quarterly monitoring in Cell 5 only based on the outcome of the parameter selection process that was being conducted at the time. It was discovered in 2013 that the designation was a mistake. The parameter selection process that was conducted for Cell 5 required a detection rate of at least 25 percent. Vanadium in the Cell 5 LCS only had a detection rate of 21 percent [See Table A.5.5-4 in the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010)]. A review of the data collected through 2012 indicates that vanadium still only has a detection rate of 21.7 percent in the LCS (Table A.5.5-1). It has never been detected in the LDS or HTW of Cell 5. With EPA and Ohio EPA concurrence, vanadium was dropped from the quarterly monitoring list for Cell 5 beginning January 1, 2014. It continues to be sampled annually in the LCS.

A.5.5 Summary of Overall Performance/Findings and Recommendations

Based on LCS and LDS flow data, engineered drainage features within the OSDF continue to perform as designed. Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of each cell (and uranium and sulfate in Cell 8) indicate that waters from the different horizons are not mixing, and therefore it can be inferred that the primary and secondary liners are not leaking. Water quality constituent concentration increases noted in the HTW and GMA wells are attributed to fluctuating ambient concentrations beneath the OSDF, and not to OSDF performance.

Specific findings are listed below:

- LCS volumes continue to diminish with time, but the decline is decreasing. Total facility leachate volume in 2013 was 5 percent less than in 2012 (approximately 143,733 gallons compared to 151,343 gallons).
- There was not enough water in the LDS of Cells 1, 3, 4, and 7 during 2013 to collect a water sample.
- The largest LDS maximum accumulation rate recorded in 2013 was 0.07 gpad in Cell 6, approximately 0.3 percent of the initial response leakage rate of 20 gpad.
- LDS accumulation rates indicate that the liner systems are performing well within the specification outlined in the approved cell design.
- Quarterly apparent liner efficiencies were consistently greater than 99 percent for Cells 1 through 8 throughout 2013.
- Bivariate plots continue to illustrate that the water chemistries in the LCS, LDS, and HTW of each cell are distinct and separate indicating that waters from the different horizons are not mixing. Therefore, upward concentration trends beneath the cells (i.e., HTWs and GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- In 2013, 127 data sets met the criteria for control Shewhart-CUSUM control charts. Of the 127 control charts presented for 2013, 124 (98 percent) exhibited "in control" conditions, and 3 (2 percent) exhibited "out of control" conditions.
- Annual LCS sampling for Appendix I and PCB parameters led to the following results.
  - One new Appendix I or PCB parameter (cadmium) was detected in the LCS of Cell 6. Detection of cadmium in the LCS of Cell 6 in 2014 will trigger sampling for cadmium in the LDS of Cell 6 during the subsequent next sampling event.
- In 2013, quarterly physical inspections of the OSDF revealed no visual signs that the integrity of the OSDF cap had been compromised.

A.5.6 References

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EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*, EPA 530/R-09-007, March.

Table A.5-1. OSDF Initiation and Completion Dates

Cell	Sample Initiation per Horizon[a]	Waste Placement Initiation	LDS Volume Measurement Initiation[b]	Cap Geomembrane Layer Completion[c]	Cap Completion[d]
1	LCS: February 17, 1998 LDS: February 18, 1998 HTW: October 30, 1997 GMA-U: March 31, 1997 GMA-D: March 31, 1997	December 23, 1997	May 1999	August 17, 2001	December 20, 2001
2	LCS: November 23, 1998 LDS: December 14, 1998 HTW: June 29, 1998 GMA-U: June 30, 1997 GMA-D: June 25, 1997	November 12, 1998	May 1999	July 17, 2003	November 12, 2003
3	LCS: October 13, 1999 LDS: August 26, 2002 HTW: July 28, 1998 GMA-U: August 24, 1998 GMA-D: August 24 1998	October 26, 1999	October 1999	July 16, 2004	September 20, 2004
4	LCS: November 4, 2002 LDS: November 4, 2002 HTW: February 26, 2002 GMA-U: November 6, 2001 GMA-D: November 5, 2001	November 08, 2002	November 2002	December 18, 2004	April 29, 2005
5	LCS: November 4, 2002 LDS: November 4, 2002 HTW: February 26, 2002 GMA-U: November 6, 2001 GMA-D: November 5, 2001	November 19, 2002	November 2002	June 22, 2005	August 29, 2005
6	LCS: October 27, 2003 LDS: October 27, 2003 HTW: March 14, 2003 GMA-U: December 16, 2002 GMA-D: December 16, 2002	November 18, 2003	January 2004	October 28, 2005	January 12, 2006

Table A.5-1 (continued). OSDF Initiation and Completion Dates

Cell	Sample Initiation per Horizon[a]	Waste Placement Initiation	LDS Volume Measurement Initiation[b]	Cap Geomembrane Layer Completion[c]	Cap Completion[d]
7	LCS: September 2, 2004 LDS: September 2, 2004 HTW: February 24, 2004 GMA-U: January 21, 2004 GMA-D: January 21, 2004	September 9, 2004	September 2004	July 2006	October 25, 2006
8	LCS: October 18, 2004 LDS: October 18, 2004 HTW: May 19, 2004 GMA-U: March 31, 2004 GMA-D: March 31, 2004 GMA-SW: August 22, 2005 GMA-SE: August 22, 2005	December 2, 2004	December 2004	September 24, 2006	October 25, 2006

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; and GMA-SE = southeast Great Miami Aquifer
[b]Prior to 1999, overall LDS volumes were measured. From 1999 on, LDS volumes were measured by cell.
[c]The cap geomembrane layer is made of high density polyethylene.
[d]Cap completion includes seeding.

Table A.5-2. Rules for Summary Statistics for Cells 1 Through 8

Rules	No. of Detected Samples	Total No. of Samples	Percent of Detects	Min[a,b]	Max[a,b]	Average	Std. Dev.	Distribution Type	Trend	Serial Correlation	Outliers
Include outliers	Yes	Yes	Yes	No	No	No	No	No	No	No	
Only one result	Yes	Yes	Yes	report "NA"	report value	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	
Only two results	Yes	Yes	Yes	report value	report value	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	
All non-detects	Yes	Yes	Yes	report "ND"	report "NA"	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	report "Insuff"	
Other rules						Need 3 detections otherwise report "Insuff"	Need 4 detections otherwise report "Insuff"	Need at least 3 samples to report distriburtion	Need at least 4 samples to report trend	Need at least 6 samples to report serial correlation	Need at least 4 samples to report outliers
Other rules						If distribution is "Lognormal," substitute "LogMean"					
Other rules						If distribution is "Undefined," substitute "Median"					

[a]NA=not applicable; ND=not detected

[b]If reported value is a nondetected result, report ND.

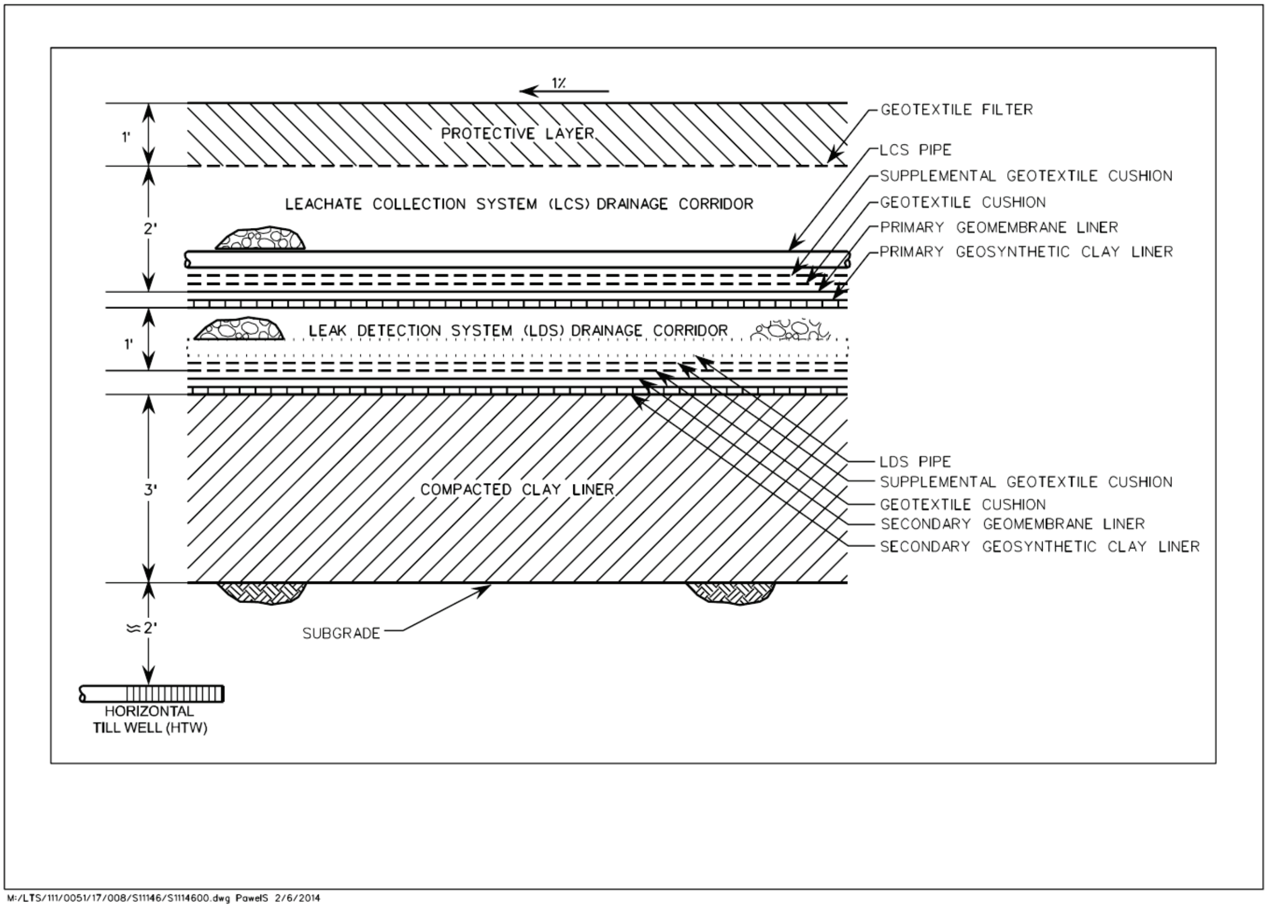

Figure A.5-1. On-Site Disposal Facility Liner System with HTW at the Drainage Corridor

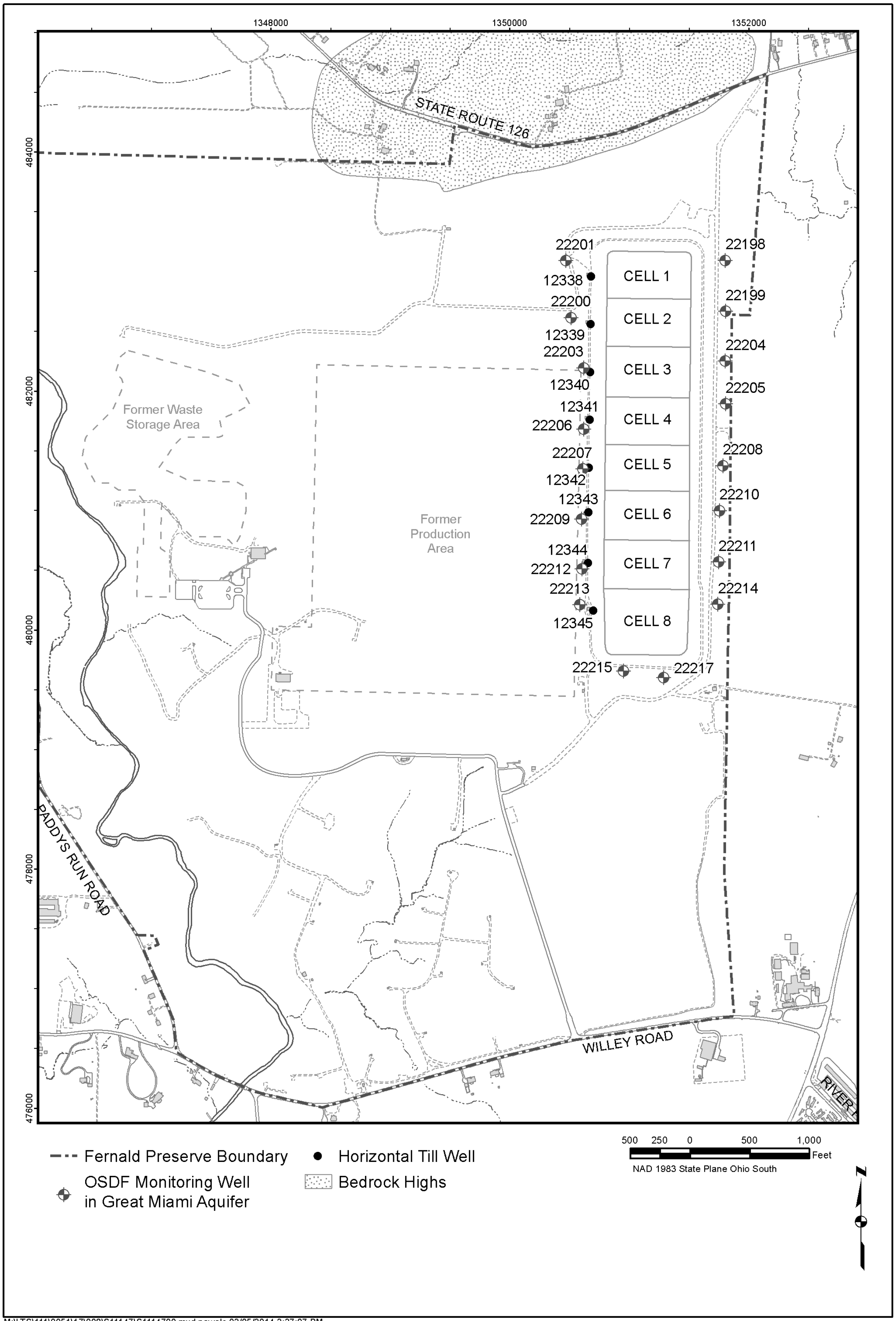

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Figure A.5-2. OSDF Footprint and Monitoring Well Locations

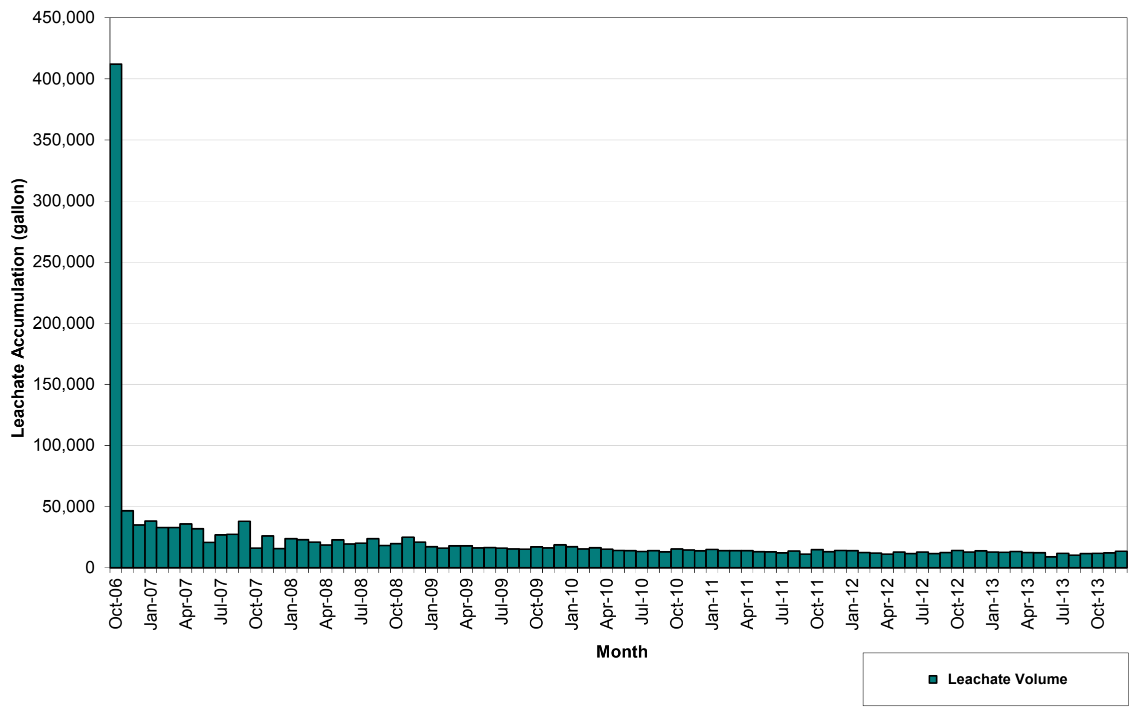

Figure A.5-3. OSDF Monthly LCS Flow (October 2006 Through December 2013)

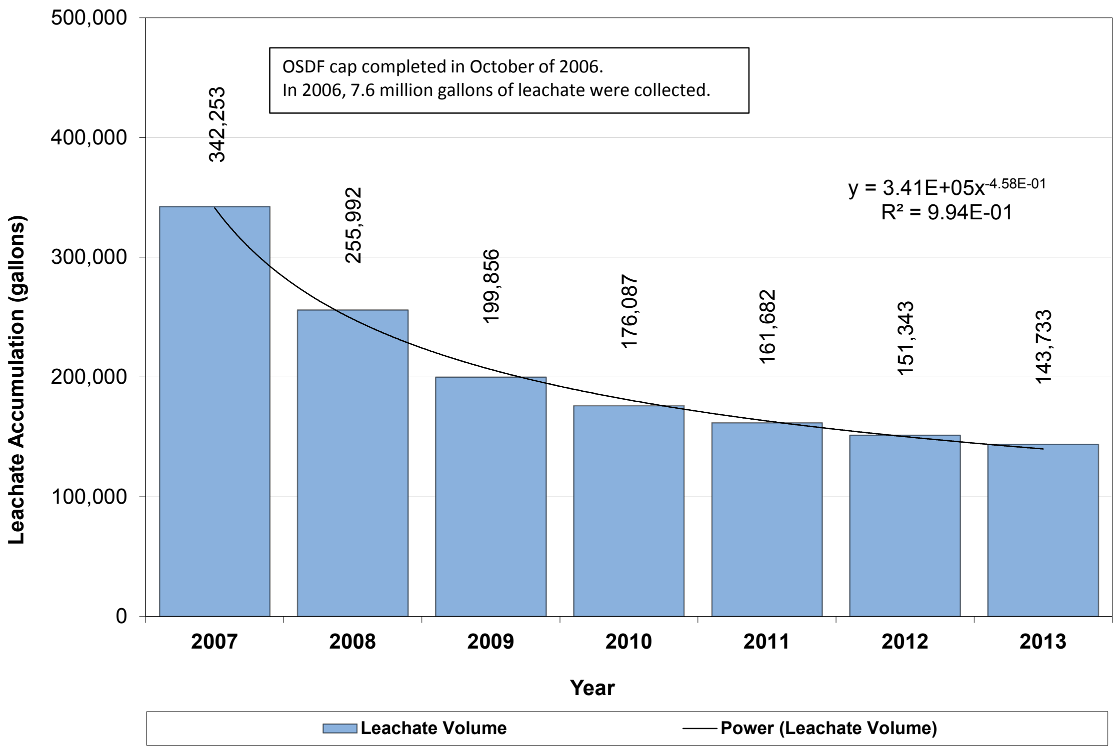

Figure A.5-4. OSDF Annual LCS Flow (2007 Through 2013)

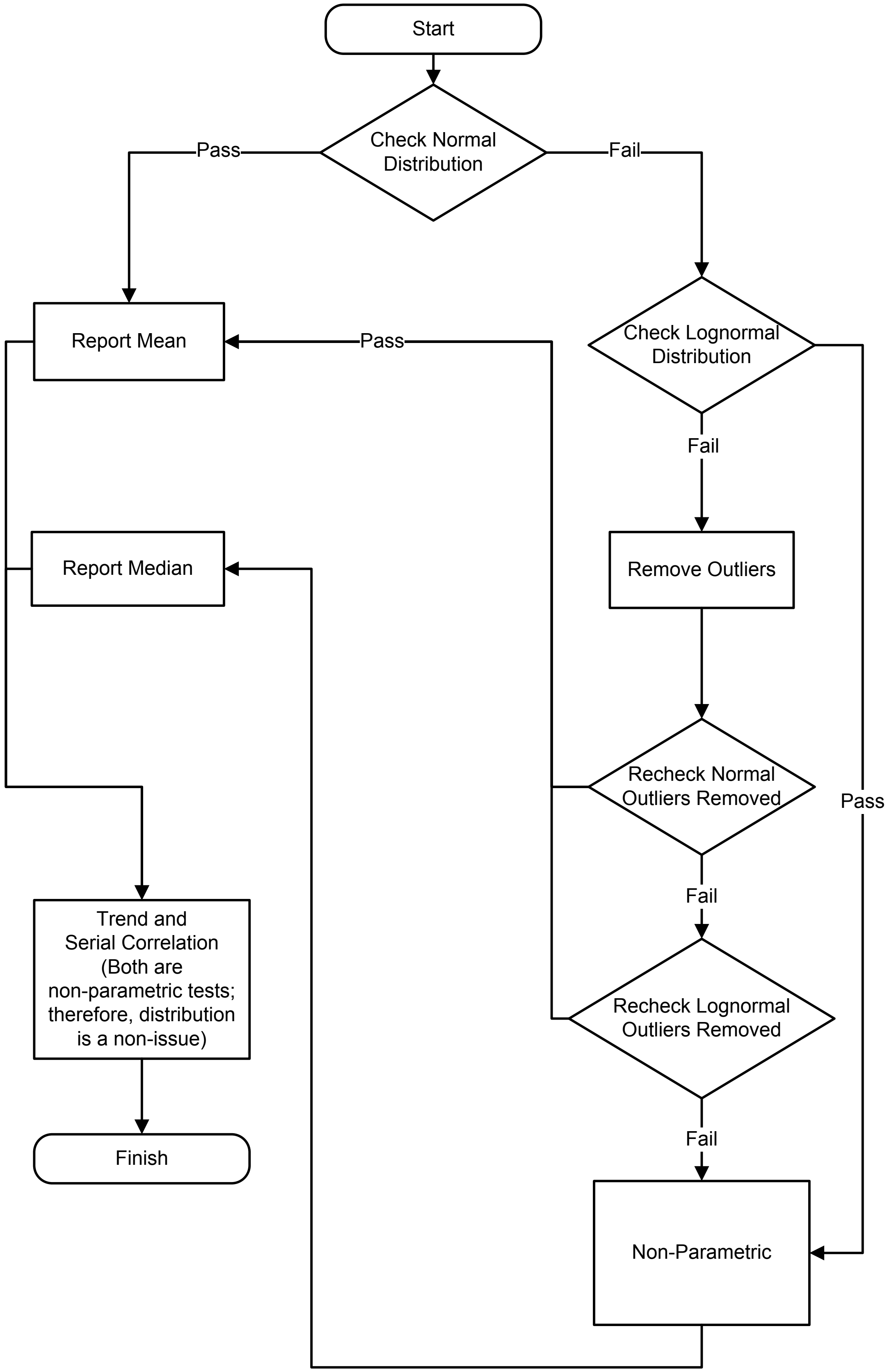

Figure A.5-5. OSDF Statistical Evaluation Process

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