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 2014 Operational 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 U.S. 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
GMA	Great Miami Aquifer
Ohio EPA	Ohio Environmental Protection Agency
PRRS	Paddys Run Road Site
UCL	upper confidence level
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 2014,
- Uranium concentrations trends for each extraction well compared to model predicted concentration trends, and
- Estimates of uranium removal from the aquifer when the pump and treat remediation operation ends.

Operational changes were implemented on July 1, 2014. From January 1 to June 30, 2014, the remediation system operated to pumping rates defined in the Waste Storage Area (WSA) Phase II Design (DOE 2005), which was established in 2005. The WSA Phase II Design called for the operation of 23 extraction wells at a target pumping rate of 4,775 gallons per minute (gpm). From July 1 to December 31, 2014, the remediation system operated to the Operational Design Adjustments-1 Design (DOE 2014b). The new 2014 design requires the operation of 20 extraction wells at a target pumping rate of 5,075 gpm. The operational changes are further discussed in Section A.1.1.

Because of the operational change noted above, 23 extraction wells were operational from January 1 to April 15, 2014. On April 15, 2014, three extraction wells were shut down in preparation of the operational change on July 1, 2014; therefore, between April 15 and December 31, 2014, only 20 extraction wells were operational. Figure A.1-1 depicts the locations of extraction, 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 2014 and for August 1993 through December 2014.

Information in this attachment is organized into the following subsections:

- Summary of Operational Changes Implemented in 2014 (Section A.1.1)
- South Field Module (Section A.1.2)
- South Plume Module (Section A.1.3)
- Waste Storage Area Module (Section A.1.4)
- Total Uranium Data (Section A.1.5)
- Pumping Rates (Section A.1.6)

A.1.1 Summary of Operational Changes Implemented in 2014

Since 2006, the pump-and-treat system had been operating to a design established in 2005 (referred to in this year's report as the 2005 design). The 2005 design was based on uranium concentrations measured in the aquifer up to that time (i.e., 2005). Additional groundwater modeling was conducted in 2012 using the 2005 operational design but with an updated uranium plume. Additional details concerning the modeling effort using the updated plume are provided in the *Operational Design Adjustments-1 WSA Phase-II Groundwater Remediation Design Fernald Preserve* (DOE 2014b). The updated plume contained 7 additional years of data and better reflected the actual plume at the start of 2012. Modeling runs with the updated uranium plume indicated that pump-and-treat operations would take longer than previously predicted. The table below compares model predicted cleanup times for both the original 2005 design and updated model run.

Alternative	South Plume Module	South Field Module	Waste Storage Area Module
2005 Model Prediction Cleanup Date	2015	2022	2023
Updated Model Prediction Cleanup Date	2021	2028	2032
Model Predicted Increase in Years	6	6	9

As shown above, model predicted cleanup times were extended by 6 to 9 years. Additional groundwater modeling was conducted to determine if the predicted cleanup times could be shortened. Sixteen different alternatives were modeled. All 16 modeling alternatives and results are reported in the *Operational Design Adjustments-1 WSA Phase-II Groundwater Remediation Design Fernald Preserve* (DOE 2014b). The selected alternative incorporates the following operational changes:

- Three extraction wells were turned off (EW-28a, EW-31, and EW-32) because the wells were no longer providing benefit to the ongoing remediation. When installed, the wells were removing uranium-contaminated groundwater from the aquifer; however, by 2014 the wells were removing groundwater from areas of the plume that had achieved pump-and-treat cleanup goals.
- The pumping budget freed up from the three extraction wells that were turned off was re-allocated to select extraction wells in the southern portion of the South Field and the South Plume to shorten the predicted cleanup times in those areas.
- The target system pumping rate was increased from 4,775 gpm to 5,075 gpm.

The groundwater model predicts that operating to the new design defined by the selected operational alternative will achieve clean up in the southern South Field 7 years earlier than the 2005 design predicted. Figure A.1-2 compares model predicted cleanup times for both designs. As shown in Figure A.1-2 the overall model predicted cleanup time for the WSA is increased by 1 year, but the predicted accelerated cleanup of the southern South Field 7 years earlier makes the 1 year extension an acceptable trade off.

With concurrence and support of the U.S. Environmental Protection Agency (EPA), the Ohio Environmental Protection Agency (Ohio EPA), and site stakeholders, preparations to implement the operational changes occurred in the spring of 2014:

- Three extraction wells were turned off (EW-28a, EW-31, and EW-32).
- Seven existing extraction wells were chemically rehabilitated.
- Larger pumps were installed in seven extraction wells.

On July 1, 2014, the pump-and-treat system began operating to the new design rate of 5,075 gpm.

Initial results from these operational changes are promising. As shown in Figure A.1-3, more uranium was removed from the aquifer after the operational changes were implemented in July. Two South Plume wells are not meeting the new, more aggressive, operational target pumping rates. New pumps are being purchased in an effort to meet the target pumping rates and are scheduled to be installed in the summer of 2015.

The new operational design is more aggressive than the 2005 design in that for the first 9 years the target system pumping rate is 300 gpm higher. The new design is also more efficient because pumping is more concentrated where the pumping is needed, when it is needed. The result is predicted lower pumping rates as the remedy progresses. The predicted lower pumping rates come with predicted cost savings of approximately 6 million dollars over the life of the pump-and-treat operation.

The new more aggressive pumping rates could involve higher maintenance costs due to iron fouling of the pumps and well screens. Figure A.1-4 shows the difference between a clean pump and one removed from an active pumping well at the Fernald Preserve after it had been operating for some time. As shown in the bottom photo, the pump pulled from the well is coated with iron which interfered with operation of the pump and motor. Operational experience has been used to create and refine an aggressive, successful well maintenance program to address this iron fouling. The challenge for the future is to see if the higher pumping rates increase the occurrence of iron fouling, and if operation of the wells at the higher target pumping rates will remain cost effective.

A.1.2 South Field Module

Thirteen extraction wells were operational in the South Field Module in 2014. The 13 active extraction wells were 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). As discussed above in Section A.1.1, three extraction wells were shut down on April 14, 2014 (33334 [EW-28a], 33265 [EW-31], 33266 [EW-32]). Two of the three wells (33265 [EW-31] and 33266 [EW-32]) were part of the South Field Module.

The target combined pumping rate for the South Field Module wells in 2014 was 2,575 gpm from January 1 to July 1 and 2,875 gpm from July 1 to December 31. The combined performance data for the South Field Module are presented in Table A.1-1. The target pumping rates are consistent with pumping rates defined for the WSA (Phase II) Model Design (January 1 thru June 30, 2014) and the Operational Design Adjustments-1 Design (July 1 thru December 31, 2014). Tables A.1-2 through A.1-20 provide individual extraction well performance data for 2014. Target pumping rate adjustments are noted on each table. The footnotes explain individual extraction well outages of greater than 24 hours.

During 2014, 1,312 million gallons (M gal) of groundwater were pumped by the active extraction wells in the South Field Module, resulting in the removal of 330.97 pounds (lb) of uranium from the Great Miami Aquifer (GMA). Since startup of the South Field Module in July 1998, the module has removed 18.73 billion gallons of water and 7,444 lb of uranium from the GMA.

A.1.3 South Plume Module

Six extraction wells were operational in the South Plume Module in 2014. The six active recovery wells 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 wells in 2014 was 1,200 gpm under the previous operational design and 1,400 gpm under the new operational design. Tables A.1-15 through A.1-20 provide individual extraction well performance data for the South Plume Module extraction wells in 2014. Target pumping rate adjustments are noted on each table. 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.

During 2014, 617.50 M gal of groundwater was pumped by the six wells in the South Plume Module, resulting in the removal of 103.24 lb of uranium from the GMA. Since startup of the South Plume Module in August 1993, the module has removed 14.83 billion gallons of groundwater and 2,971.90 lb of uranium from the GMA.

During 2014, 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 2014, 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 six 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.1-5 through A.1-16. Groundwater flow directions are reported in Attachment A.3 in the form of water table maps. The water table maps for 2014 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 2014.

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 EPA and Ohio EPA, and would only be implemented with their concurrence.

A.1.4 Waste Storage Area Module

Four extraction wells were operational in the former WSA in 2014. The four extraction wells were 32761 (EW-26), 33062 (EW-27), 33334 (EW-28a), and 33347 (EW-33a). As discussed above in Section A.1.1, three extraction wells were shut down on April 14, 2014 (33334 [EW-28a], 33265 [EW-31], 33266 [EW-32]). One of the three wells (EW-28a) was in the WSA Module.

The target combined pumping rate for the WSA Module wells in 2014 was 1,000 gpm from January 1 to June 30 and 800 gpm from July 1 to December 31. The target combined pumping rates are consistent with target pumping rates defined for the WSA (Phase II) Model Design (January 1 through June 30, 2014) and the Operational Design Adjustments-1 Design (July 1 through December 31, 2014). Tables A.1-22 through A.1-25 provide individual extraction well performance data for the WSA Module wells. Target pumping rate adjustments are noted on each table. The footnotes explain individual extraction well outages of greater than 24 hours. The combined performance data for the WSA Module are presented in Table A.1-1.

During 2014, 410.82 M gal of groundwater were pumped from extraction wells in the WSA Module, resulting in the removal of 81.64 lb of uranium from the GMA. Since startup of the WSA Module in May 2002, 5,686 billion gallons of water and 1,961 lb of uranium have been removed from the GMA.

A.1.5 Total Uranium Data

Water samples were collected monthly in 2014 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 2014. The total uranium concentrations were also used to determine if a well needed to be routed to treatment or to bypass treatment.

Under the 2005 operational design, the aquifer remedy had been able to achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 micrograms per liter (µg/L) and 600 lb annually) established in the Operable Unit 5 Record of Decision (DOE 1996) without groundwater treatment since 2010. With implementation of the new operational design in

July 2014 (Section A.1.1) groundwater treatment was needed until mid-November 2014 to achieve uranium discharge limits. In 2014, 2.34 billion gallons of water were pumped from the GMA, and 26.2 M gal of groundwater was treated. This equates to approximately 1.1 percent.

Uranium concentration data collected from the extraction wells are tracked graphically to assess how the concentration data is trending. Uranium concentrations are plotted over time and then a regression line is fitted to the data set. Figures A.1-17 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 how quickly pumping concentrations will continue to decrease. 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 be used to help evaluate the uncertainty of the predicted data trend.

The graphs in Figures A.1-17 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 for total uranium. For example, the concentration trend of pumped water from extraction well 31562 (refer to Figure A.1-28) 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.1-17 through A.1-36 also provide a comparison of the modeled uranium concentration predictions to the measured and 95 percent UCL data trends. The Fernald aquifer remediation was designed using the Variable Saturated Model in 3 Dimensions (VAM-3D). When the site was transitioned to DOE Office of Legacy Management in 2006, the remediation was operating to a 2005 design called the WSA (Phase II) Design (DOE 2005). As explained in Section A.1.1 a new design was implemented in July of 2014 (DOE 2014b). Groundwater model predictions for both designs 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, 2014, are summarized in Table A.1-26. Changing water levels in the aquifer result in cleanup variations and uncertainty. Modeling is therefore conducted under low water level conditions, high water level conditions, and nominal water level conditions to bracket the uncertainty in model predicted cleanup times. For purposes of this tracking exercise, model predictions for high water level conditions were used as they were the most conservative (i.e., longest cleanup times).

At the end of December 2014, data indicated that 12,300 net lb of uranium had been removed from the GMA by the pump-and-treat remedy. The new 2014 cleanup operational design predicts that cleanup objectives will be achieved in 2035, based on a start date of 2014.

Modeling predicts that through 2035 an additional 3,436 lb of uranium will be removed from the GMA. The concentration data set indicates that an additional 3,763 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 14,590 lb of uranium will be removed from the GMA based on regression analyses of the individual well data. A summary of the three predictions are provided below.

Net pounds of uranium extracted through December 2014	12,300		
	Data	**Model**	**95% UCL**
Predicted pounds of uranium to be extracted between 2015 and the end of the pump and treat stage of the aquifer remedy (per the new 2014 Operational Design)	3,763	3,436	14,590
Total predicted pounds of uranium to be removed	**16,063**	**15,736**	**26,890**
Estimated Percent Complete (based on pounds of uranium to be removed)	**77%**	**78%**	**46%**

Table A.1-27 provides a yearly breakdown for the three predictions. Figure A.1-39 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 cleanup goals. 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, 2015, the uranium concentration data trend predicts that the estimated mass completeness of the pump-and-treat stage of the aquifer remedy is approximately 77 percent. The groundwater model predicted an estimated mass completeness of 78 percent. The estimated mass completeness of the pump-and-treat stage based on the 95 percent UCL is approximately 46 percent. Following the EPA guidelines mentioned earlier, the estimated mass completeness can be estimated as being between 46 percent and 77 percent complete. These percentages are lower than reported in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014a) when the system was operating to the 2005 design. But as explained in Section A.1.1, new groundwater modeling indicated that the cleanup would take longer; therefore, the decrease in percentage complete corresponds to the predicted increase in cleanup time.

The uranium decreases plotted at each extraction well illustrate that the concentration curves are trending asymptotic. This trend is a characteristic of pump-and-treat remediations in general. It was this trend in part that resulted in DOE implementing a more aggressive cleanup design in 2014. DOE will continue to track this trend while operating under the new 2014 Operational Design and may recommend operational changes in the future in efforts to improve uranium removal efficiencies as the remedy continues.

In the *Fernald Preserve 2013 Site Environmental Report*, a table was provided that compared the groundwater model prediction concentration and the actual concentration measured at each extraction well. This comparison was not made for this year's report. It will resume in next year's report to allow the system time to operate under the new operational design that was implemented in July 2014.

A.1.6 Pumping Rates

Target extraction well pumping rates for 2014 are provided in Table A.1-28. 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. The total target pumping rate of 5,075 gpm is consistent with the rate defined for the 2014 operational design (DOE 2014b). 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). At the time, all four of these wells were equipped with pumps and motors that operated most efficiently at rates of approximately 300 gpm. The WSA (Phase II) Model Design called 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.

With the exception of extraction well 31561(EW-20), the new 2014 design also calls for a pumping rate of 100 gpm for each of these wells. To be more energy efficient, when weather or temperatures are above freezing, the three wells that remained at 100 gpm under the new operational design 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 operational design. 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. Extraction well 31561(EW-20) has a target pumping rate of 200 gpm under the new operational design, so pulse pumping is no longer being used at this well.

A.1.7 References

DOE (U.S. Department of Energy), 1993. *South Plume Groundwater Recovery System Design, Monitoring, and Evaluation Program Plan,* Fluor Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, April.

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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.

DOE (U.S. Department of Energy), 2014a. *Fernald Preserve 2013 Site Environmental Report*, LMS/FER/S11109, Office of Legacy Management, May.

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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 2014 through December 2014			August 1993 through December 2014		
	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	1,312.16	330.97	0.25	18,730.88	7,443.71	0.40
Waste Storage Area Module	410.82	81.64	0.20	5,686.47	1,960.68	0.34
South Plume Module	617.50	103.24	0.17	14,832.28	2,971.90	0.20
Re-injection Module[b]	0	0	NA	1,936.478	76.27	NA
Aquifer Restoration Systems Totals						
Extraction Wells	2,340.48	515.85	0.22	39,249.63	12,376.29	0.32
(Re-injection Wells[b])	0	0	NA	(1,936.478)	(76.27)	NA
Net	2,340.48	515.85	NA	37,313.15	12,300.02	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 2014

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 – 667

Hours pumped – 8,093
Operational percent – 92.39

Adjusted operational percent[a] – 96.59

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	113.0	5.045	35.8	0.30
Feb	113.0	4.556	36.0	0.30
Mar	110.0	4.910	35.9	0.30
Apr	79.1	3.418	31.8	0.27
May	65.5	2.923	40.4	0.34
Jun	53.3	2.303	36.2	0.30
Jul	102.0	4.555	37.3	0.31
Aug	107.0	4.777	33.8	0.28
Sep	106.6	4.605	36.3	0.30
Oct	106.1	4.735	34.1	0.28
Nov	109.4	4.727	31.9	0.27
Dec	111.4	4.972	30.5	0.25
	Average 98.0	Total 51.523	Average 35.0	Average 0.29

[a] Adjusted for planned annual well field shutdowns.
[b] Well 18 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume. Well 18 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
[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 2014

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 – 1,001

Hours pumped – 7,759
Operational percent – 88.57

Adjusted operational percent[a] – 92.36

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	113.3		5.059		16.1		0.13
Feb	117.3		4.731		17.2		0.14
Mar	94.9		4.235		17.2		0.14
Apr	41.7		1.801		16.0		0.13
May	65.5		2.923		22.6		0.19
Jun	53.6		2.314		20.2		0.17
Jul	106.0		4.730		20.7		0.17
Aug	109.7		4.897		16.6		0.14
Sep	107.9		4.661		18.0		0.15
Oct	104.5		4.663		15.8		0.13
Nov	109.6		4.735		12.9		0.11
Dec	112.1		5.004		12.3		0.10
Average	94.7	Total	49.754	Average	17.1	Average	0.14

[a] Adjusted for planned annual well field shutdowns.
[b] Well 19 was down from March 20, 2014, to March 21, 2014, for a chemical treatment.
Well 19 was down from March 28, 2014, to April 11, 2014, due to an electrical issue.
Well 19 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 19 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 19 was down from July 30, 2014, to July 31, 2014, 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 2014

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 pumped – 8,084 Target pumping rate – 100 gpm[a]
Hours not pumped – 676.0 Operational percent – 92.28 Target pumping rate – 200 gpm[b]

Adjusted operational percent[c] – 96.48

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[d] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[e] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	112.1	5.002	28.2	0.24
Feb	114.7	4.623	28.5	0.24
Mar	106.9	4.773	30.9	0.26
Apr	88.9	3.841	26.8	0.22
May	65.4	2.919	30.4	0.25
Jun	109.5	4.732	25.7	0.21
Jul	212.7	9.496	27.8	0.23
Aug	220.2	9.829	27.8	0.23
Sep	213.9	9.240	31.0	0.26
Oct	211.3	9.434	30.9	0.26
Nov	219.4	9.478	32.7	0.27
Dec	219.0	9.776	31.9	0.27
	Average 157.8	Total 83.143	Average 29.4	Average 0.25

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 20 was down from March 12, 2014, to March 13, 2014, to upgrade the control panel.
Well 20 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 20 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 20 was down from July 30, 2014, to July 31, 2014, for chemical treatment.
[e] 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 2014

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 not pumped – 915.5

Hours pumped – 7,845
Operational percent – 89.55

Adjusted operational percent[a] – 93.44

Target pumping rate – 175 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		192.1		8.577		16.6		0.14
Feb		196.9		7.938		16.3		0.14
Mar		183.4		8.185		16.0		0.13
Apr		141.7		6.121		15.4		0.13
May		115.3		5.149		18.1		0.15
Jun		91.9		3.969		17.3		0.14
Jul		194.1		8.667		18.0		0.15
Aug		193.7		8.647		15.9		0.13
Sep		182.0		7.860		15.8		0.13
Oct		145.4		6.491		15.7		0.13
Nov		194.7		8.409		13.8		0.12
Dec		194.4		8.680		13.2		0.11
	Average	168.8	Total	88.692	Average	16.0	Average	0.13

[a] Adjusted for planned annual well field shutdowns.
[b] Well 17 was down from March 11, 2014, to March 13, 2014, to upgrade the control panel.
Well 17a was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 17a was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 17a was down from September 29, 2014, to October 7, 2014, due to an electrical problem.
[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 2014

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 – 715

Hours pumped – 8,045
Operational percent – 91.84

Adjusted operational percent[a] – 95.98

Target pumping rate – 300 gpm

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		322.1		14.377		26.5		0.22
Feb		328.2		13.233		25.1		0.21
Mar		290.0		12.944		25.3		0.21
Apr		238.4		10.301		24.3		0.20
May		195.7		8.737		29.1		0.24
Jun		165.0		7.126		21.6		0.18
Jul		330.0		14.732		26.6		0.22
Aug		329.9		14.726		27.0		0.23
Sep		319.7		13.810		28.3		0.24
Oct		317.2		14.160		25.1		0.21
Nov		329.5		14.235		23.6		0.20
Dec		329.5		14.709		23.8		0.20
	Average	291.3	Total	153.089	Average	25.5	Average	0.21

[a] Adjusted for planned annual well field shutdowns.
[b] Well 22 was down from March 11, 2014, to March 13, 2014, to upgrade the control panel.
Well 22 was down from March 19, 2014, to March 20, 2014, for a chemical treatment.
Well 22 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 22 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
[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 2014

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 – 856.5

Hours pumped – 7,903.5
Operational percent – 90.22

Adjusted operational percent[c] – 94.19

Target pumping rate – 300 gpm[a]
Target pumping rate – 400 gpm[b]

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[d] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[e] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	323.1	14.424	38.9	0.32
Feb	325.7	13.133	25.1	0.21
Mar	324.4	14.483	36.9	0.31
Apr	228.9	9.886	35.3	0.29
May	192.8	8.605	41.8	0.35
Jun	113.3	4.893	32.7	0.27
Jul	367.6	16.409	32.6	0.27
Aug	364.7	16.282	32.2	0.27
Sep	380.6	16.440	38.0	0.32
Oct	364.8	16.284	38.7	0.32
Nov	439.7	18.997	37.0	0.31
Dec	440.0	19.642	34.9	0.29
	Average 322.1	Total 169.480	Average 35.3	Average 0.30

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 24 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 24 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 24 was down from October 29, 2014, to October 30, 2014, for a chemical treatment.
[e] 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 2014

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 – 732.5

Hours pumped – 8,028
Operational percent – 91.64

Adjusted operational percent[c] – 95.76

Target pumping rate – 300 gpm[a]
Target pumping rate – 500 gpm[b]

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[d] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[e] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		299.4		13.367		41.5		0.35
Feb		289.2		11.663		44.0		0.37
Mar		294.6		13.153		42.7		0.36
Apr		235.9		10.192		39.6		0.33
May		193.9		8.655		48.1		0.40
Jun		262.1		11.322		40.7		0.34
Jul		474.4		21.175		42.7		0.36
Aug		454.6		20.292		40.2		0.34
Sep		478.0		20.651		44.6		0.37
Oct		457.2		20.410		44.3		0.37
Nov		549.7		23.747		44.0		0.37
Dec		550.0		24.554		45.5		0.38
	Average	378.3	Total	199.180	Average	43.2	Average	0.36

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 23 was down from March 20, 2014, to March 21, 2014, for a chemical treatment.
Well 23 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 23 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 23 was down from October 29, 2014, to October 30, 2014, for chemical treatment.
[e] 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 2014

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 – 661.5

Hours pumped – 8,098.5
Operational percent – 92.45

Adjusted operational percent[a] – 96.66

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	127.8	5.706	21.40	0.18
Feb	104.7	4.222	26.80	0.22
Mar	99.4	4.435	26.40	0.22
Apr	88.5	3.823	23.70	0.20
May	75.6	3.376	36.90	0.31
Jun	84.9	3.668	42.55	0.36
Jul	114.3	5.103	26.30	0.22
Aug	119.0	5.313	23.60	0.20
Sep	108.1	4.668	26.00	0.22
Oct	105.5	4.711	26.60	0.22
Nov	104.2	4.502	22.80	0.19
Dec	111.4	4.975	19.10	0.16
	Average 104.0	Total 54.501	Average 26.8	Average 0.22

[a] Adjusted for planned annual well field shutdowns.
[b] Well 25 was down from March 19, 2014, to March 20, 2014, for a chemical treatment.
Well 25 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 25 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 25 was down from July 31, 2014, to August 1, 2014, 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 2014

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 – 1,385.5

Hours pumped – 7,375
Operational percent – 84.18

Adjusted operational percent[c] – 87.48

Target pumping rate – 200 gpm[a]
Target pumping rate – 300 gpm[b]

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[d] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[e] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		229.8		10.257		25.8		0.22
Feb		223.9		9.029		28.7		0.24
Mar		210.2		9.382		28.6		0.24
Apr		159.7		6.898		28.2		0.24
May		30.3		1.352		32.2		0.27
Jun		63.7		2.751		34.9		0.29
Jul		219.5		9.798		31.1		0.26
Aug		303.5		13.547		29.7		0.25
Sep		319.5		13.800		29.7		0.25
Oct		317.0		14.151		25.3		0.21
Nov		329.6		14.237		20.7		0.17
Dec		329.6		14.712		22.2		0.19
	Average	228.0	Total	119.915	Average	28.1	Average	0.23

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 15a was down from March 11, 2014, to March 12, 2014, to upgrade the control panel.
Well 15a was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 15a was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 15a was down from June 24, 2014, to July 9, 2014, due to pump fouling and replacement.
[e] 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 2014

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 – 914.3

Hours pumped – 7,845.75
Operational percent – 89.56

Adjusted operational percent[c] – 93.46

Target pumping rate – 200 gpm[a]
Target pumping rate – 400 gpm[b]

Monthly Measurements at Well Field								
Month		Monthly Average Pumping Rate[d] (gpm)		Volume Pumped (M gal)		Monthly Total Uranium Concentration[e] (µg/L)		Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan		214.3		9.566		31.5		0.26
Feb		219.0		8.832		32.1		0.27
Mar		208.7		9.315		31.0		0.26
Apr		158.3		6.839		29.8		0.25
May		129.2		5.769		35.3		0.29
Jun		101.1		4.366		29.2		0.24
Jul		414.5		18.505		28.1		0.23
Aug		439.5		19.619		26.6		0.22
Sep		425.8		18.395		31.2		0.26
Oct		422.7		18.869		32.1		0.27
Nov		425.5		18.381		31.7		0.26
Dec		438.9		19.591		27.6		0.23
	Average	299.8	Total	158.048	Average	30.5	Average	0.25

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 30 was down from March 4, 2014, to March 5, 2014, to upgrade the control panel.
Well 30 was down from March 18, 2014, to March 19, 2014, for a chemical treatment.
Well 30 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 30 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 30 was down from November 12, 2014, to November 13, 2014, for a chemical treatment.
[e] 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 2014

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 – 2,496
Hours not pumped – 65
Hours pumped – 2,431
Operational percent – 97.4
Target pumping rate – 300 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		269.9		12.049		10.3		0.09
Feb		239.4		9.651		11.6		0.10
Mar		207.6		9.266		15.3		0.13
Apr		92.2		3.984		10.9		0.09
May		0.0		0.000		0.0		0.00
Jun		0.0		0.000		0.0		0.00
Jul		0.0		0.000		0.0		0.00
Aug		0.0		0.000		0.0		0.00
Sep		0.0		0.000		0.0		0.00
Oct		0.0		0.000		0.0		0.00
Nov		0.0		0.000		0.0		0.00
Dec		0.0		0.000		0.0		0.00
	Average	202.3	Total	34.950	Average	12.0	Average	0.10

[a] Well 31 was down from March 4, 2014, to March 5, 2014, to upgrade the control panel.
Well 31 was shut down permanently on April 14, 2014.
[b] 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 2014

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 – 2,496
Hours not pumped – 151
Hours pumped – 2,345
Operational percent – 93.95
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	217.7	9.718	4.5	0.04
Feb	217.7	8.777	4.0	0.03
Mar	210.0	9.373	4.2	0.04
Apr	63.8	2.757	4.1	0.03
May	0.0	0.000	0.0	0.00
Jun	0.0	0.000	0.0	0.00
Jul	0.0	0.000	0.0	0.00
Aug	0.0	0.000	0.0	0.00
Sep	0.0	0.000	0.0	0.00
Oct	0.0	0.000	0.0	0.00
Nov	0.0	0.000	0.0	0.00
Dec	0.0	0.000	0.0	0.00
	Average 177.3	Total 30.624	Average 4.2	Average 0.04

[a] Well 32 was down from March 4, 2014, to March 5, 2014, to upgrade the control panel.
Well 32 was down from April 3, 2014, to April 7, 2014, due to a malfunctioning variable frequency drive.
Well 32 was shut down permanently on April 14, 2014.
[b] 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 2014

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 – 1,511

Hours pumped – 7,249
Operational percent – 82.75

Target pumping rate – 200 gpm[a]
Target pumping rate – 300 gpm[b]

Adjusted operational percent[c] – 85.89

Monthly Measurements at Well Field								
Month		**Monthly Average Pumping Rate[d] (gpm)**		**Volume Pumped (M gal)**		**Monthly Total Uranium Concentration[e] (µg/L)**		**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan		219.7		9.807		34.1		0.28
Feb		169.0		6.815		36.2		0.30
Mar		202.6		9.043		42.6		0.36
Apr		95.9		4.141		36.5		0.30
May		55.0		2.455		50.3		0.42
Jun		153.2		6.620		52.7		0.44
Jul		287.6		12.839		42.3		0.35
Aug		300.5		13.415		44.0		0.37
Sep		285.8		12.347		38.8		0.32
Oct		316.9		14.145		34.2		0.29
Nov		320.4		13.841		30.0		0.25
Dec		309.0		13.792		27.9		0.23
	Average	226.3	Total	119.261	Average	39.1	Average	0.33

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdowns.
[d] Well 21a was down from April 15, 2014, to April 29, 2014, for rehabilitation.
Well 21a was down from February 15, 2014, to February 20, 2014, due to a fault in the variable frequency drive.
Well 21a was down from March 18, 2014, to March 20, 2014, for a chemical treatment.
Well 21a was down from April 14, 2014, to May 12, 2014, for rehabilitation and to install new instrumentation at the Parshall Flume.
Well 21a was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 21a was down from September 10, 2014, to September 11, 2014, for chemical treatment.
Well 21a was down from December 29, 2014, to December 30, 2014, for chemical treatment.
[e] 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 2014

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 not pumped – 665.2
Hours pumped – 8,094.8
Operational percent – 92.41
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	220.0	9.819	17.8	0.15
Feb	215.9	8.706	19.4	0.16
Mar	194.8	8.694	19.6	0.16
Apr	74.0	3.198	16.6	0.14
May	205.0	9.151	18.5	0.15
Jun	209.3	9.041	15.2	0.13
Jul	213.2	9.516	15.2	0.13
Aug	214.1	9.557	15.6	0.13
Sep	212.7	9.188	16.8	0.14
Oct	210.7	9.407	16.4	0.14
Nov	215.4	9.303	15.3	0.13
Dec	203.7	9.094	17.3	0.14
	Average 199.1	Total 104.675	Average 17.0	Average 0.14

[a] Well 1 was down from March 13, 2014, to March 14, 2014, for a chemical treatment.
Well 1 was down from March 17, 2014, to March 18, 2014, for a chemical treatment.
Well 1 was down from March 31, 2014, to April 11, 2014, to install new wires and control panels.
Well 1 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 1 was down from May 27, 2014, to May 29, 2014, for valve annual preventative maintenance.
Well 1 was down from June 22, 2014, to June 23, 2014, to repair a leak in the pitless adaptor.
[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 2014

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 pumped – 7,844.8 | Target pumping rate – 200 gpm
Hours not pumped – 915.2 | Operational percent – 89.55

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	211.9	9.459	15.4	0.13
Feb	117.3	4.728	15.9	0.13
Mar	203.7	9.093	15.8	0.13
Apr	74.6	3.221	16.0	0.13
May	209.2	9.340	18.7	0.16
Jun	213.4	9.220	15.9	0.13
Jul	203.7	9.092	17.1	0.14
Aug	213.6	9.535	15.9	0.13
Sep	196.8	8.501	16.6	0.14
Oct	201.0	8.974	15.8	0.13
Nov	209.3	9.040	15.4	0.13
Dec	194.6	8.688	14.1	0.12
	Average 187.4	Total 98.891	Average 16.1	Average 0.13

[a] Well 2 was down from February 13, 2014, to February 24, 2014, due to a fault in the variable frequency drive.
Well 2 was down from March 13, 2014, to March 14, 2014, for a chemical treatment.
Well 2 was down from March 31, 2014, to April 11, 2014, to install wires and new control panels.
Well 2 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 2 was down from May 27, 2014, to May 29, 2014, for valve annual preventative maintenance.
Well 2 was down from July 15, 2014, to July 16, 2014, for chemical treatment.
Well 2 was down from October 8, 2014, to October 9, 2014, for a chemical treatment.
Well 2 was down from December 15, 2014, to December 16, 2014, to replace the pump.
[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 2014

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 – 8,075.3 Target pumping rate – 200 gpm
Hours not pumped – 684.7 Operational percent – 92.18

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	218.1	9.738	24.2	0.20
Feb	206.0	8.306	24.7	0.21
Mar	197.0	8.793	24.9	0.21
Apr	63.1	2.726	25.0	0.21
May	208.1	9.290	29.1	0.24
Jun	223.3	9.648	23.6	0.20
Jul	211.7	9.448	22.1	0.18
Aug	219.3	9.787	19.4	0.16
Sep	204.2	8.820	24.0	0.20
Oct	200.1	8.934	23.6	0.20
Nov	198.2	8.562	22.0	0.18
Dec	198.7	8.870	20.9	0.17
	Average 195.6	Total 102.923	Average 23.6	Average 0.20

[a] Well 3 was down from March 10, 2014, to March 12, 2014, for a chemical treatment.
Well 3 was down from March 31, 2014, to April 11, 2014, to install wires on poles and install new control panels.
Well 3 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 3 was down from May 27, 2014, to May 29, 2014, for valve annual preventative maintenance.
Well 3 was down from July 15, 2014, to July 16, 2014, for chemical treatment.
Well 3 was down from October 8, 2014, to October 9, 2014, for a 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 2014

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 – 7,964.8 | Target pumping rate – 200 gpm
Hours not pumped – 795.2 | Operational percent – 90.92

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	181.0	8.081	3.4	0.03
Feb	148.3	5.979	2.9	0.02
Mar	175.2	7.820	3.5	0.03
Apr	48.5	2.094	3.5	0.03
May	217.5	9.711	3.7	0.03
Jun	232.0	10.021	3.1	0.03
Jul	207.0	9.241	3.1	0.03
Aug	214.0	9.555	2.6	0.02
Sep	196.8	8.501	2.9	0.02
Oct	208.1	9.288	2.7	0.02
Nov	195.5	8.444	2.5	0.02
Dec	193.9	8.654	2.6	0.02
	Average 184.8	Total 97.388	Average 3.0	Average 0.03

[a] Well 4 was down from March 10, 2014, to March 12, 2014, for a chemical treatment.
Well 4 was down from March 31, 2014, to April 11, 2014, to install wires and new control panels.
Well 4 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 4 was down from May 27, 2014, to May 29, 2014, for valve annual preventative maintenance.
Well 4 was down from September 3, 2014, to September 5, 2014, for chemical treatment.
Well 4 was down from July 16, 2014, to July 17, 2014, for chemical treatment.
Well 4 was down from November 12, 2014, to November 13, 2014, for a chemical treatment.
[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 2014

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 – 900.2

Hours pumped – 7,859.83
Operational percent – 89.72

Adjusted operational percent[c] – 93.63

Target pumping rate – 200 gpm[a]
Target pumping rate – 300 gpm[b]

Monthly Measurements at Well Field				
Month	**Monthly Average Pumping Rate[d] (gpm)**	**Volume Pumped (M gal)**	**Monthly Total Uranium Concentration[e] (µg/L)**	**Uranium Removal Index (lb of total uranium removed/M gal pumped)**
Jan	220.6	9.850	32.4	0.27
Feb	215.6	8.693	33.6	0.28
Mar	208.6	9.310	31.8	0.27
Apr	70.6	3.049	32.9	0.27
May	44.2	1.975	35.3	0.29
Jun	121.0	5.228	31.4	0.26
Jul	261.7	11.681	29.3	0.24
Aug	275.8	12.310	29.2	0.24
Sep	285.3	12.323	33.1	0.28
Oct	285.6	12.751	33.0	0.28
Nov	259.7	11.217	33.4	0.28
Dec	268.7	11.993	33.9	0.28
	Average 209.8	Total 110.379	Average 32.4	Average 0.27

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdown.
[d] Well 6 was down from March 13, 2014, to March 14, 2014, for a chemical treatment.
Well 6 was down from March 31, 2014, to April 11, 2014, to install wires and new control panels.
Well 6 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 6 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 6 was down from November 5, 2014, to November 6, 2014, for a chemical treatment.
[e] 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 2014

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 – 1,611.5

Hours pumped – 7,148.5
Operational percent – 81.60

Target pumping rate – 200 gpm[a]
Target pumping rate – 300 gpm[b]

Adjusted operational percent[c] – 84.62

Monthly Measurements at Well Field							
Month		Monthly Average Pumping Rate[d] (gpm)		Volume Pumped (M gal)		Monthly Total Uranium Concentration[e] (µg/L)		Uranium Removal Index (lb of total uranium removed/M gal pumped)
Jan		222.7		9.942		25.3		0.21
Feb		213.6		8.611		26.6		0.22
Mar		205.1		9.154		25.5		0.21
Apr		22.2		0.960		24.0		0.20
May		0.0		0.000		24.0		0.00
Jun		147.0		6.350		24.0		0.20
Jul		253.2		11.301		25.2		0.21
Aug		252.4		11.266		24.7		0.21
Sep		265.6		11.474		29.2		0.24
Oct		269.7		12.039		29.1		0.24
Nov		252.3		10.899		27.7		0.23
Dec		251.9		11.245		27.1		0.23
	Average	196.3	Total	103.241	Average	26.0	Average	0.20

[a] Target Pumping Rate under 2005 Operational Design.
[b] Target Pumping Rate under 2014 Operational Design.
[c] Adjusted for planned annual well field shutdown.
[d] Well 7 was down from March 17, 2014, to March 18, 2014, for a chemical treatment.
Well 7 was down from March 31, 2014, to April 11, 2014, to install wires and new control panels.
Well 7 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 7 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 7 was down from November 5, 2014, to November 6, 2014, for a chemical treatment.
[e] 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	244	0.000195	0.188	0.0112	0.0204	Down
	2625	215	0.00110	0.0706	0.0118	0.0095	Down
	2636	185	0.0100	0.0939	0.0440	0.0185	Down
	2898	61	0.000147	0.0820	0.0043	0.0112	**Up**
	2899	54	0.00032	0.0283	0.0023	0.0040	**Up**
	2900	243	0.00032	0.0609	0.0049	0.0054	Down
	3128	64	0.0004	0.234	0.0072	0.0292	No Trend
	3636	62	0.0005	0.0233	0.0028	0.0038	**Up**
	3898	61	0.0005	0.0434	0.0043	0.0065	**Up**
	3899	62	0.000147	0.0307	0.0027	0.0046	**Up**
	3900	62	0.000375	0.0208	0.0028	0.0032	No Trend
Phosphorus	2128	70	0.025	16.2	1.39	2.36	Down
	2625	39	0.307	18.6	3.84	3.88	**Up**
	2636	37	9.60	170	83.9	42.9	Down
	2898	62	0.005	9.95	0.250	1.28	No Trend
	2899	53	0.005	0.831	0.060	0.117	No Trend
	2900	60	0.050	4.74	0.471	0.654	Down
	3128	71	0.005	13.0	0.237	1.54	No Trend
	3636	61	0.00955	1.10	0.070	0.146	No Trend
	3898	60	0.0075	1.24	0.100	0.171	No Trend
	3899	61	0.005	0.830	0.087	0.146	Down
	3900	62	0.005	1.38	0.089	0.234	Down
Potassium	2128	62	0.83	18.0	3.32	3.28	No Trend
	2625	40	0.64	9.49	3.54	2.15	No Trend
	2636	37	4.60	218	63.5	51.0	Down
	2898	62	1.11	9.64	4.39	1.21	**Up**
	2899	53	1.36	8.85	4.09	0.97	**Up**
	2900	60	0.0095	6.00	2.01	1.07	No Trend
	3128	64	1.09	3.70	1.93	0.63	Down
	3636	61	1.09	4.24	2.01	0.55	Down
	3898	61	0.61	4.09	2.59	0.69	**Up**
	3899	62	0.875	4.54	2.67	0.67	**Up**
	3900	62	0.975	3.19	1.72	0.39	Down
Sodium	2128	62	12.3	75.2	34.4	11.3	Down
	2625	40	13.1	61.4	31.5	9.6	Down
	2636	37	19.1	148	52.0	26.6	No Trend
	2898	62	4.95	31.0	19.6	4.9	No Trend
	2899	54	11.2	25.1	17.8	3.4	No Trend
	2900	61	0.0136	43.3	26.5	7.4	Down
	3128	64	3.52	13.4	5.64	2.57	Down
	3636	61	3.14	13.0	5.80	2.75	Down
	3898	61	7.29	28.8	12.0	5.3	**Up**
	3899	62	6.24	43.6	12.0	8.6	**Up**
	3900	62	3.13	10.8	4.84	1.77	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 2014 groundwater data (unfiltered and filtered for 2001 through 2014).
[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 2014

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 – 1,335

Hours pumped – 7,425
Operational percent – 84.75

Adjusted operational percent[a] – 88.12

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		314.9		14.058		23.4		0.20
Feb		325.1		13.106		24.8		0.21
Mar		285.2		12.731		25.1		0.21
Apr		245.6		10.610		26.7		0.22
May		194.1		8.664		31.9		0.27
Jun		0.0		0.000		31.9		0.00
Jul		222.1		9.913		29.9		0.25
Aug		327.8		14.632		24.0		0.20
Sep		320.0		13.823		25.3		0.21
Oct		315.5		14.083		24.4		0.20
Nov		329.4		14.229		21.5		0.18
Dec		314.2		14.024		22.1		0.18
	Average	266.1	Total	139.873	Average	25.9	Average	0.19

[a] Adjusted for planned annual well field shutdowns.
[b] Well 26 was down from March 13, 2014, to March 17, 2014, due to programming problems.
Well 26 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 26 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 26 was down from June 23, 2014, to July 7, 2014, for rehabilitation.
[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 2014

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 – 641

Hours pumped – 8,119
Operational percent – 92.68

Adjusted operational percent[a] – 96.91

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		213.6		9.536		27.2		0.23
Feb		220.9		8.908		28.4		0.24
Mar		218.0		9.732		28.2		0.24
Apr		170.7		7.375		27.3		0.23
May		128.7		5.745		31.4		0.26
Jun		109.4		4.726		28.1		0.23
Jul		219.6		9.801		28.3		0.24
Aug		219.7		9.805		25.8		0.22
Sep		212.5		9.179		30.3		0.25
Oct		211.1		9.423		29.4		0.25
Nov		219.4		9.476		28.2		0.24
Dec		213.6		9.534		27.2		0.23
	Average	196.4	Total	103.241	Average	28.31	Average	0.24

[a] Adjusted for planned annual well field shutdowns.
[b] Well 27 was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 27 was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
[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 2014

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 – 2,496
Hours not pumped – 39.5
Hours pumped – 2,457
Operational percent – 98.42
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	196.2	8.759	8.70	0.07
Feb	183.2	7.387	8.70	0.07
Mar	175.8	7.850	9.00	0.08
Apr	75.1	3.243	8.90	0.07
May	0.0	0.000	0.00	0.00
Jun	0.0	0.000	0.00	0.00
Jul	0.0	0.000	0.00	0.00
Aug	0.0	0.000	0.00	0.00
Sep	0.0	0.000	0.00	0.00
Oct	0.0	0.000	0.00	0.00
Nov	0.0	0.000	0.00	0.00
Dec	0.0	0.000	0.00	0.00
	Average 157.58	Total 27.239	Average 8.80	Average 0.07

[a] Well 28a was shut down permanently on April 14, 2014.
[b] 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 2014

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 – 1,283

Hours pumped – 7,477
Operational percent – 85.35

Adjusted operational percent[a] – 88.78

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	328.7	14.672	20	0.17
Feb	325.2	13.111	19.90	0.17
Mar	318.1	14.200	19.70	0.16
Apr	237.8	10.271	20.7	0.17
May	193.2	8.623	26.2	0.22
Jun	0.0	0.000	0.0	0.00
Jul	203.7	9.094	33.5	0.28
Aug	320.9	14.326	24.9	0.21
Sep	319.5	13.801	24.1	0.20
Oct	315.3	14.076	22.1	0.18
Nov	329.9	14.252	19.9	0.17
Dec	314.6	14.042	20.1	0.17
	Average 267.2	Total 140.468	Average 20.92	Average 0.17

[a] Adjusted for planned annual well field shutdowns.
[b] Well 33a was down from March 10, 2014, to March 11, 2014, due to controller malfunction.
Well 33a was down from April 14, 2014, to April 22, 2014, to install new instrumentation at the Parshall Flume.
Well 33a was down from May 19, 2014, to June 16, 2014, for the annual well field shutdown.
Well 33a was down from June 13, 2014, to June 20, 2014, for rehabilitation.
[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, 2014

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 = 1.91E-02e^1.27E-04x	0.31	y = 4.96E-01e^5.93E-05x	0.26	Exponential Function
RW-6	32308	y = 3.90E+04e^-1.74E-04x	0.85	y = 4.75E+03e^-1.06E-04x	0.84	Exponential Function
RW-7	32309	y = 1.47E+05e^-2.09E-04x	0.89	y = 7.66E+03e^-1.16E-04x	0.86	Exponential Function
EW-15a	33262	y = 4.20E+45x^-9.57E+00	0.79	y = 8.18E+27x^-5.67E+00	0.77	Power Function
EW-17a	33326	y = 8.97E+03e^-1.51E-04x	0.65	y = 1.51E+03e^-9.08E-05x	0.62	Exponential Function
EW-18	31550	y = 8.21E+03e^-1.35E-04x	0.47	y = 1.80E+03e^-7.93E-05x	0.44	Exponential Function
EW-19	31560	y = 5.37E+07e^-3.65E-04x	0.88	y = 3.08E+04e^-1.44E-04x	0.76	Exponential Function
EW-20	31561	y = 2.55E+03e^-1.09E-04x	0.53	y = 9.39E+02e^-7.22E-05x	0.51	Exponential Function
EW-21a	33298	y = 4.94E+05e^-2.33E-04x	0.77	y = 1.32E+04e^-1.19E-04x	0.74	Exponential Function
EW-22	32276	y = 4.77E+08e^-4.09E-04x	0.94	y = 9.19E+04e^-1.58E-04x	0.85	Exponential Function
EW-23	32447	y = 3.47E+07e^-3.32E-04x	0.88	y = 7.90E+04e^-1.54E-04x	0.82	Exponential Function
EW-24	32446	y = 4.88E+04e^-1.75-04x	0.74	y = 5.36E+03e^-1.04E-04x	0.69	Exponential Function
EW-25	33061	y = 3.46E+04e^-1.73E-04x	0.48	y = 3.15E+03e^-9.90E-05x	0.45	Exponential Function
EW-30	33264	y = 5.44E+08e^-4.03E-04x	0.92	y = 2.34E+05e^-1.86E-04x	0.87	Exponential Function
EW-26	32761	y = 1.36E+08e^-3.78E-04x	0.86	y = 7.83E+04e^-1.65E-04x	0.78	Exponential Function
EW-27	33062	y = 2.79E+08e^-3.93E-04x	0.81	y = 7.87E+04e^-1.59E-04x	0.68	Exponential Function
EW-33a	33347	y = 2E+45x^-9.545	0.17	y = 1E+24x^-4.806	0.22	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 of Uranium To Be Extracted Based on Regression of 95% UCL**
2015	533	487	1,633
2016	485	430	1,548
2017	441	386	1,473
2018	401	351	1,401
2019	368	262	1,332
2020	340	232	1,266
2021	179	210	714
2022	165	193	691
2023	152	179	660
2024	141	166	631
2025	131	156	603
2026	121	59	576
2027	113	55	551
2028	105	52	527
2029	21	47	217
2030	19	46	206
2031	17	44	196
2032	16	42	187
2033	13	40	175
Estimate of Total To Be Extracted	3,763	3,436	14,590
Actual Pounds Extracted Through December 23, 2014	12,300	12,300	12,300
Estimate of Total Pounds to be Extracted	16,063	15,736	26,890
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**
2014	77	78	46
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

Table A.1-28. Extraction Well Target Pumping Rates

Module/Extraction Well	January 1 to June 30 (gpm)[a]	July 1 to December 31 (gpm)[b]
South Plume		
3924 (RW-1)	200	200
3924 (RW-2)	200	200
3925 (RW-3)	200	200
3927 (RW-4)	200	200
32308 (RW-6)	200	300
32309 (RW-7)	200	300
Subtotal	1,200	1,400
Waste Storage Area		
32761 (EW-26)	300	300
33062 (EW-27)	200	200
33334 (EW-28a)	200	0
33347 (EW-33a)	300	300
Subtotal	1,000	800
South Field Extraction		
31550 (EW-18)	100	100
31560 (EW-19)	100	100
31561 (EW-20)	100	200
33298 (EW-21a)	200	300
33326 (EW-17a)	175	175
32276 (EW-22)	300	300
32446 (EW-24)	300	400
32447 (EW-23)	300	500
33061 (EW-25)	100	100
33264 (EW-30)	200	400
33265 (EW-31)	300	0
33266 (EW-32)	200	0
33262 (EW-15a)	200	300
Subtotal	2,575	2,875
Total Pumping	4,775	5,075

[a] 2005 Operational Design
[b] 2014 Operational Design

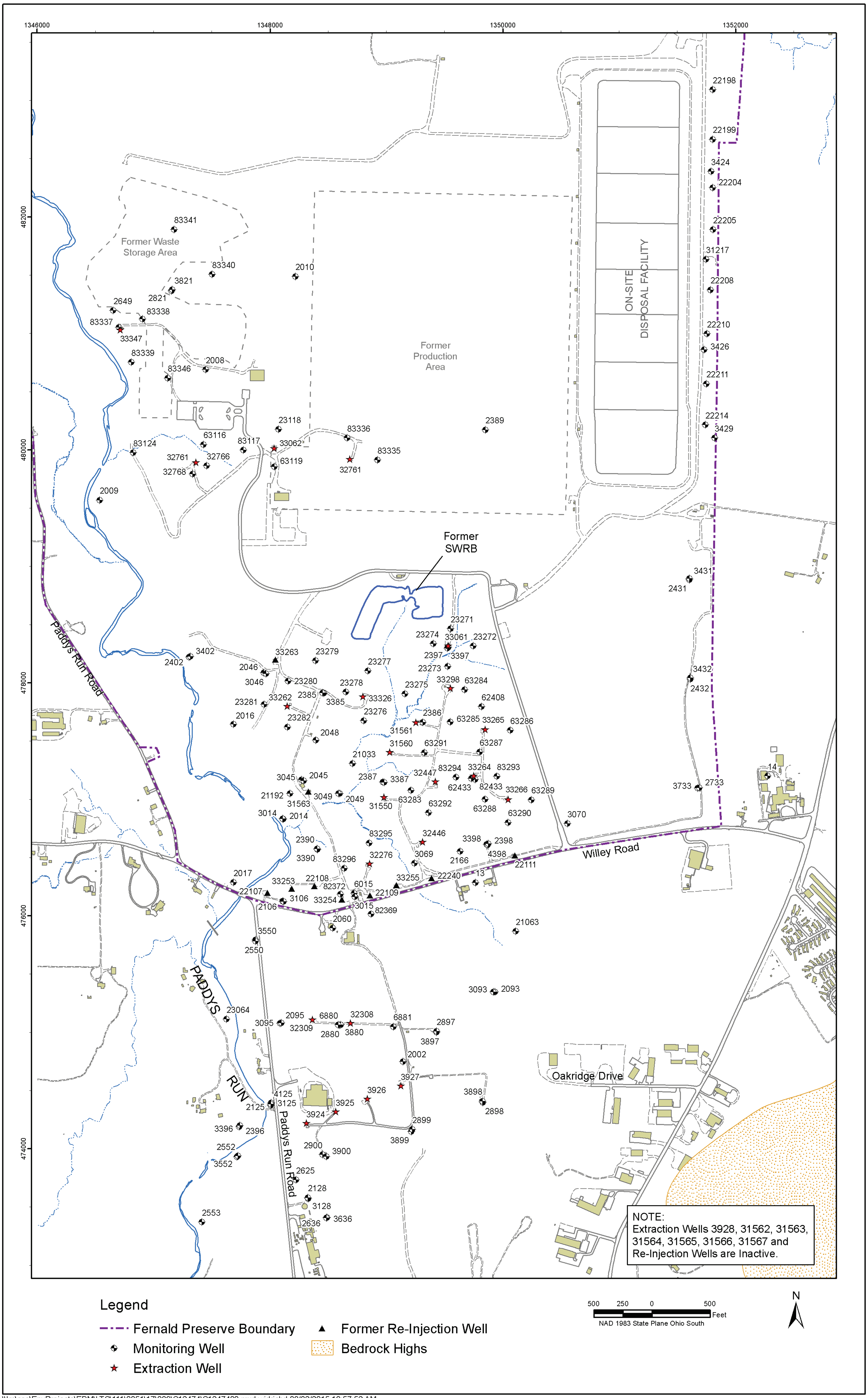

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Figure A.1-1. Well Locations for South Plume, South Field, Waste Storage Area, and PRRS Monitoring Activities

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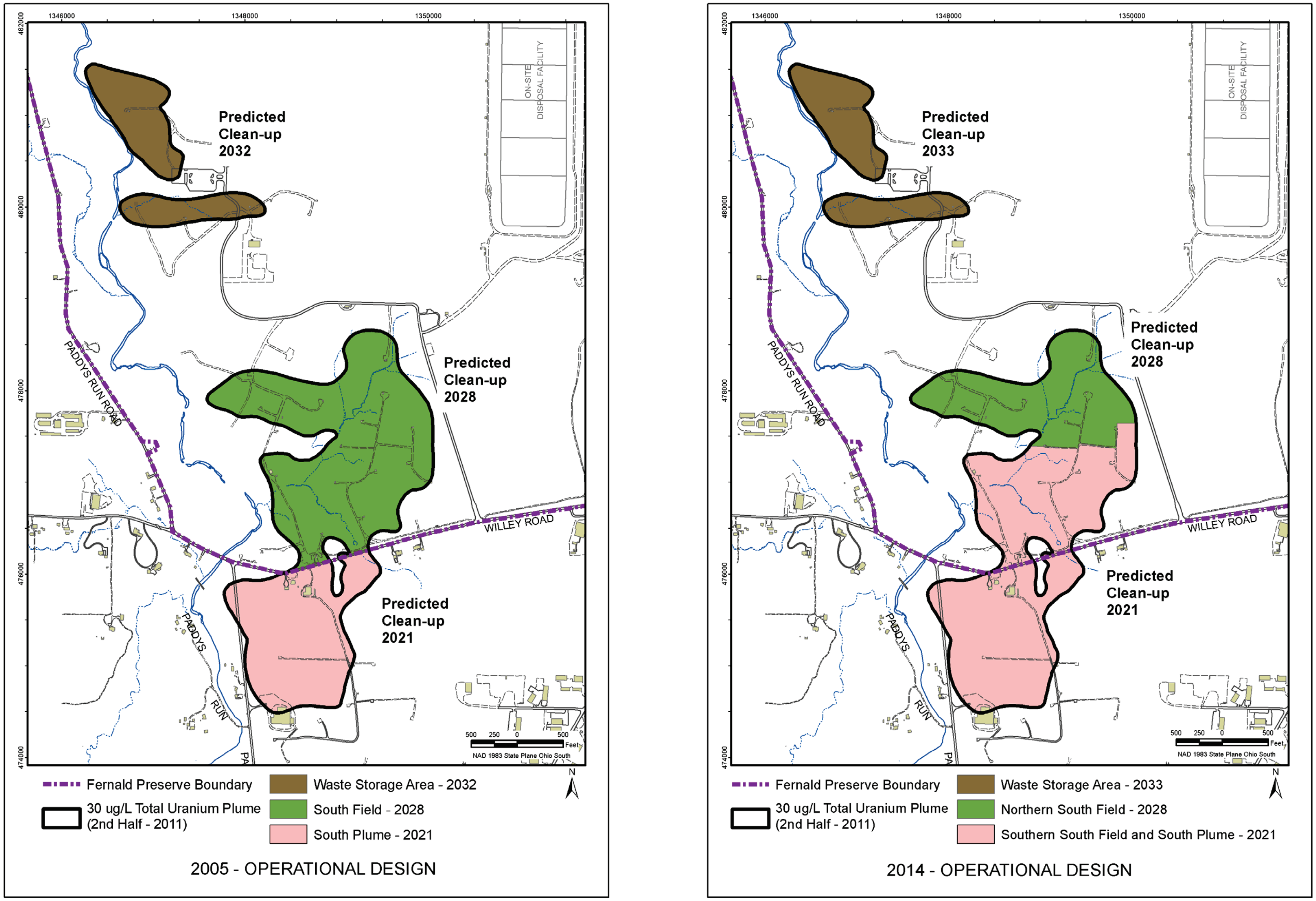

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Figure A.1-2. Comparison of Predicted Cleanup Dates, 2005 versus 2014 Operational Designs

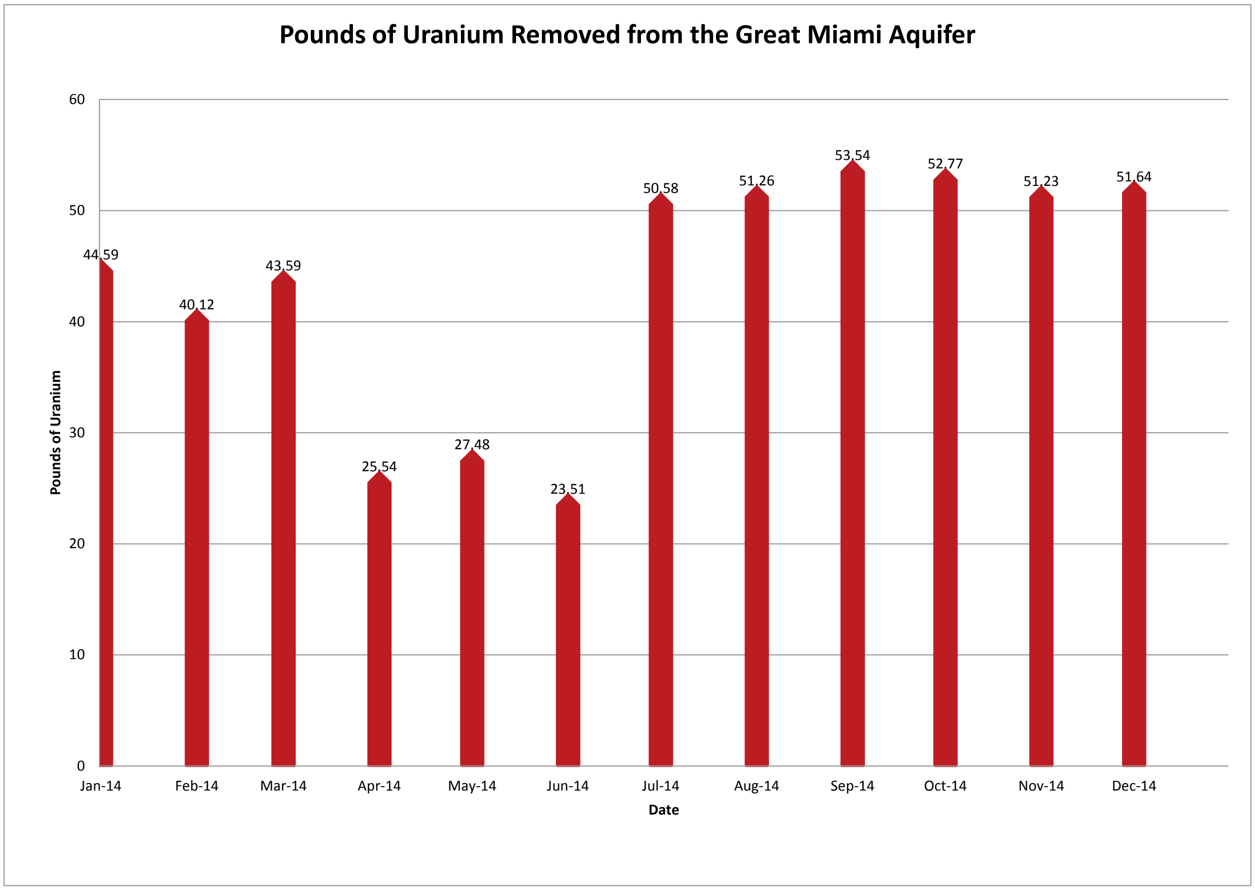

Figure A.1-3. Pounds of Uranium Removed from the Aquifer

Figure A.1-4. Clean Pump (Top) versus Iron-Fouled Pump (Bottom)

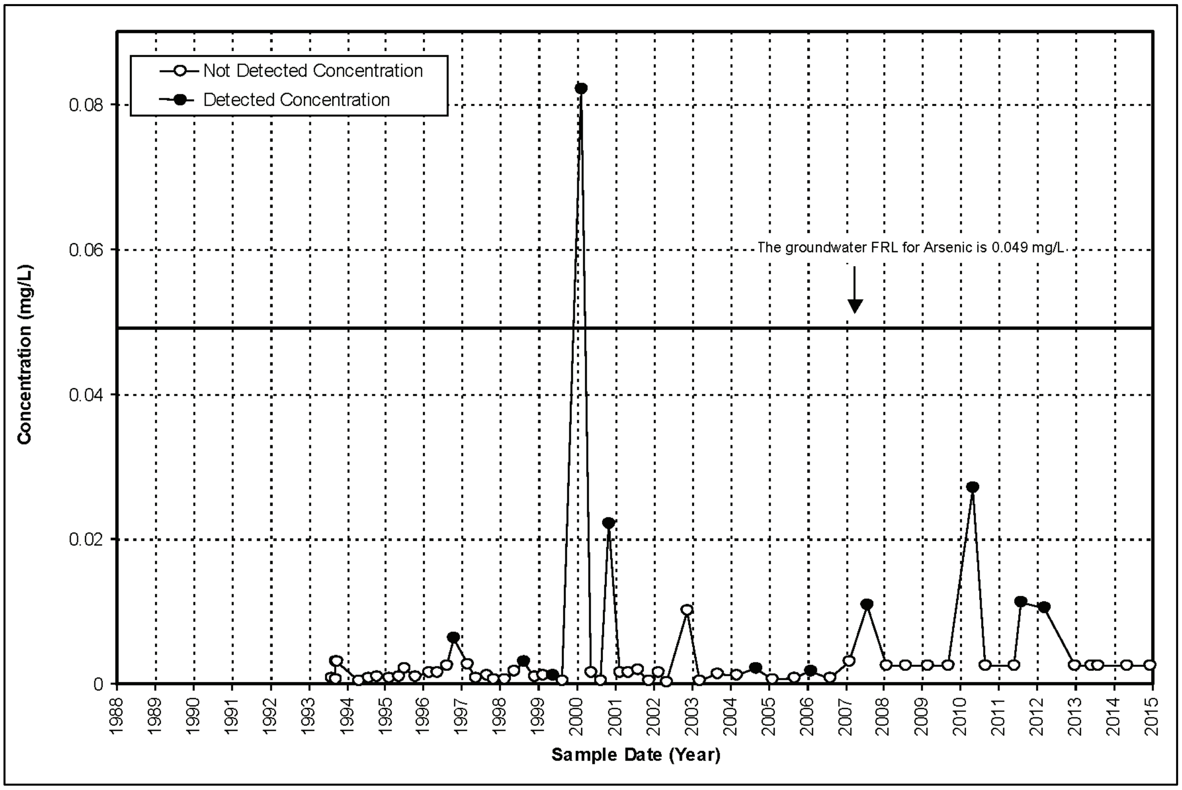

Figure A.1-5. Arsenic Concentration Versus Time Plot for Monitoring Well 2898

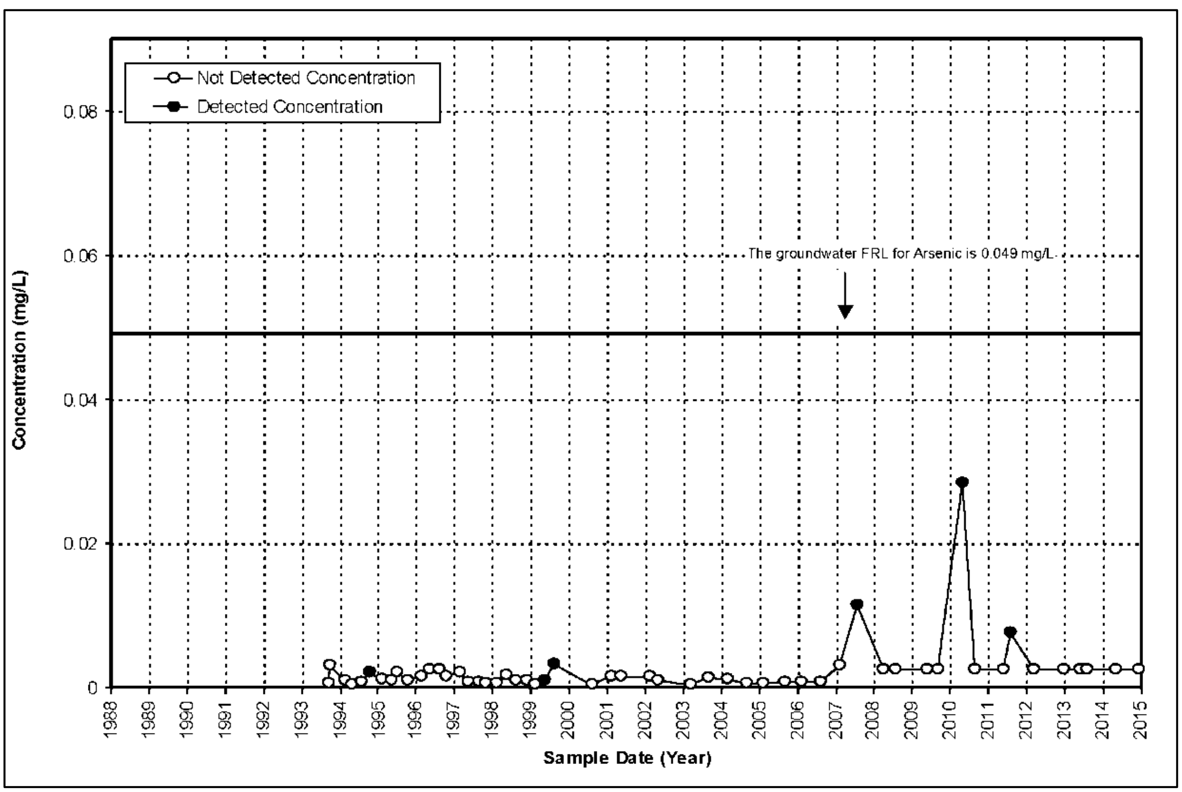

Figure A.1-6. Arsenic Concentration Versus Time Plot for Monitoring Well 2899

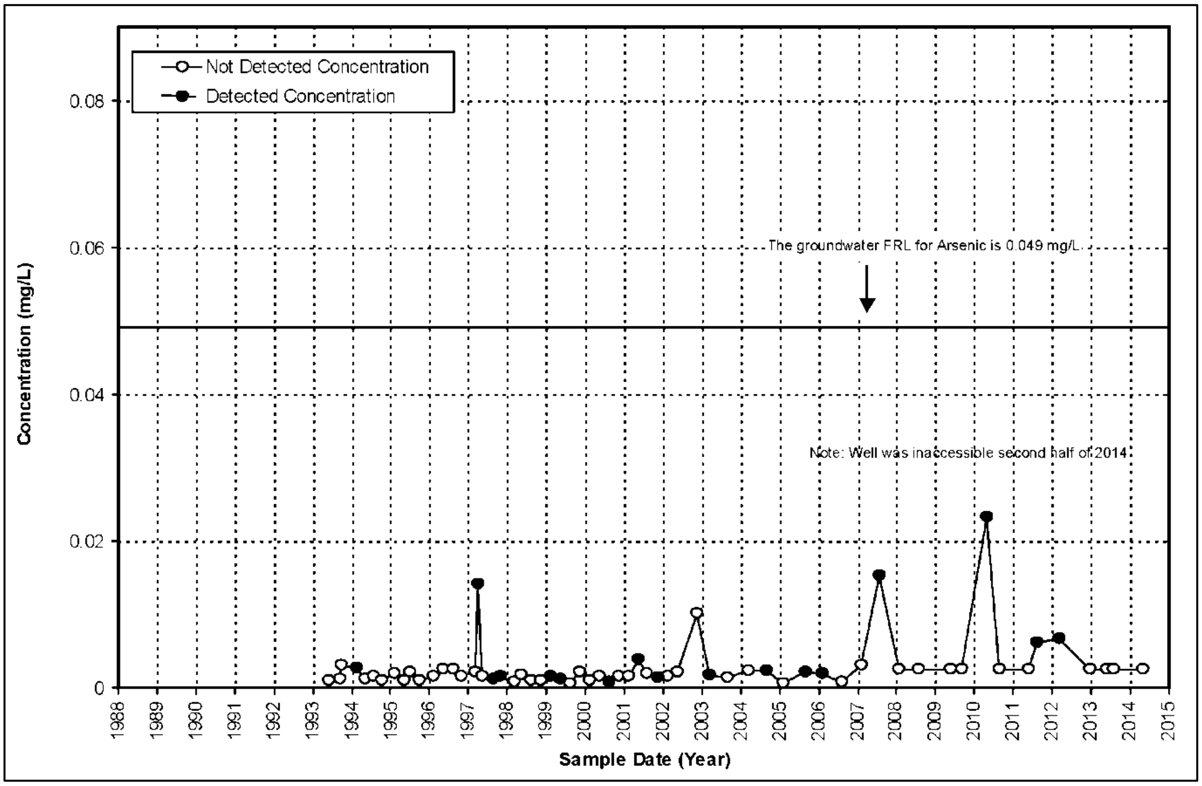

Figure A.1-7. Arsenic Concentration Versus Time Plot for Monitoring Well 3636

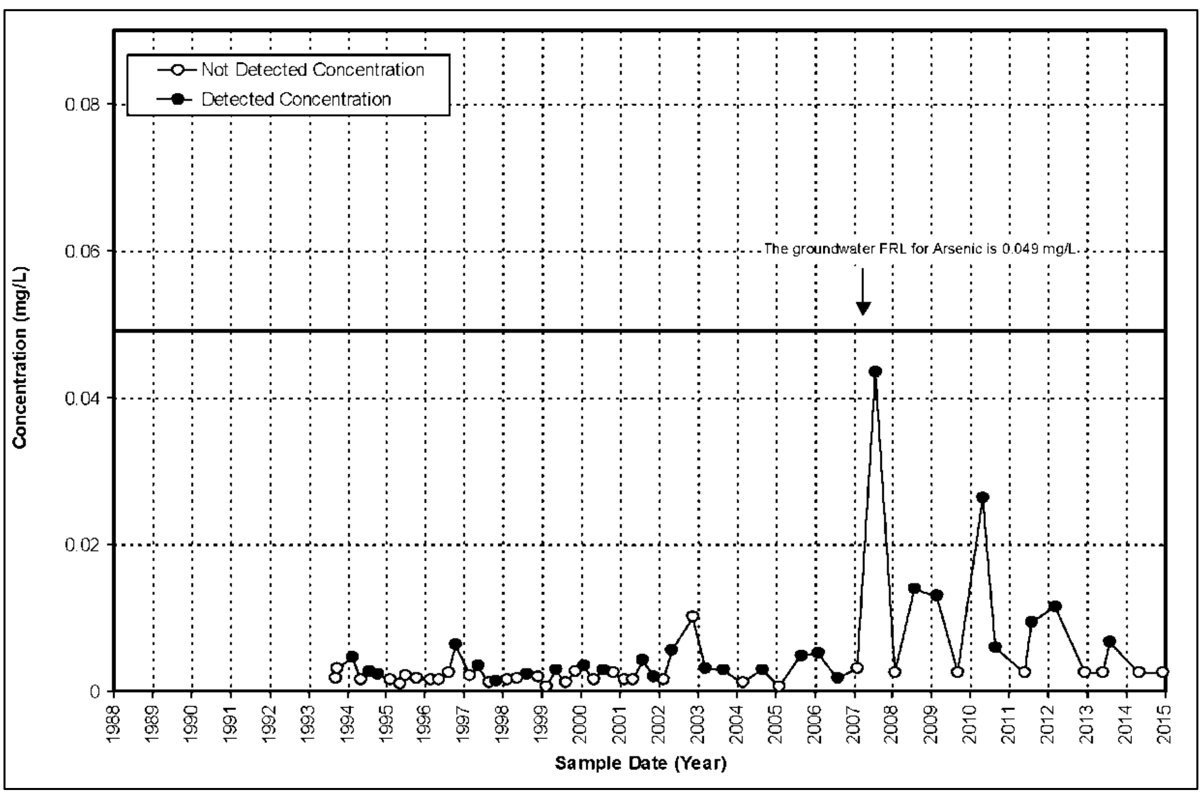

Figure A.1-8. Arsenic Concentration Versus Time Plot for Monitoring Well 3898

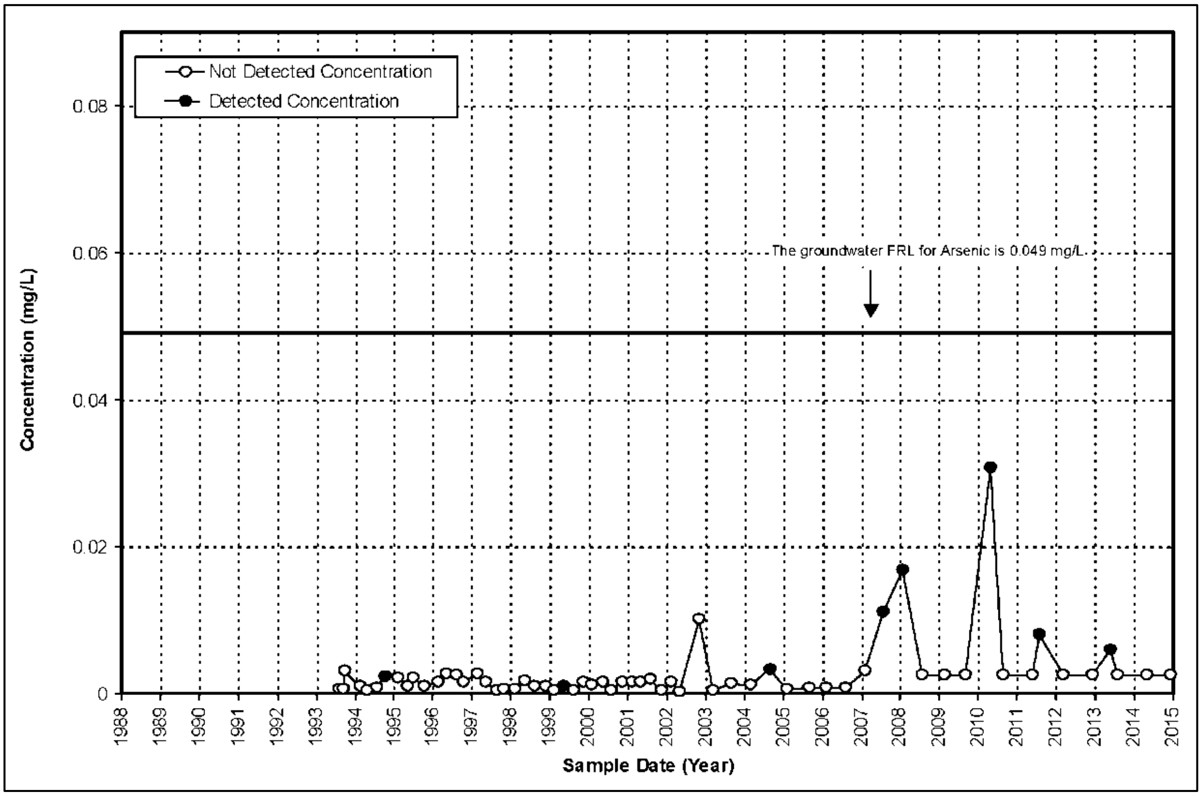

Figure A.1-9. Arsenic Concentration Versus Time Plot for Monitoring Well 3899

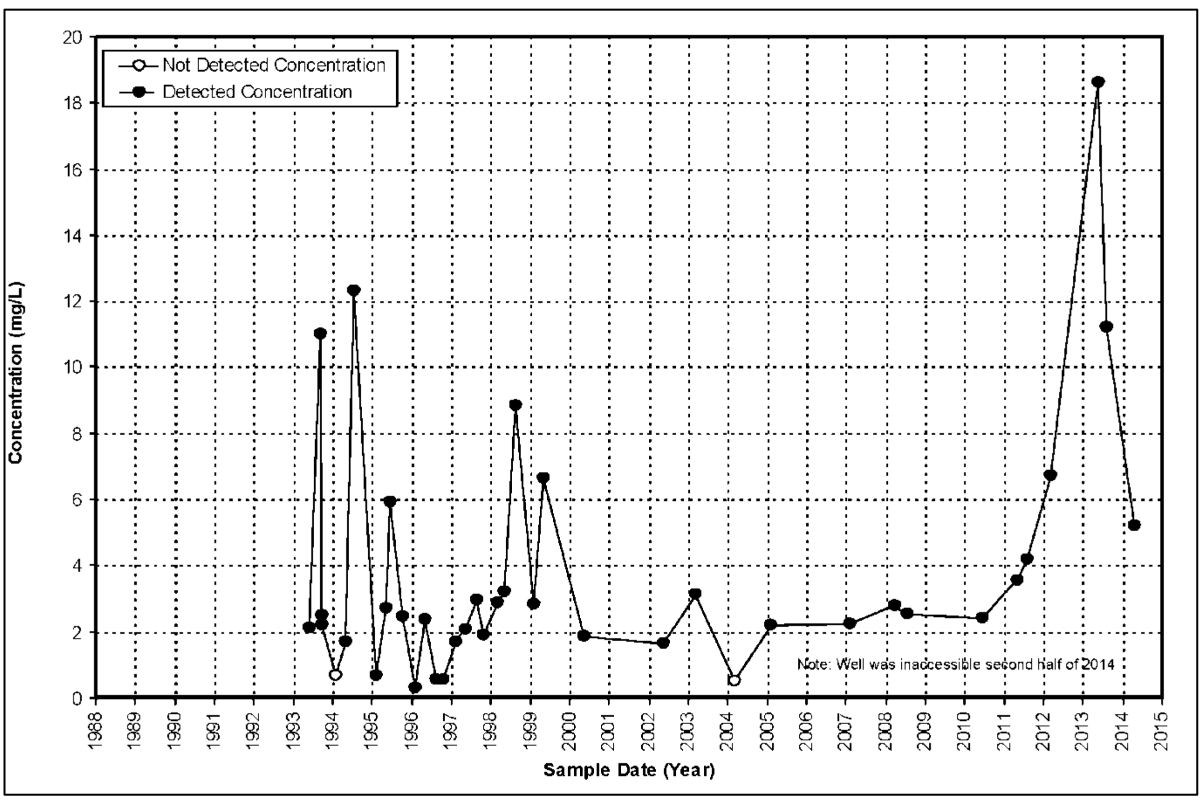

Figure A.1-10. Phosphorous Concentration Versus Time Plot for Monitoring Well 2625

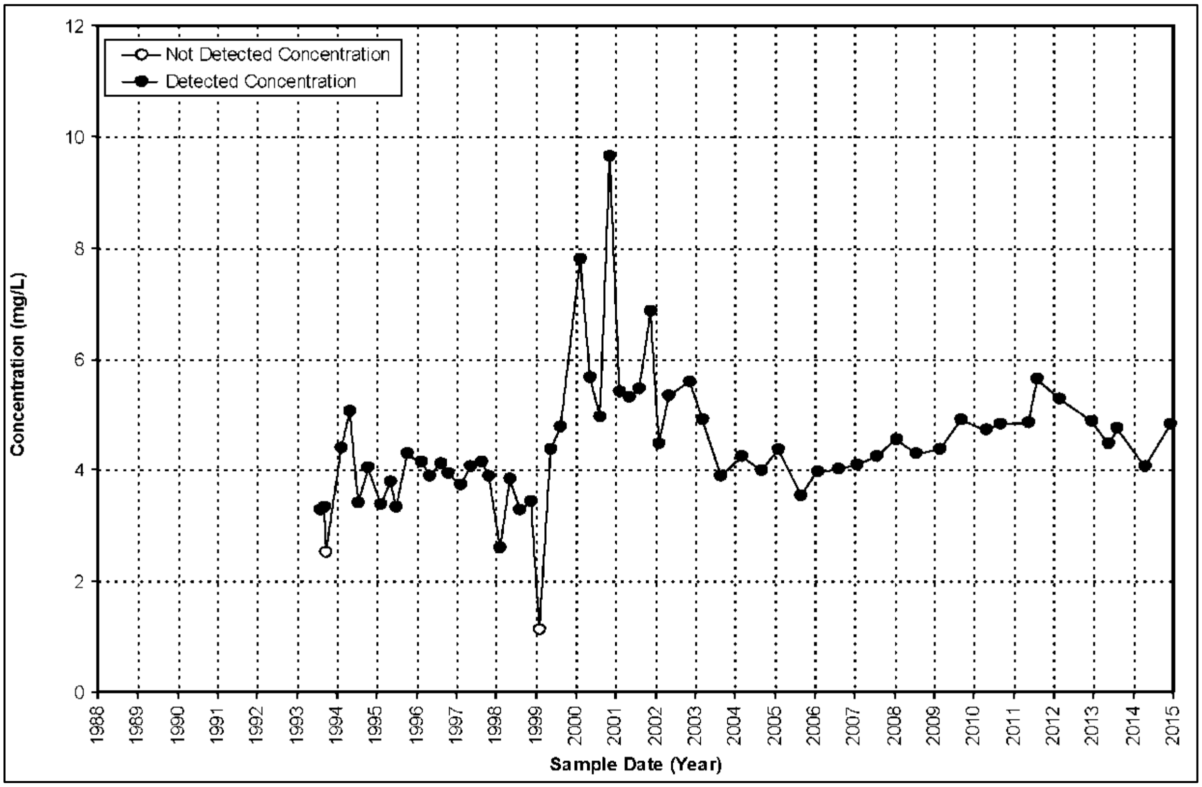

Figure A.1-11. Potassium Concentration Versus Time Plot for Monitoring Well 2898

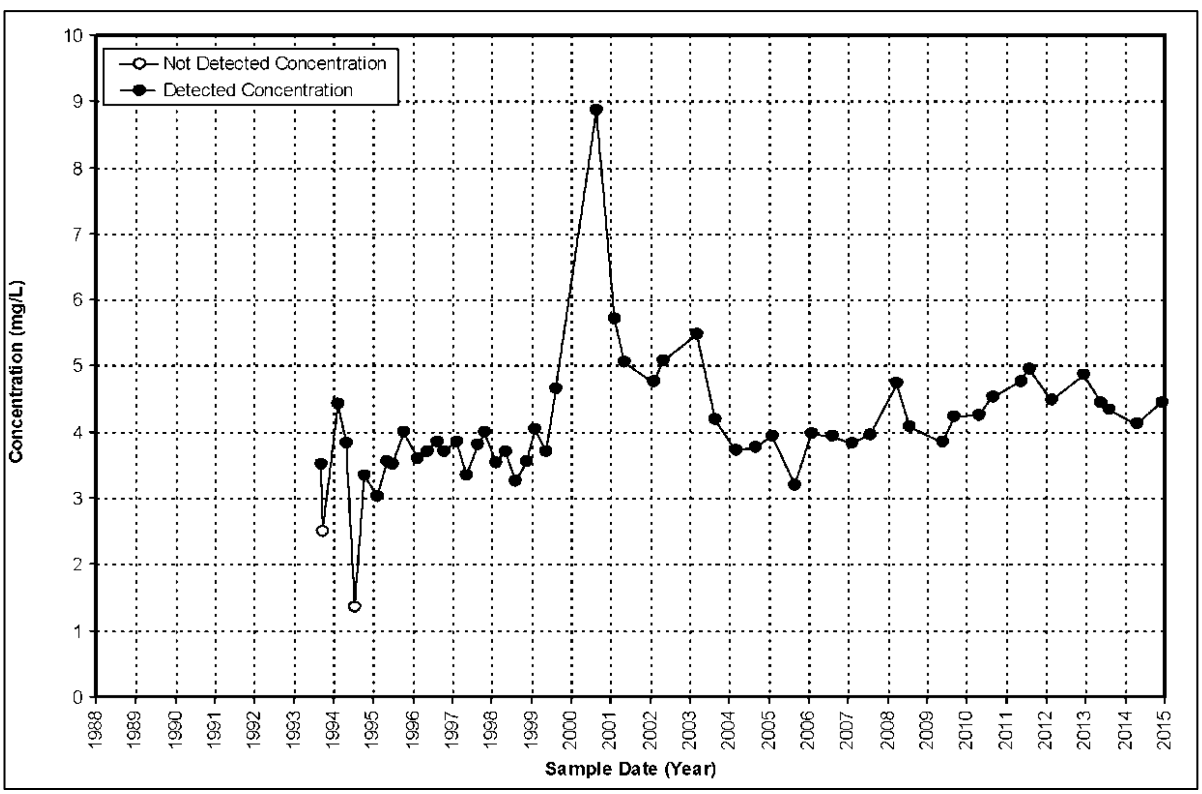

Figure A.1-12. Potassium Concentration Versus Time Plot for Monitoring Well 2899

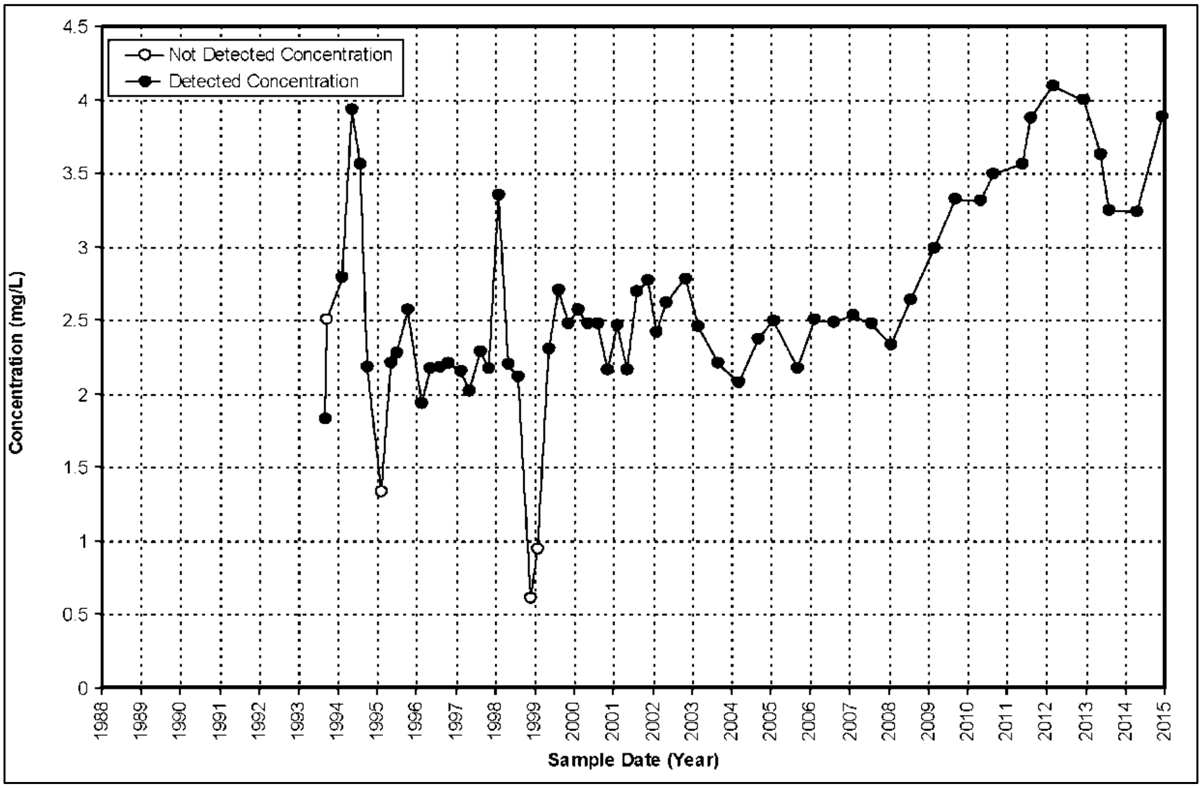

Figure A.1-13. Potassium Concentration Versus Time Plot for Monitoring Well 3898

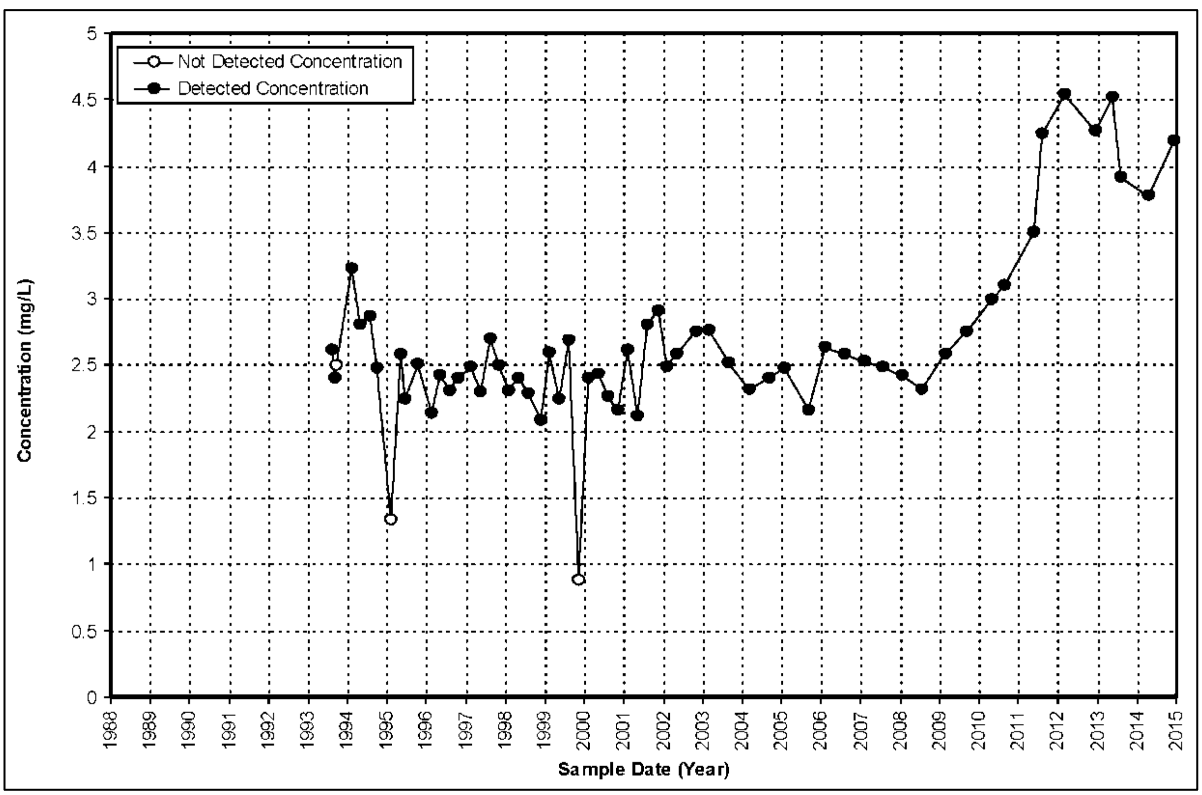

Figure A.1-14. Potassium Concentration Versus Time Plot for Monitoring Well 3899

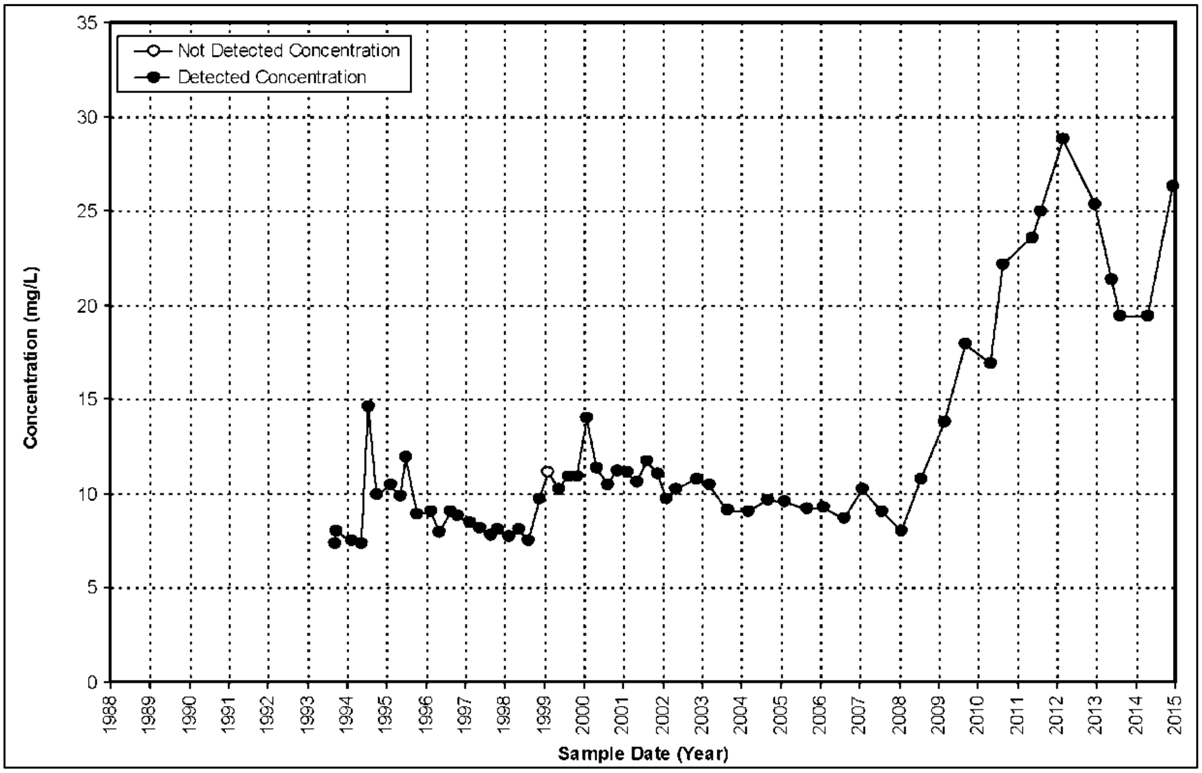

Figure A.1-15. Sodium Concentration Versus Time Plot for Monitoring Well 3898

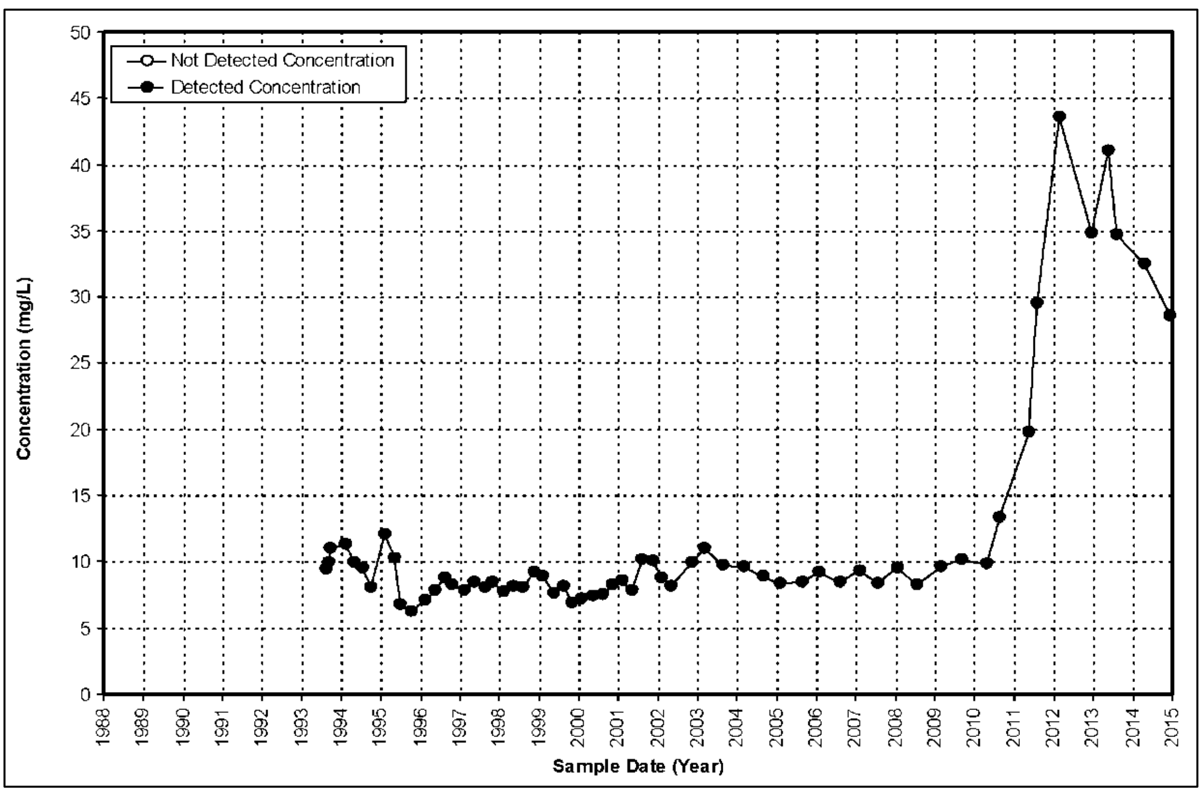

Figure A.1-16. Sodium Concentration Versus Time Plot for Monitoring Well 3899

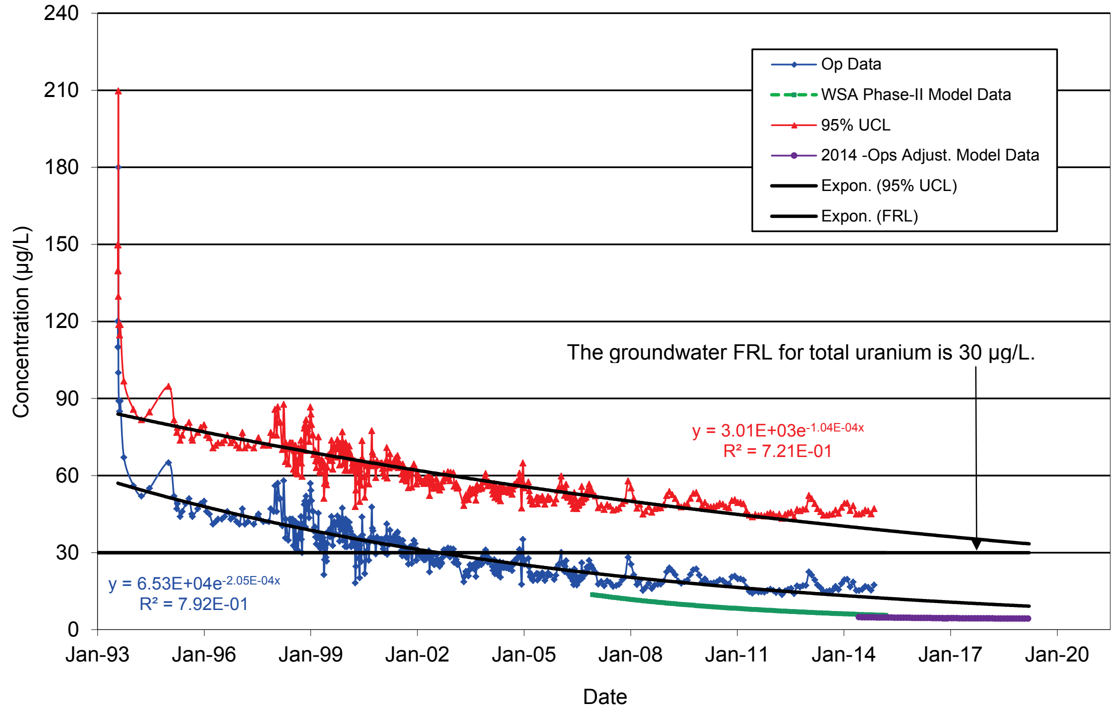

Figure A.1-17. Total Uranium Concentration Versus Time Plot for Extraction Well 3924 (RW-1) with Regression Analysis

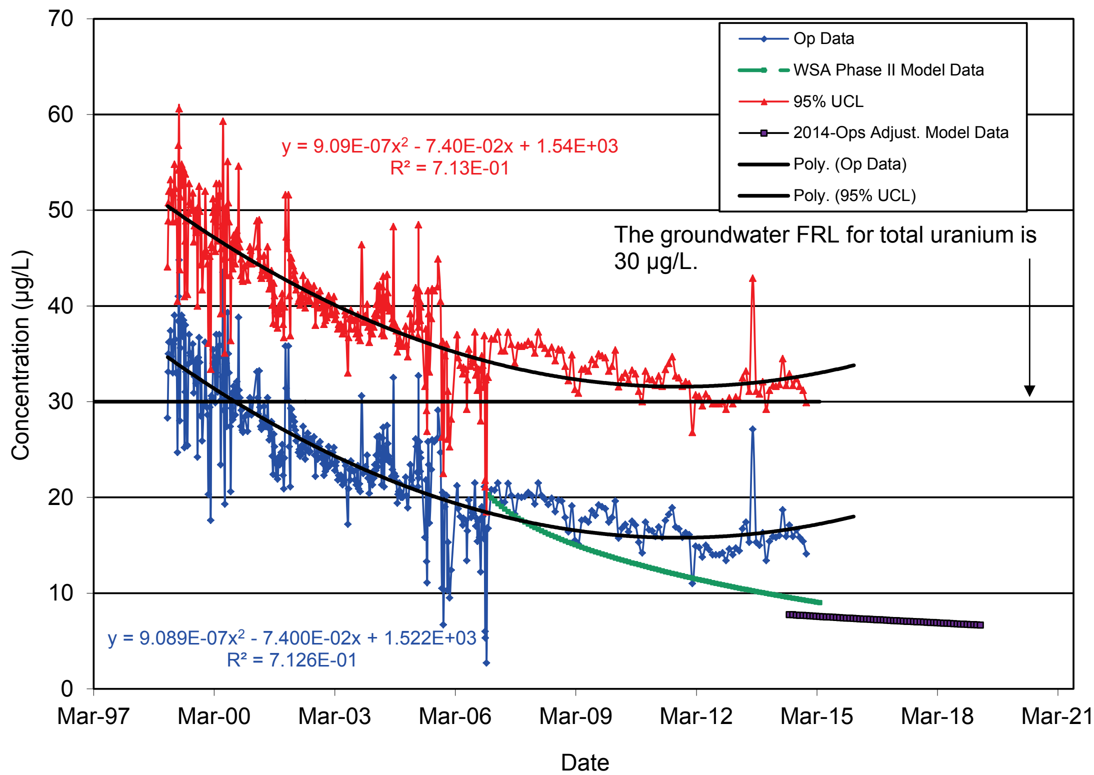

Figure A.1-18. Total Uranium Concentration Versus Time Plot for Extraction Well 3925 (RW-2) with Regression Analysis

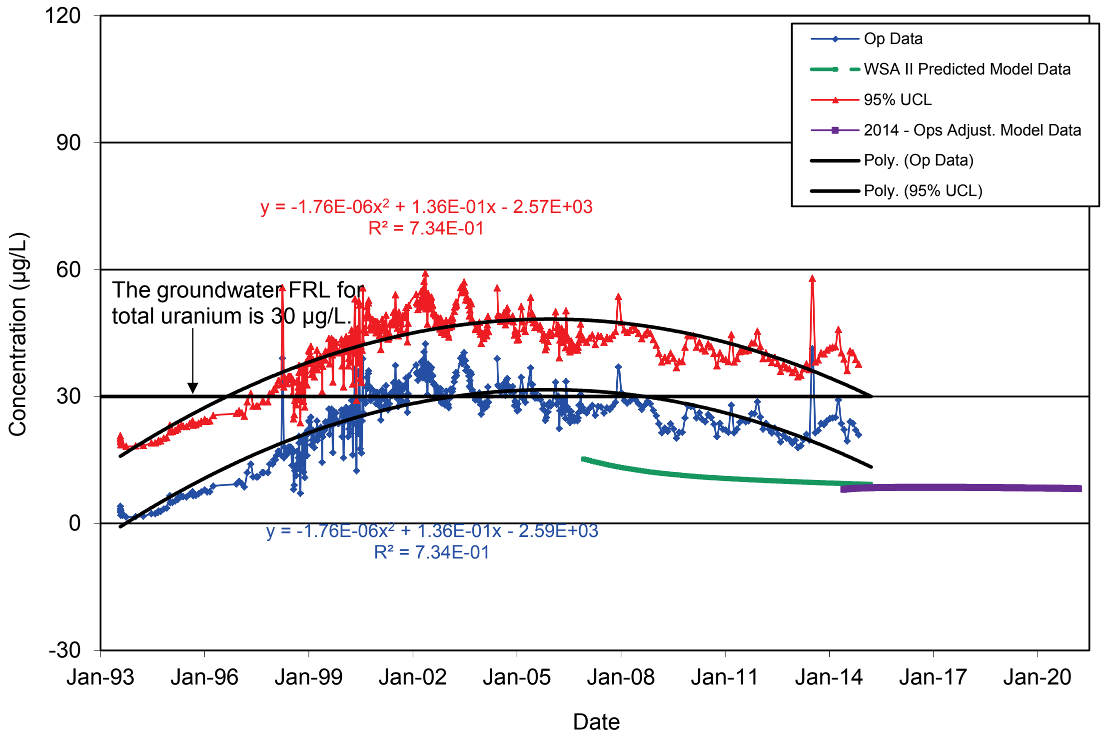

Figure A.1-19. Total Uranium Concentration Versus Time Plot for Extraction Well 3926 (RW-3) with Regression Analysis

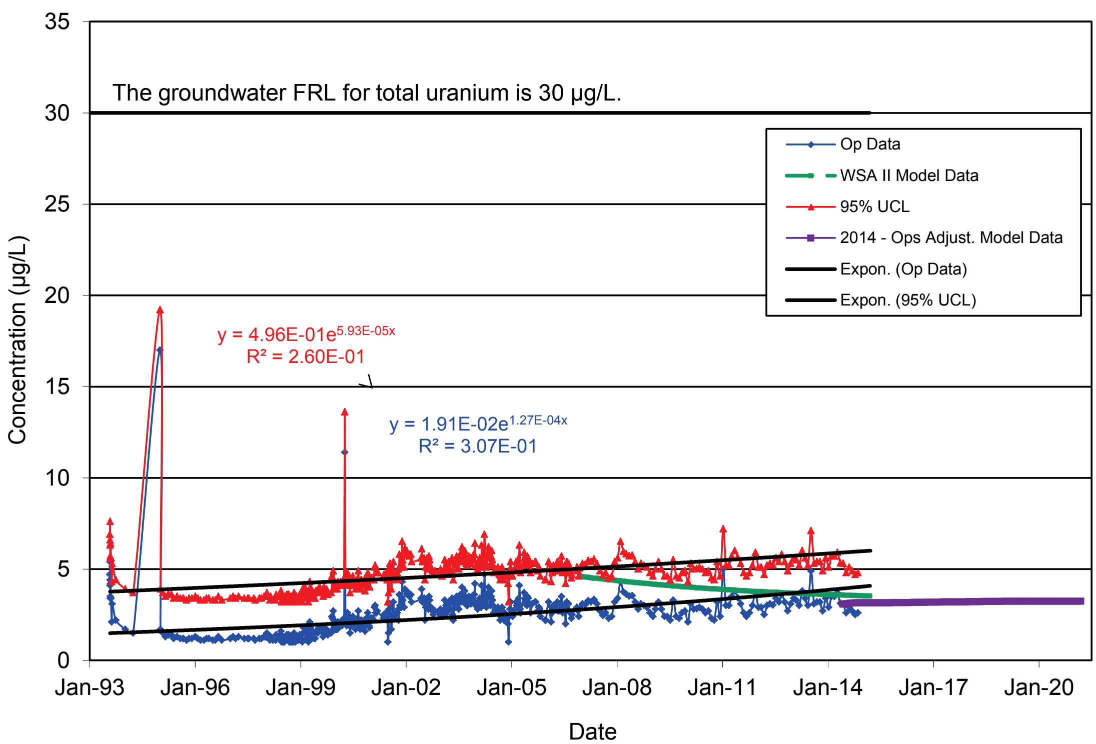

Figure A.1-20. Total Uranium Concentration Versus Time Plot for Extraction Well 3927 (RW-4) with Regression Analysis

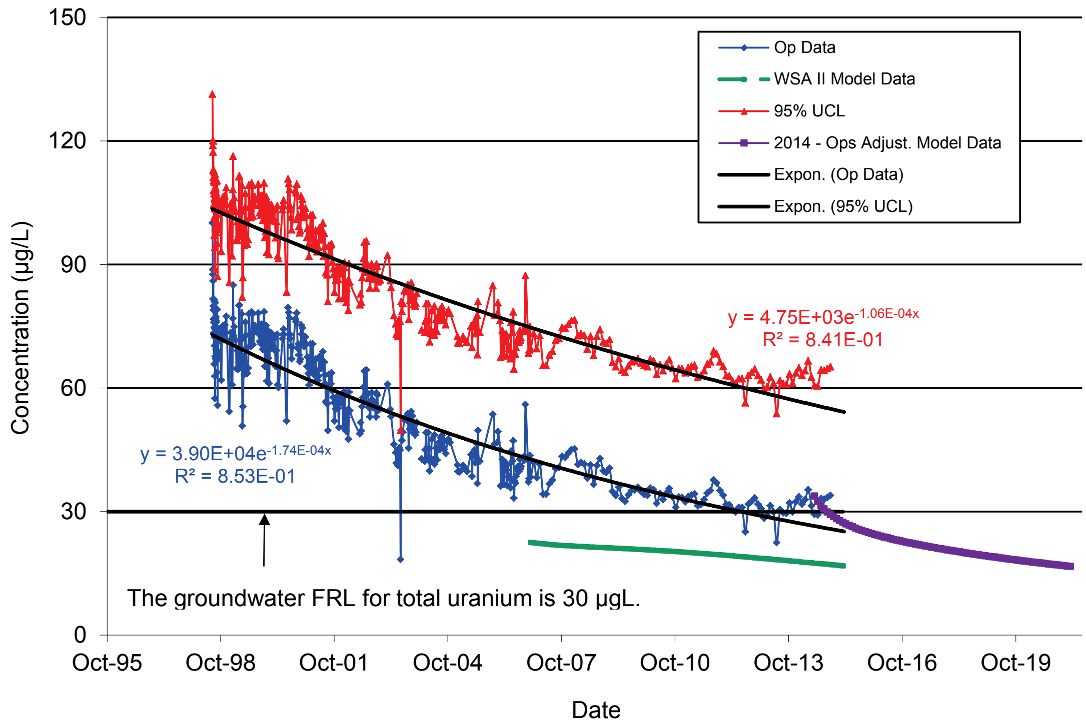

Figure A.1-21. Total Uranium Concentration Versus Time Plot for Extraction Well 32308 (RW-6) with Regression Analysis

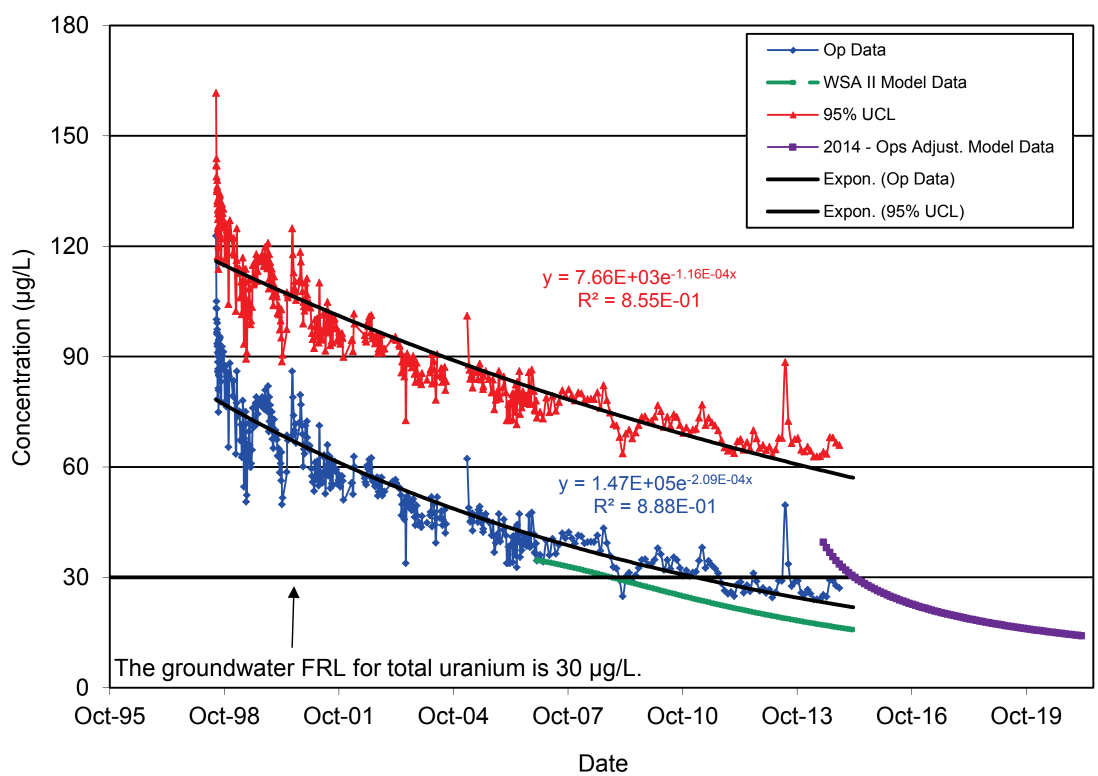

Figure A.1-22. Total Uranium Concentration Versus Time Plot for Extraction Well 32309 (RW-7) with Regression Analysis

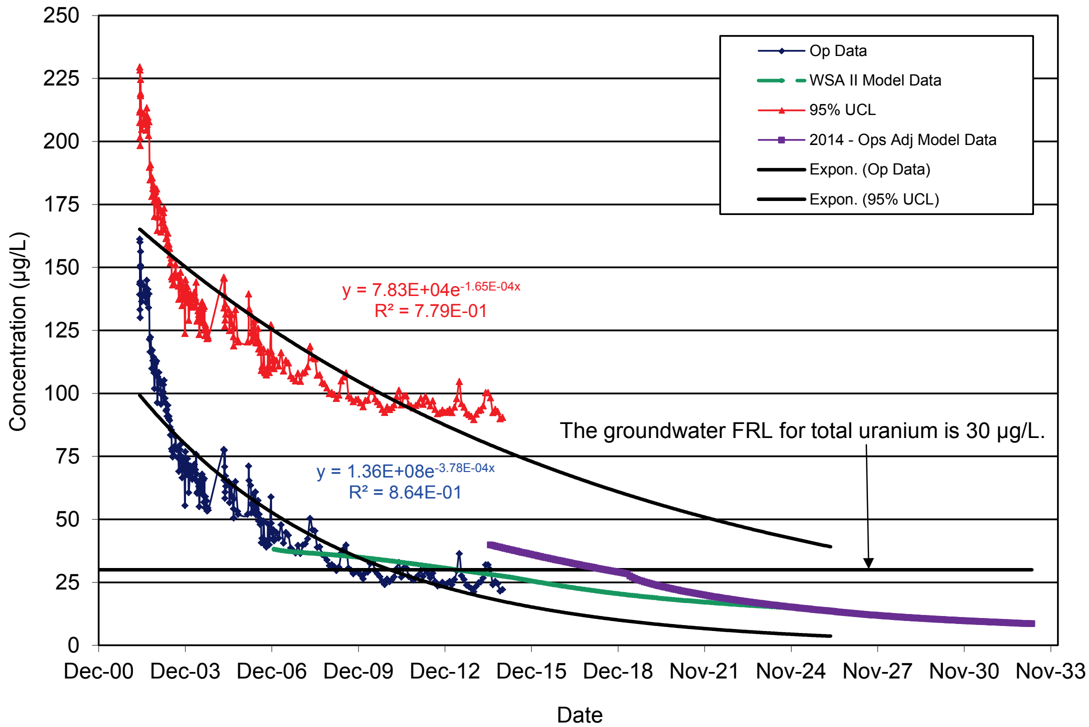

Figure A.1-23. Total Uranium Concentration Versus Time Plot for Extraction Well 32761 (EW-26) with Regression Analysis

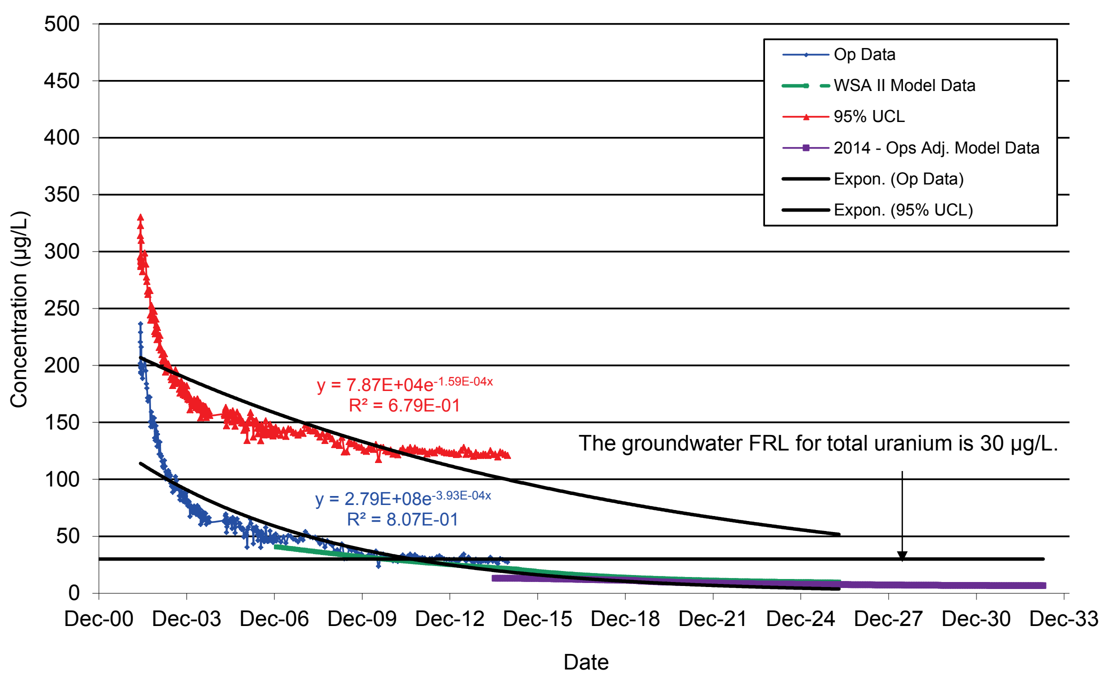

Figure A.1-24. Total Uranium Concentration Versus Time Plot for Extraction Well 33062 (EW-27) with Regression Analysis

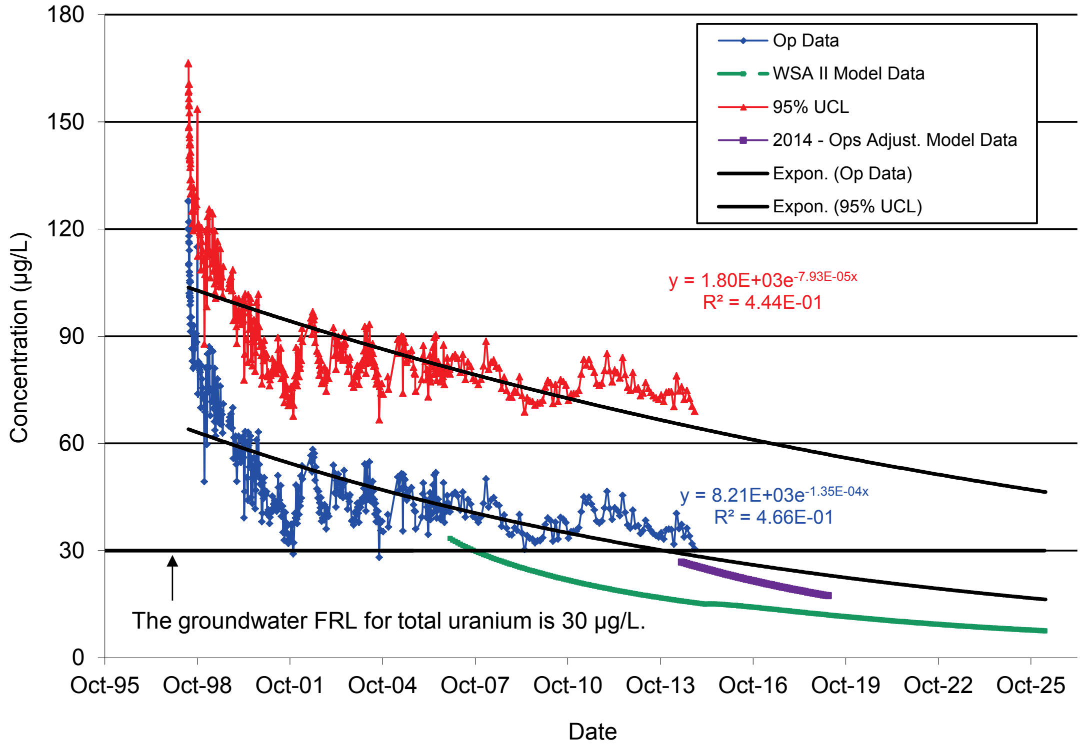

Figure A.1-25. Total Uranium Concentration Versus Time Plot for Extraction Well 31550 (EW-18) with Regression Analysis

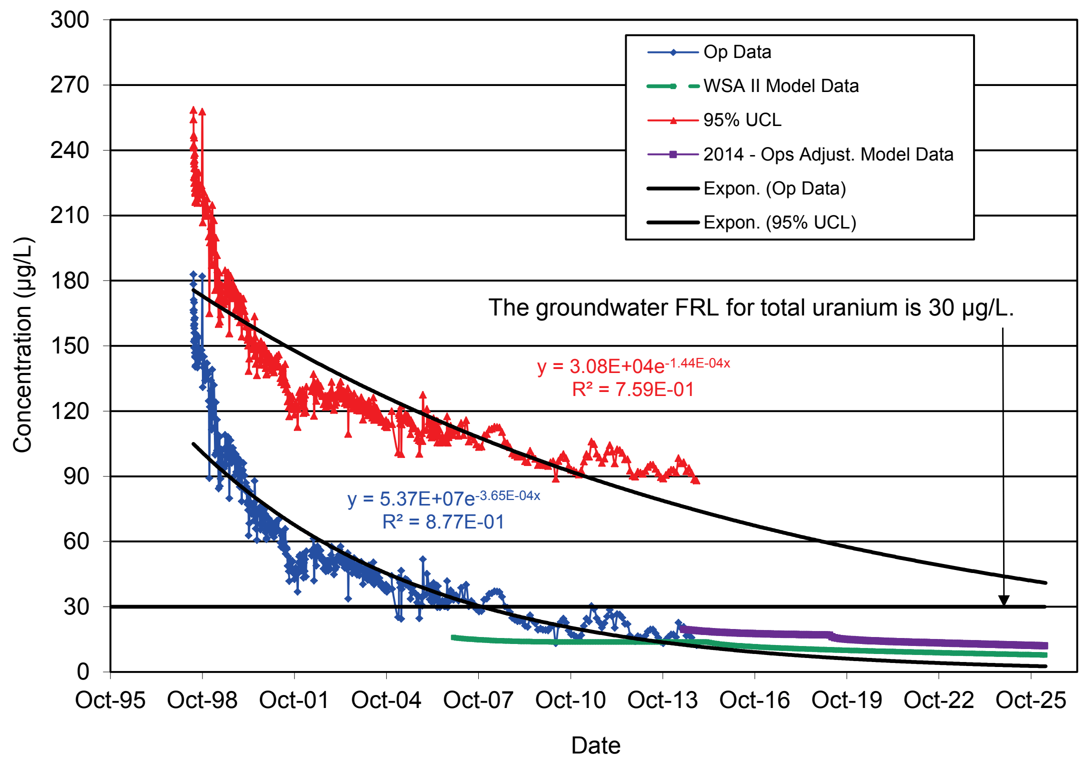

Figure A.1-26. Total Uranium Concentration Versus Time Plot for Extraction Well 31560 (EW-19) with Regression Analysis

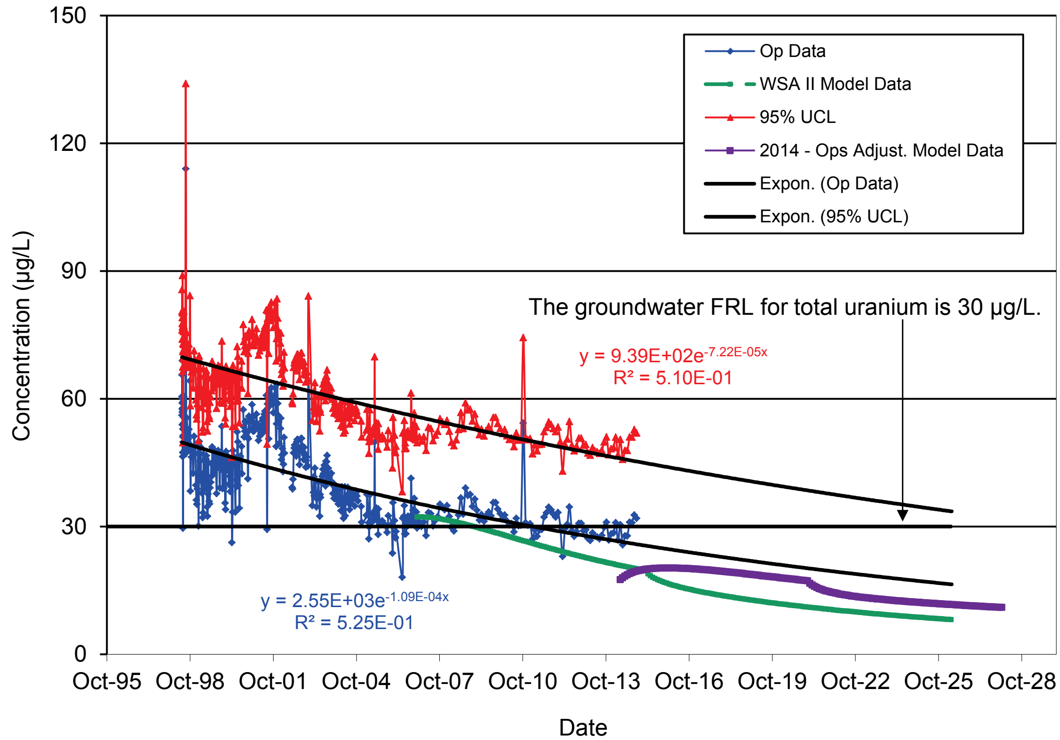

Figure A.1-27. Total Uranium Concentration Versus Time Plot for Extraction Well 31561 (EW-20) with Regression Analysis

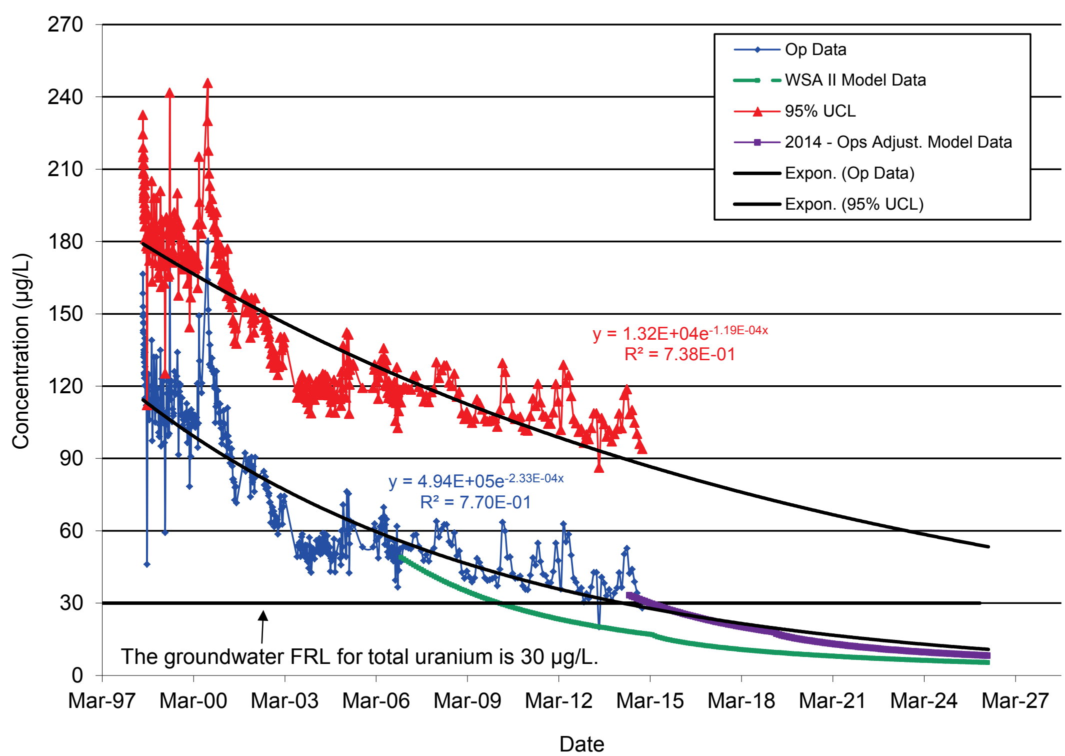

Figure A.1-28. Total Uranium Concentration Versus Time Plot for Extraction Well 31562 (EW-21)/ 33298 (EW-21a) with Regression Analysis

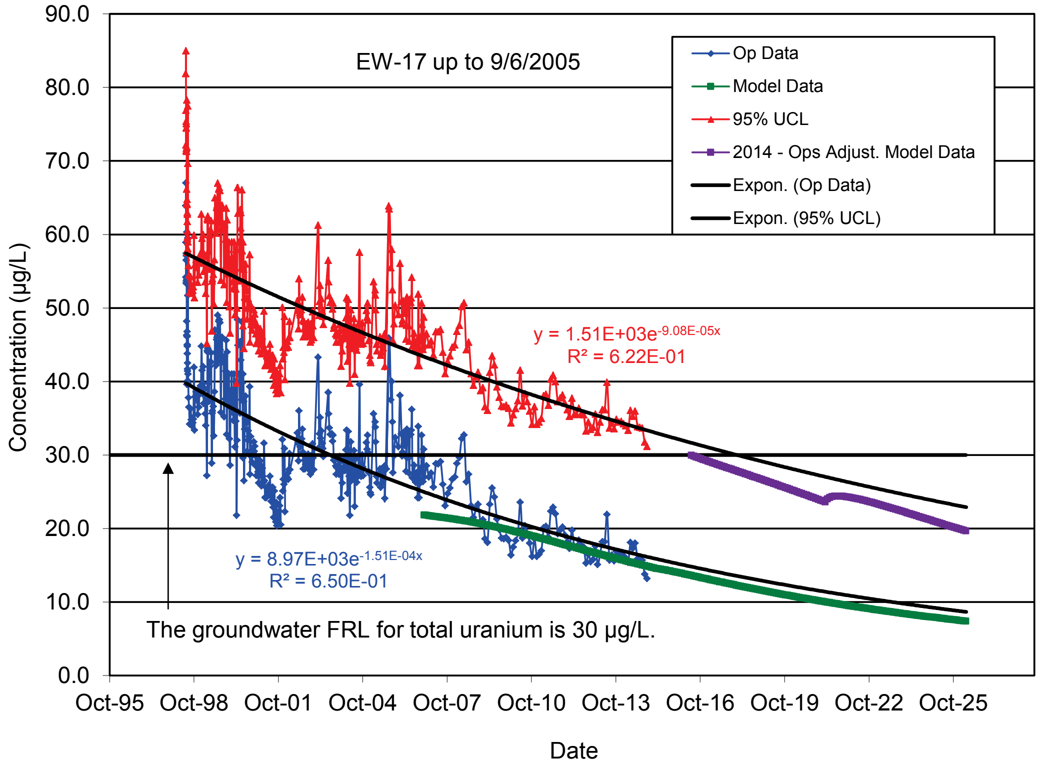

Figure A.1-29. Total Uranium Concentration Versus Time Plot for Extraction Well 31567 (EW-17)/ 33326 (EW-17a) with Regression Analysis

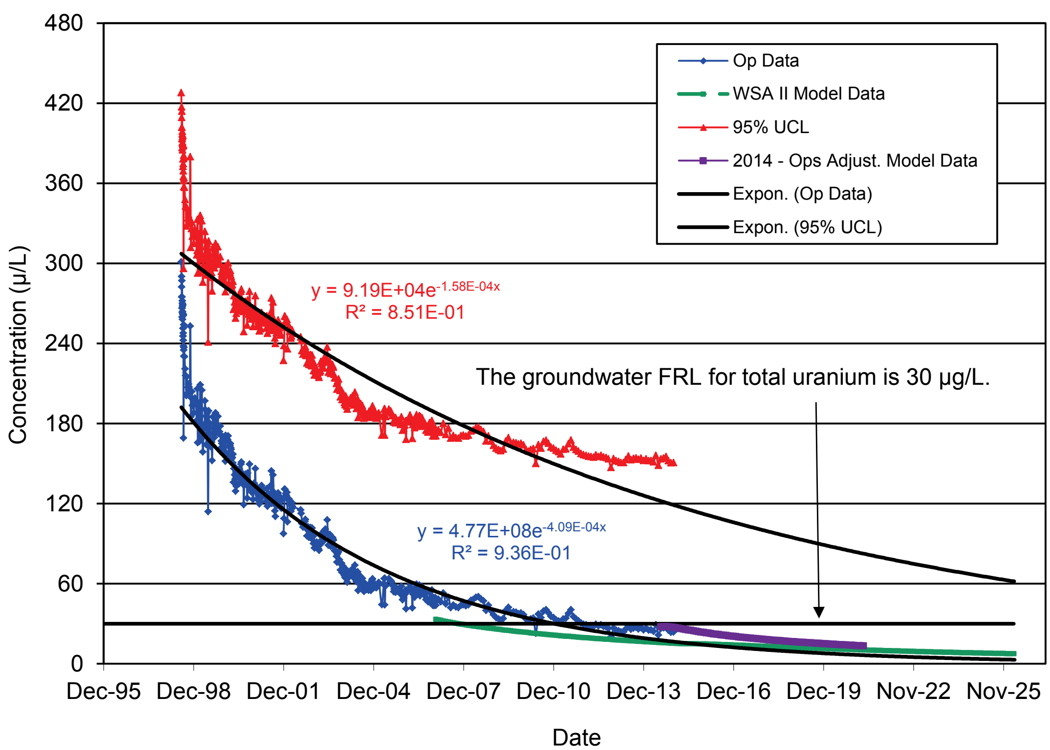

Figure A.1-30. Total Uranium Concentration Versus Time Plot for Extraction Well 32276 (EW-22) with Regression Analysis

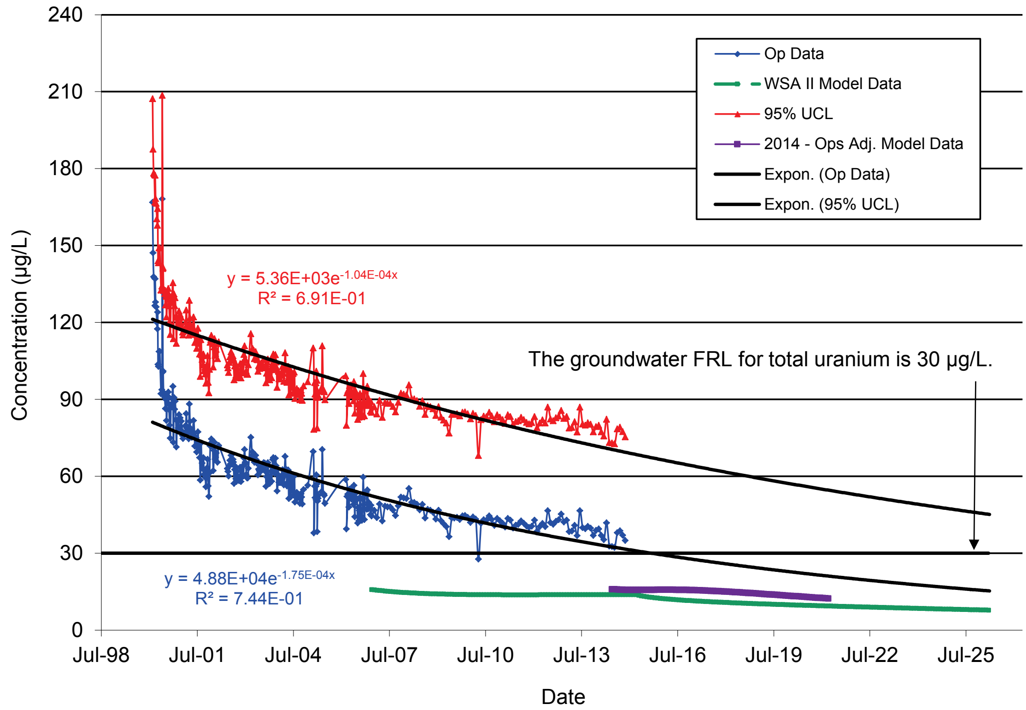

Figure A.1-31. Total Uranium Concentration Versus Time Plot for Extraction Well 32446 (EW-24) with Regression Analysis

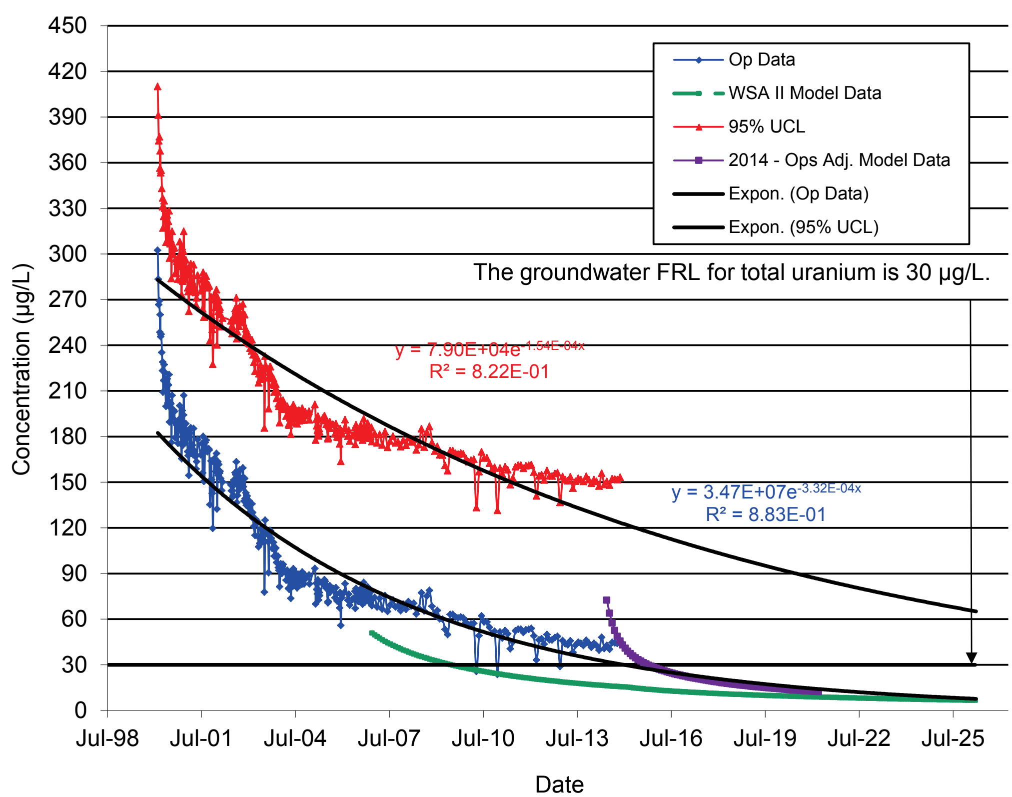

Figure A.1-32. Total Uranium Concentration Versus Time Plot for Extraction Well 32447 (EW-23) with Regression Analysis

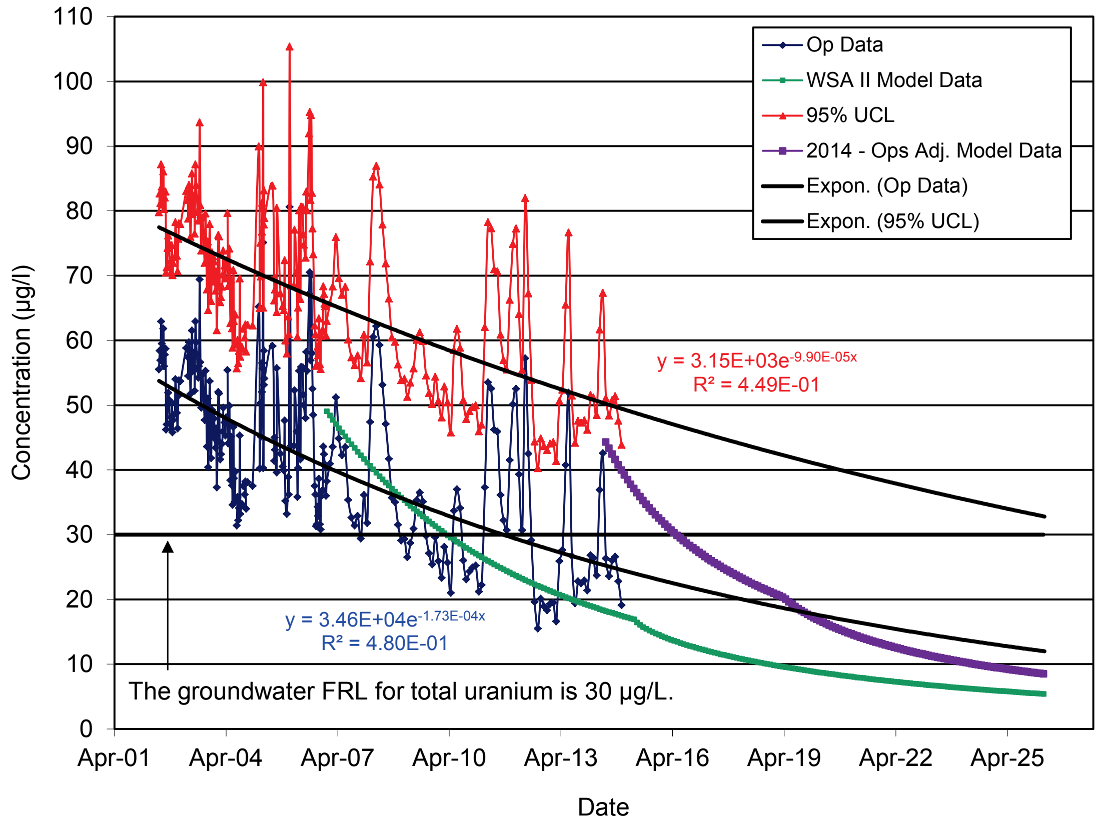

Figure A.1-33. Total Uranium Concentration Versus Time Plot for Extraction Well 33061 (EW-25) with Regression Analysis

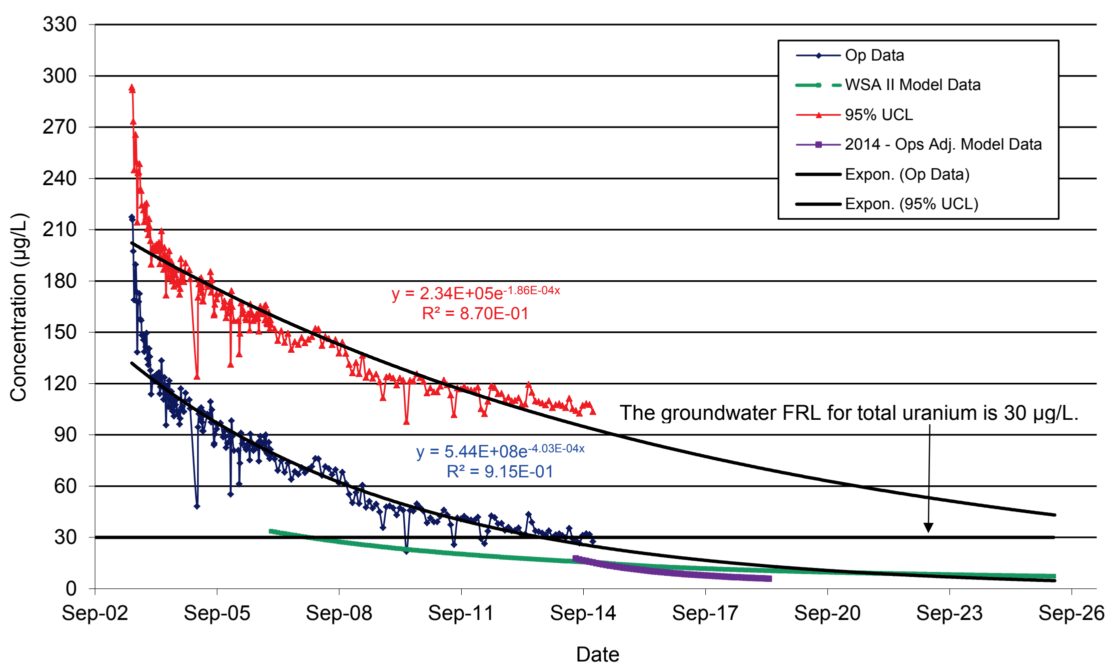

Figure A.1-34. Total Uranium Concentration Versus Time Plot for Extraction Well 33264 (EW-30) with Regression Analysis

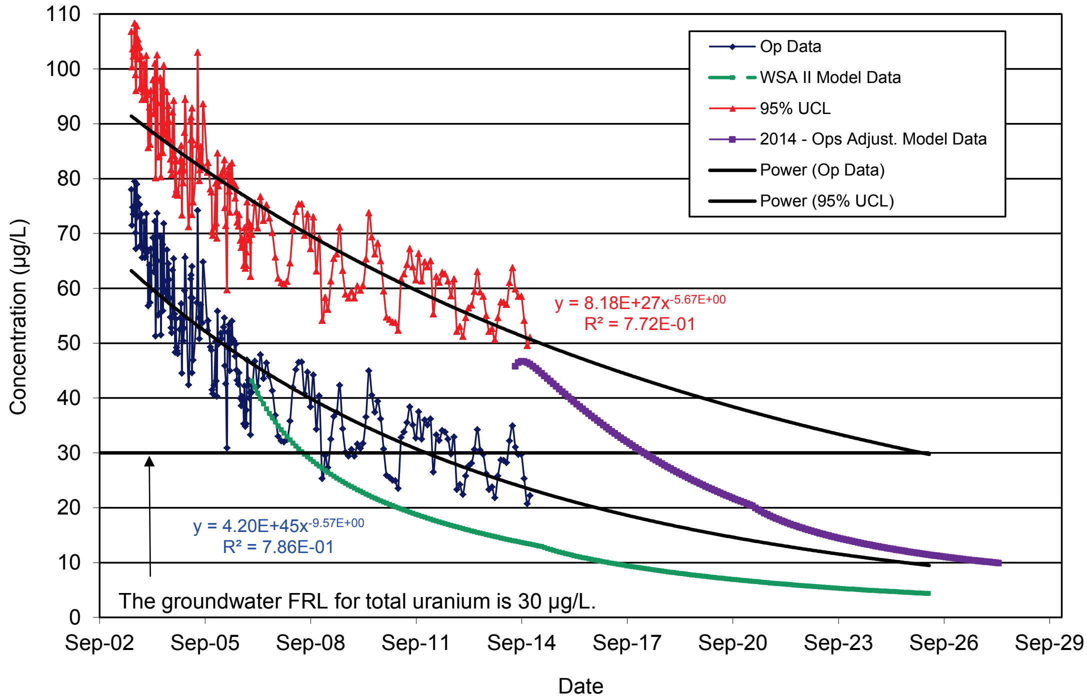

Figure A.1-35. Total Uranium Concentration Versus Time Plot for Extraction Well 33262 (EW-15a) with Regression Analysis

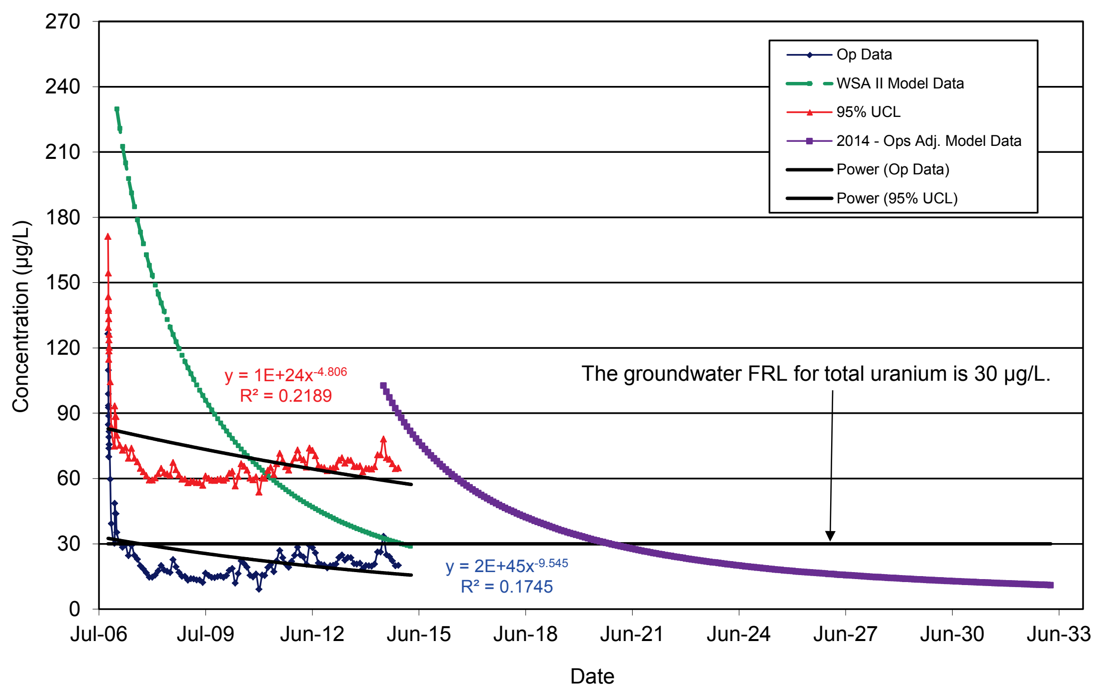

Figure A.1-36. Total Uranium Concentration Versus Time Plot for Extraction Well 33347 (EW-33a) with Regression Analysis

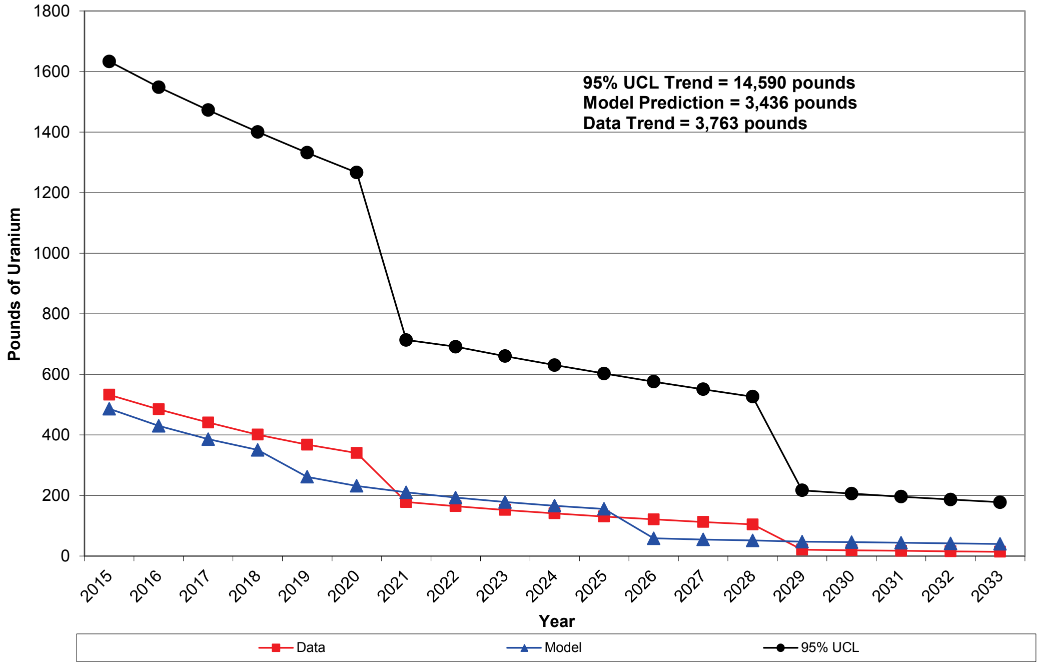

Figure A.1-37. Estimate of Yearly Pounds of Uranium to be Pumped from Aquifer (Model Predictions Versus Measured Concentration Trends) Data Collected Through 2014

Attachment A.2

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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
GMA	Great Miami Aquifer
IEMP	Integrated Environmental Monitoring Plan
Ohio EPA	Ohio Environmental Protection Agency
PPDD	Pilot Plant Drainage Ditch
WSA	Waste Storage Area

Measurement Abbreviations

ft	feet
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 2014. 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 (GMA) 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). Both the area of the aquifer targeted for remediation and 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* (DOE 2015). 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 in Figure A.2-1. In addition to the routine well monitoring specified in the IEMP, 27 locations were sampled using a direct-push sampling tool (Geoprobe) in 2014. Direct-push sampling results for the 27 locations (12405A, 12618D, 12827A, 12828A, 13234B, 13235B, 13237B, 13238B, 13308C, 13355A, 13421B, 13423A, 13425A, 13467, 13468, 13469, 13470, 13471, 13472, 13473, 13474, 13475, 13476, 13477, 13478, 13479, and 13480) are presented in Tables A.2-1 through A.2-27. 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 2014, 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.2-28 lists the monitoring wells where total uranium concentrations exceeded the 30 µg/L FRL during 2014. Included in the table are total uranium statistical summaries for each well, which include Mann-Kendall trend analyses. Table A.2-29 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.2-28 (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 2013 compared to the footprint of the 30 µg/L total uranium plume from the second half of 2014. Since the 2013 plume is highlighted in yellow, the yellow areas indicate areas where the plume was reduced for 2014. Acreage changes within the 30 µg/L footprint (i.e., area above 50 µg/L and area above 100 µg/L) are also tracked and reported. A breakdown for the past 2 years is provided below.

Comparison of 2013 and 2014 Maximum Uranium Plume Footprint Area

Year	Area > 30 µg/L	Area > 50 µg/L	Area > 100 µg/L
2013 (acres)	127.3	76.3	37.1
2014 (acres)	110.9	65.5	34.9
Difference (acres)	16.4	10.8	2.2
Difference (percent)	12.9%	14.2%	5.9%

Monitoring results are 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 of the three sections, information is presented concerning:

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

Section A.2.4 presents information concerning monitoring well maintenance.

A.2.1 Former Waste Storage Area

A.2.1.1 Former Waste Storage Area Maximum Uranium Plume

The mapped footprint of the 30 µg/L maximum uranium plume in the former Waste Storage Area (WSA) at the end of 2014 was reduced in size by approximately 1.5 acres compared to the mapped footprint at the end of 2013. The plume reductions were based on new monitoring well and direct-push sampling data obtained in 2014. At the end of 2013, the mapped footprint was estimated to be 20.6 acres. At the end of 2014, the mapped footprint was estimated to be 19.1 acres, a decrease of 7.3 percent. The area of reduction is shown in yellow in Figure A.2-5.

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

Direct-push sampling was conducted in 2014 at four locations in the former WSA (locations 13467, 13480, 13469, and 12618D). Sampling results are provided in Tables A.2-1 through A.2-4. Locations 13467 and 13480 were located within a ground surface swale located on the west side of the former WSA. Location 13469 was located just east of extraction well 33347. Location 12618D was located within a small lobe of the uranium plume located between the main plume to the north and the PPDD plume to the south.

<u>Location 13467</u>
Direct-push sampling location 13467 is located in the northwest corner of the former WSA in a ground surface swale. In the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014), it was reported that between 2008 and 2013 the maximum uranium concentration in the GMA at a location just east (and downgradient) of this swale (location 13374) increased from 74.0 µg/L (13374) to 293 µg/L (13374A), approximately 296 percent. Location 13467 was selected in 2014 to identify the western extent of the 30 µg/L maximum uranium plume in the area. Soil samples were also collected at location 13467 to verify that the thickness of the glacial till in the site conceptual model for this area was correct. As presented in Appendix B, the uranium concentration of many of the surface water samples collected from this swale area exceeds the groundwater FRL.

Direct-push sampling results from location 13467 are provided in Table A.2-1. The location is identified in Figure A.2-3A. A maximum uranium concentration of 5.51 µg/L was measured at an elevation of 517 ft above mean sea level (amsl), indicating that the 30 µg/L maximum uranium plume does not extend west to this location. Four feet of glacial till was measured at location 13467 during the sampling event.

<u>Location 13480</u>
Direct-push sampling location 13480 is also located in the northwestern corner of the former WSA in the same swale as location 13467. Location 13480 is in an area of the surface swale where ponded water with elevated concentrations of uranium intermittently collects. The location was selected for sampling to determine if uranium might be infiltrating down into the GMA at this location. As discussed below, the thickness of the glacial till was also measured at location 13480 to verify that thickness of the glacial till in the site conceptual model for this area was correct.

Direct-push sampling results from location 13480 are provided in Table A.2-2. The location is identified in Figure A.2-3A. A maximum uranium concentration of 7.48 μg/L was measured at an elevation of 516 ft amsl, indicating that the 30 μg/L maximum uranium plume does not extend to this location. Two and one-half feet of glacial till was measured at location 13480 during the sampling event.

Thickness of Glacial Till in the Site Conceptual Model

As reported above, the thickness of the glacial till was measured at direct-push sampling locations 13467 and 13480 in 2014 in order to verify the thickness of the glacial till in the site conceptual model for the area beneath the surface swale. As reported in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014), the uranium concentration in the GMA at location 13374 had increased from 74.0 μg/L (13374) to 293 μg/L (13374A), approximately 296 percent, between 2008 and 2013. A small swale is located on the ground surface northwest of location 13374. Water intermittently ponds in this small swale and has elevated uranium concentrations. The swale is isolated from surface drainage features, so water in the swale either evaporates or infiltrates into the ground. It should be noted that if uranium infiltrates into the aquifer beneath the swale it is quickly captured by nearby extraction well 33347 and possess no threat to human health or the environment.

Given the proximity of this swale to the increasing uranium concentrations recorded at location 13374, it was decided to collect direct-push samples from the aquifer from beneath this swale in 2014 to determine if there could be a connection between it and the uranium concentration increases observed in the aquifer downgradient of the swale. Additionally, the information was used to verify the geologic interpretations for the area which indicated that approximately 2 to 4 ft of glacial till is present beneath the swale.

The thickness of the glacial till was measured at both direct-push locations. The updated conceptual model is provided in Figure A.2-6. The glacial till thickness measurements obtained in 2014 matched existing thickness interpretations for the area. Uranium concentration data in the aquifer indicates that the 30 μg/L maximum uranium plume originates very close to direct-push location 13347.

Location 13469

Direct-push sampling location 13469 is located east of extraction well 33347. Uranium concentration data collected in 2014 for this location are provided in Table A.2-3. The location is shown in Figure A.2-3A. As shown in Table A.2-3, the highest uranium concentration measured in 2014 was 39.6 μg/L.

The maximum uranium plume map for 2014 was not adjusted to honor this lower concentration for the 2014 interpretation. Location 13327, located to the south of this location, will be resampled first to determine if the uranium concentration measured at 13327 in 2005 (447 μg/L) has also decreased.

Location 12618D

Direct-push sampling location 12618D is located southeast of extraction well 33347. Uranium concentration data collected in 2014 for this location are provided in Table A.2-4. The location is shown in Figure A.2-3A. As shown in Table A.2-4, the highest uranium concentration measured in 2014 was 26.9 µg/L. This location was previously sampled in 1999, 2004, and 2011. Uranium concentration data for all four sampling dates are presented below.

Location 12618 (1999)		Location 12618B (2004)		Location 12618C (2011)		Location 12618D (2014)	
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)
515	31.0	519	50.5	514	117	515	26.9
506	6.00	510	10.9	504	7.89	505	16.1
496	7.20	500	7.50	494	11.2	495	8.35
486	0.90	490	4.10	484	8.26	485	9.81

The uranium concentration data indicates that the maximum uranium concentration increased between 1999 and 2011 from 31.0 µg/L to 117 µg/L, but in 2014 the maximum uranium concentration was 26.9 µg/L. The 2014 maximum uranium plume map was revised to honor the 2014 data.

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 2014 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. Monitoring well 83340_C1 is also identified in Table A.2-28 as having an increasing uranium concentration trend.

Figure A.2-7 is a time versus concentration graph for monitoring well 83340. The graph shows that the uranium concentrations for channel 1 were above 30.1 µg/L in 2014. Although the overall trend is up (based on a Mann-Kendell interpretation) the data indicates that concentrations have been trending down from a high of approximately 45 µg/L measured in 2011.

Figure A.2-8 is a time versus concentration graph for monitoring well 83341. The graph shows that the uranium concentrations for all channels of the well were below 30 µg/L in 2014.

Monitoring wells 83340 and 83341 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 in Figure A.2-4, four monitoring wells have increasing uranium concentration trends in the former WSA (i.e., 2649, 3821, 83337, and 83340). These same four wells were reported in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014) as having increasing concentration trends in 2013. Summary statistics for the four wells are provided in Table A.2-28. All four of these monitoring locations are within capture of the groundwater remediation system.

Figure A.2-9 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.2-10 is a uranium concentration versus time plot for monitoring well 83337. The increasing trend is shown for the shallowest channel in the well, channel 1. The increasing trends at these two monitoring wells (2649 and 83337_C1) are most likely to residual uranium contamination that is sorbed to aquifer sediments in the vadose zone. When water levels are high, higher uranium concentrations are measured.

Figure A.2-11 and Figure A.2-12 are uranium concentration versus time plots for monitoring wells 2821 and 3821, respectively. As shown in Table A.2-28 and in Figure A.2-12, monitoring well 3821 had a statistically significant "up" uranium concentration trend in 2014. Monitoring well 3821 is screened several feet beneath the water table. As shown in Figure A.2-12, since 2012, the uranium concentration in monitoring well 3821 is intermittently above 30 µg/L. 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.2-11, the uranium concentration at monitoring well 2821 has also increased slightly since 2012, but is still well below 30 µg/L. The U.S. Department of Energy (DOE) plans to continue to monitor this location to see if the trend in well 3821 continues. If the upward trend continues, then the increase may represent a small area of contamination that moved by the well in response to pumping.

Figure A.2-13 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. The area is also being targeted for direct-push sampling in 2015.

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 exceed groundwater FRLs.

High uranium concentrations in the northwest corner of the plume continue to be a concern. Additional direct-push sampling in 2014 provided data that indicates that the western extent of the 30 µg/L maximum uranium plume is properly identified. 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 surface water samples collected from this area exceeds 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, however, (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.

In 2014 groundwater modeling was conducted to determine the potential impact to predicted aquifer clean up times if uranium contaminated groundwater is infiltrating into the aquifer from the swale. A worst-case scenario was modeled based on the highest uranium concentration measured in ponded water within the swale and high infiltration rates. The conservative groundwater modeling scenario:

- Took no credit for attenuation of uranium in glacial till, or alluvium
- Input infiltration rates of 50 inches per year rather than 6 inches per year, and
- Input infiltrating total uranium concentration of 1,900 µg/L, which is the highest total uranium concentration measured in ponded water within the swale between 2007 and 2014.

Modeling under these extreme conditions had no impact to model predicted cleanup times for the aquifer in this area. DOE will continue to work with the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (EPA) to determine the best path forward for remediation of the aquifer in this area given its unique challenge with having contamination in the vadose zone.

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

One direct-push sample was collected in the PPDD Area in 2014 (location 13468). Uranium concentration data collected in 2014 at location 13468 are provided in Table A.2-5. Location 13468 is shown in Figure A.2-3A.

In the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014) this location was mapped as having a uranium concentration above 200 µg/L. As shown in Table A.2-5 the maximum uranium concentration measured at this location in 2014 was 159 µg/L. Map contours were adjusted to honor this new concentration measurement.

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 2014 in the former PPDD Area (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.2-14. The figure shows that uranium concentrations measured in 2014 were below the uranium groundwater FRL for all monitoring channels. This well will continue to be identified on maximum uranium plume maps 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 in Table A.2-28, one monitoring well had an increasing uranium concentration trend in 2014 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 4 is the fourth channel. Summary statistics for monitoring well 83124_C4 are provided in Table A.2-28.

Figure A.2-15 is a uranium concentration versus time plot for all of the channels in monitoring well 83124. This well was also reported in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014) as having an increasing concentration trend. 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 was consistently near or above 200 µg/L since 2001; however, during the second half of 2014 the concentration was below 200 µg/L. 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 2014 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.2-28).

Figure A.2-16 is a uranium concentration versus time plot for uranium at monitoring well 2389 that shows that between 2002 and 2010 sporadic uranium FRL exceedances were detected at this well. As discussed below, FRL exceedances are detected in this area when the water elevation is approximately 515 ft amsl or higher. Since 2011, water levels have been at or near 515 ft amsl and the uranium FRL exceedances have been consistent. In 2014, uranium concentrations were above 50 µg/L. As shown in Figure A.2-16, the water level during both sampling events was approximately 515 ft amsl.

Previous direct-push sampling in this area indicates that the 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	< 1.00	512
2008	13360A	37.2	515
2010	13360B	4.40	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 15 acres in 2014, compared to 2013. In 2013, the mapped footprint was estimated to be 106.8 acres. In 2014, the mapped footprint is estimated to be 91.8 acres, a decrease of 14 percent (Figure A.2-5).

The footprint of the plume greater than 50 µg/L was reduced from 62.4 acres in 2013 to 52.4 acres in 2014; a decrease of 10 acres (16 percent). The footprint of the plume greater than 100 µg/L was reduced from 27.3 acres in 2013 to 25.5 acres in 2014, a decrease of 1.8 acres (6.6 percent).

A.2.3.1 South Field

The plume reductions noted above were based on new monitoring well and direct-push sampling data obtained in 2014. In 2014, direct-push sampling was conducted at 12 locations in the South Field (locations 12405A, 12827A, 12828A, 13355A, 13470, 13471, 13472, 13473, 13474, 13475, 13476, and 13479).

For reporting purposes the 12 locations are grouped into two areas: (1) former Flyash Pile Area (three locations) and (2) main South Field plume (nine locations).

A.2.3.1.1 New Direct-Push Sampling Data in the Former Flyash Pile Area of the South Field

In 2014, three locations were sampled in the former Flyash Pile Area (12827A, 12405A, and 12828A. All three locations had been sampled in previous years.

Location 12827A
This location is in the former Flyash Pile Area of the South Field and was first sampled in 2001. The sample collected in 2001 was identified as location 12827. The sample collected in 2014 is identified as 12827A. Direct-push sampling results for location 12827A are provided in Table A.2-6. The location is identified in Figure A.2-3A. Uranium concentrations from 2001 and 2014 are provided below.

Location 12827 (2001)		Location 12827A (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
512	180	514	369
503	29.0	504	44.3
493	22.0	494	26.3
483	26.0	484	21.1
493	18.0	474	10.8

The maximum uranium concentration at this location has increased from 180 µg/L in 2001 (elevation of 512 ft amsl) to 369 µg/L in 2014 (elevation of 514 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly. The increase in uranium concentration is attributed to contamination being pulled past the location to nearby extraction wells.

Location 12405A
This location is in the former Flyash Pile Area of the South Field and was first sampled in 1999. The sample collected in 1999 was identified as location 12405. The sample collected in 2014 is identified as 12405A. Direct-push sampling results for location 12405A are provided in Table A.2-7. The location is identified in Figure A.2-3A. Uranium concentrations from 1999 and 2014 are provided below.

Location 12405 (1999)		Location 12405A (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
516	208	515	28.6
507	110	505	16.4
497	35.0	495	10.3
487	9.20	485	17.2

The maximum uranium concentration at this location has decreased from 208 µg/L in 1999 (elevation of 516 ft amsl) to 28.6 µg/L in 2014 (elevation of 515 ft amsl). Map contours were not adjusted to honor this lower value. The total uranium concentration at nearby monitoring well 2385 was approximately 150 µg/L in 2013 and was 83.7 µg/L in the second half of 2014. Additional data will be collected in 2015 to determine if the plume interpretation can be adjusted in this area.

Location 12828A

This location is in the former Flyash Pile Area of the South Field. This direct-push location was first sampled in 2001. The sample collected in 2001 was identified as location 12828. The sample collected in 2014 is identified as location 12828A. Direct-push sampling results for location 12828A are provided in Table A.2-8. The location is identified in Figure A.2-3A. Uranium concentrations from 2001 and 2014 are provided below.

Location 12828 (2001)		Location 12828A (2014)	
Midpoint Screen Elevation (ft amsl)	**Uranium (µg/L)**	**Midpoint Screen Elevation (ft amsl)**	**Uranium (µg/L)**
510	224	516	270
503	65.0	506	38.8
493	20.0	496	14.5
483	22.0	486	3.80
473	1.90	476	<1.0

The maximum uranium concentration at this location has increased from 224 µg/L in 2001 (elevation of 510 ft amsl) to 270 µg/L in 2014 (elevation of 516 ft amsl). Map contours honor the higher 2014 value. The 2014 sample was collected at a higher elevation than the 2001 sample. The former Flyash Pile Area is a former source area where contamination is known to be sorbed to aquifer sediments in the vadose zone.

A.2.3.1.2 New Direct-Push Sampling Data within the South Field Uranium Plume

In 2014, uranium concentration data collected were collected at nine locations in the main South Field plume, outside of the former Flyash Pile Area (locations 13355A, 13470, 13471, 13472, 13473, 13474, 13475, 13476, and 13479). Data from the locations was used to refine concentration interpretations within the 30 µg/L total uranium plume in the South Field.

Location 13355A

Direct-push location 13355 was first sampled in 2006. The sample collected in 2006 was identified as location 13355. The sample collected in 2014 is identified as location 13355A. Direct-push sampling results for location 13355A are provided in Table A.2-9. The location of 13355A is identified in Figure A.2-3A. Uranium concentrations from 2006 and 2014 are provided below.

Location 13355 (2006)		Location 13355A (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
		512	38.9
506	79.3	502	30.4
496	39.4	492	13.0
486	10.4	482	5.40

The maximum uranium concentration at this location has decreased from 79.3 µg/L in 2006 (elevation of 506 ft amsl) down to 38.9 µg/L in 2014 (elevation of 512 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13470

Direct-push sampling location 13470 is located in South Field, between extraction wells 31550 and 32447. Direct-push sampling results for location 13470 are provided in Table A.2-10. The location is identified in Figure A.2-3A. As shown in Table A.2-10 the maximum uranium concentration measured in 2014 at this location was 103 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13471

Direct-push sampling location 13471 is located in South Field, north of location 13470. Direct-push sampling results for location 13471 are provided in Table A.2-11. The location is identified in Figure A.2-3A. As shown in Table A.2-11 the maximum uranium concentration measured in 2014 at this location was 205 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13472

Direct-push sampling location 13472 is located in South Field, between extraction wells 31561 and 33298. Direct-push sampling results for location 13472 are provided in Table A.2-12. The location is identified in Figure A.2-3A. As shown in Table A.2-12 the maximum uranium concentration measured in 2014 at this location was 183 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13473

Direct-push sampling location 13473 is located in the southeastern corner South Field, just immediately north of Willey Road. Direct-push sampling results for location 13473 are provided in Table A.2-13. The location is identified in Figure A.2-3A. As shown in Table A.2-13 the maximum uranium concentration measured in 2014 at this location was 64.7 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13474

Direct-push sampling location 13474 is located in the east side of the South Field between extraction wells 31561 and 33264. Direct-push sampling results for location 13474 are provided in Table A.2-14. The location is identified in Figure A.2-3A. As shown in Table A.2-14 the maximum uranium concentration measured in 2014 at this location was 142 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13475
Direct-push sampling location 13475 is located in the east side of the South Field north of location 13474. Direct-push sampling results for location 13475 are provided in Table A.2-15. The location is identified in Figure A.2-3A. As shown in Table A.2-15 the maximum uranium concentration measured in 2014 at this location was 58.1 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13476
Direct-push sampling location 13476 is located in about the center of the South Field, west of extraction well 31550 and 31560. Direct-push sampling results for location 13476 are provided in Table A.2-16. The location is identified in Figure A.2-3A. As shown in Table A.2-16 the maximum uranium concentration measured in 2014 at this location was 22.1 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13479
Direct-push sampling location 13479 is located in the north part of the South Field, west of extraction well 33061. Direct-push sampling results for location 13479 are provided in Table A.2-17. The location is identified in Figure A.2-3A. As shown in Table A.2-17 the maximum uranium concentration measured in 2014 at this location was 29.0 µg/L. The 2014 maximum uranium concentration is posted on the 2014 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.2-28, five monitoring wells had "up" trends for uranium concentrations in 2014: monitoring wells 2045, 23275, 2387, 83294_C1, and 83295_C6. It should be noted that these are the same five wells that were identified as having "up" concentration trends in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014). Time versus uranium concentration plots for these five wells are provided in Figures A.2-17 through A.2-21, respectively.

The uranium concentration 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.2-17, 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 the South Plume

In 2014, direct-push sampling was conducted at 10 locations in the South Plume (13234B, 13235B, 13237B, 13238B, 13308C, 13421B, 13423A, 13425A, 13477, and 13478). Sampling locations are shown in Figure A.2-3A. Sampling results are discussed below.

For reporting purposes, the sampling locations are grouped into three areas: northwest, southeast, and northeast.

<u>Northwest Portion of the South Plume</u>
In 2014, three locations were sampled in the northwest portion of the South Plume (location 13235B, 13478, and 13238B). Results were used to adjust the footprint of the 30 µg/L maximum uranium plume map shown in Figures A.2-3A and A.2-3B.

<u>Location 13235B</u>
Location 13235B is located in the northwestern portion of the South Plume. This location was originally sampled in 2002 with a follow-up sampling in 2006. The location sampled in 2002 was identified as 13235. The location sampled in 2006 was identified as 13235A. The location sampled in 2014 is identified as 13235B. Direct-push sampling results for location 13235B are provided in Table A.2-18. The location is identified in Figure A.2-3A. Uranium concentration data from 2002, 2006, and 2014 are provided below.

Location 13235 (2002)		Location 13235A (2006)		Location 13235B (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
514	45.6	510	31.5	514	15.5
505	36.0	500	9.80	504	17.2
495	18.4	490	7.20	494	7.80
485	12.9	480	5.50		

The maximum uranium concentration at this location has decreased from 45.6 µg/L in 2002 (elevation of 514 ft amsl) to 15.5 µg/L in 2014 (elevation of 514 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Monitoring well 2550 is located approximately 125 ft west of location 13235B. Figure A.2-22 is a uranium concentration versus time plot for monitoring well 2550. As shown in Figure A.2-22, the uranium concentration at monitoring well 2550 is trending down, but there was an FRL exceedance for uranium in the first half of 2014 (33.9 µg/L). Additional direct-push sampling will be conducted in this area in 2015.

Location 13478

Direct-push sampling location 13478 is located in the northwest corner of the South Plume. Direct-push sampling results for location 13478 are provided in Table A.2-19. The location is identified in Figure A.2-3A. As shown in Table A.2-19 the maximum uranium concentration measured in 2014 at this location was 26.2 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13238B

Direct-push sampling location 13238B is located in the northwestern portion of the South Plume. This location was originally sampled in 2002 and was sampled again in 2013. The location sampled in 2002 was identified as location 13238. The location sampled in 2013 was identified as location 13238A. The sample collected in 2014 is identified as location 13238B. Direct-push sampling results for location 13238B are provided in Table A.2-20. The location is identified in Figure A.2-3A. Uranium concentrations from 2002, 2013, and 2014 are provided below.

Location 13238 (2002)		Location 13238A (2013)		Location 13238B (2014)	
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	78.4	511	51.0	513	3.10
507	84.5	501	20.7	503	22.2
497	73.8	491	15.2	493	19.7
487	38.9	481	12.9		
477	8.80	471	13.3		

The maximum uranium concentration at this location has decreased from 84.5 µg/L in 2002 (elevation of 507 ft amsl) to 22.2 µg/L in 2014 (elevation of 503 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Southeast Portion of the South Plume

In 2014, two locations were sampled in the southeast corner of the South Plume (13234B and 13308C). Results were used to adjust the footprint of the 30 µg/L maximum uranium plume map shown in Figure A.2-3A and A.2-3B.

Location 13234B

This location is located in the southeast corner of the South Plume. This location was originally sampled in 2002 and was sampled a second time in 2013. The location sampled in 2002 was identified as location 13234. The location sampled in 2013 was identified as location 13234A. The location sampled in 2014 is identified as location 13234B. Direct-push sampling results for location 13234B are provided in Table A.2-21. The location is identified in Figure A.2-3A. Uranium concentrations from 2002, 2013, and 2014 are provided below.

Location 13234 (2002)		Location 13234A (2013)		Location 13234B (2014)	
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	6.10	515	32.8	511	15.6
507	32.0	505	37.8	501	28.4
497	12.0	495	2.70	491	11.6
487	2.40				

The maximum uranium concentration at this location has decreased between 2002 and 2014. The maximum uranium concentration was 32.0 µg/L in 2002 (elevation of 507 ft amsl) and 28.4 µg/L in 2014 (elevation of 501 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13308C

This location is located in the southeast corner of the South Plume. This location was sampled in 2003, 2009, 2013, and 2014. The location sampled 2003 was identified as location 13308. The location sampled in 2009 was identified as location 13308A. The location sampled in 2013 was identified as location 13308B. The location sampled in 2014 is identified as location 13308C. Direct-push sampling results for location 13308C are provided in Table A.2-22. The location is identified in Figure A.2-3A. Uranium concentrations for each year are provided below.

Location 13308 (2003)		Location 13308A (2009)		Location 13308B (2013)		Location 13308C (2014)	
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)
512	39.5	513	31.2	510	22.0	512	24.9
503	67.6	503	32.8	500	38.6	502	55.6
493	22.1	493	2.10	490	6.00	492	37.4
483	3.10	483	2.60	480	3.10	482	1.20

The maximum uranium concentration at this location has fluctuated between 2003 and 2014 from 67.6 µg/L to 32.8 µg/L, but has never decreased to a concentration below the groundwater FRL of 30 µg/L. As shown in Figure A.2-5, direct-push sampling in 2013 indicates that the area north of location 13308C is below 30 µg/L. The 2014 maximum uranium concentration for location 13308C is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly. Based on the 2014 maximum uranium results (55.6 µg/L) the location was mapped for 2014 as being above 50 µg/L, but separated from the rest of the South Plume to the north.

Northeast corner of the South Plume

In 2014, five locations were sampled in the northeast corner of the South Plume just south of Willey Road (13421B, 13423A, 13477, 13237B, and 13425A).

Location 13421B

Location 13421B is located in the northeast corner of the South Plume. The first location sampled in 2011 was identified as location 13421A. The location sampled in 2014 is identified as location 13421B. Direct-push sampling results for location 13421B are provided in Table A.2-23. The location is identified in Figure A.2-3A. Uranium concentrations from 2011 and 2014 are provided below.

Location 13421A (2011)		Location 13421B (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
514	3.70	513	6.40
504	116	503	111
494	216	493	253
484	82.3	483	93.6
474	5.10	473	4.90
464	3.50	463	15.6
454	7.20	453	9.80

The maximum uranium concentration at this location increased from 216 µg/L in 2011, to 253 µg/L in 2014. The increase is attributed to contamination moving toward extraction wells due to pumping in the area. In 2014, the extraction rates at several wells in the area were increased. DOE plans to continue sampling in this area to track cleanup progress, and to see if the increased pumping rates in the area are working to decrease the uranium concentration.

Location 13423A

Location 13423A is in the northeast corner of the South Plume. This location was first sampled in 2011. The sample in 2011 was identified as location 13423. The sample collected in 2014 is identified as location 13423A. Direct-push sampling results for location 13423A are provided in Table A.2-24. The location is identified in Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13423 (2011)		Location 13423A (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
514	1.20	514	<1.00
504	3.70	504	22.4
494	73.7	494	1.40
484	16.0	484	47.2
474	3.90	474	12.2

The maximum uranium concentration at this location has decreased from 73.7 µg/L in 2011 (elevation of 494 ft amsl) to 47.2 µg/L in 2014 (elevation of 484 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13477

Location 13477 is in the northeast corner of the South Plume. Direct-push sampling results for location 13477 are provided in Table A.2-25. The location is identified in Figure A.2-3A. As shown in Table A.2-25 the maximum uranium concentration measured in 2014 at this location was 58.6 µg/L. The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13425A

Location 13423A is in the northeast corner of the South Plume. This location was first sampled in 2011. The location sampled in 2011 was identified as location 13425. The location sampled in 2014 is identified as location 13425A. Direct-push sampling results for location 13425A are provided in Table A.2-26. The location is identified in Figure A.2-3A. Uranium concentrations from both sampling dates are provided below.

Location 13425 (2011)		Location 13425A (2014)	
Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)	Midpoint Screen Elevation (ft amsl)	Uranium (µg/L)
513	2.60	511	8.00
503	20.7	501	20.8
493	49.0	491	36.9
483	17.3	481	3.90

The maximum uranium concentration at this location decreased from 49.0 µg/L in 2011 (elevation of 493 ft amsl) to 36.9 µg/L in 2014 (elevation of 491 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

Location 13237B

Location 13237B is in the northeast corner of the South Plume. This location was originally sampled in 2002 and was sampled again in 2007. The location sampled in 2002 was identified as location 13237. The location sampled in 2007 was identified as location 13237A. The location sampled in 2014 is identified as location 13237B. Direct-push sampling results for location 13237B are provided in Table A.2-27. The location is identified in Figure A.2-3A. Uranium concentrations from all sampling events are provided below.

Location 13237 (2002)		Location 13237A (2007)		Location 13237B (2014)	
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	9.5			512	30.4
509	80.0	510	22.7	502	29.5
499	92.2	500	85.6	492	22.5
489	33.9	490	22.6	482	25.5
479	16.0	480	5.20	472	13.9

The maximum uranium concentration at this location has decreased from 92.2 µg/L in 2002 (elevation of 499 ft amsl) to 30.4 µg/L in 2014 (elevation of 512 ft amsl). The 2014 maximum uranium concentration is posted on the 2014 maximum uranium plume map and map concentration contours are adjusted accordingly.

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 2014 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.2-23. The figure shows that a uranium FRL exceedance was measured at this location in the second half of 2014 (32.6 µg/L). This is the first exceedance measured since 2004.

A time versus uranium concentration plot for monitoring well 2900 is provided in Figure A.2-24. 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.2-28, two monitoring wells (monitoring wells 2880 and 82369_C1) had "up" uranium concentration trends in 2014. These same two wells were also reported as having increasing uranium concentration trends in the *Fernald Preserve 2013 Site Environmental Report* (DOE 2014).

Monitoring Well 2880

Table A.2-28 and Figure A.2-4 show that uranium concentrations at monitoring well 2880 had an "up" trend in 2014. Figure A.2-25 is a time versus concentration graph 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.2-28 and Figure A.2-4 show that channel 1 in monitoring well 82369 had an "up" trend for uranium concentrations in 2014. Figure A.2-26 is a time versus concentration plot for all three channels in monitoring well 82369. As the figure shows, the uranium concentrations in channel 1 had been increasing since monitoring began in 2012, but in 2014, the concentration decreased.

Prior to 2012, this location was monitored using a direct-push sampling tool. The location was identified at location 12369. Between 2001 and 2011, location 12369 was sampled 16 times using direct-push methods. 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 measured in channel 1 of monitoring well 82369 ranged from 151 µg/L to 210 µg/L. In 2014, the maximum uranium concentration decreased to 93.6 µg/L. Because this location is within capture of the groundwater remediation system, the increasing/changing concentration trend is attributed to shifting uranium concentrations in response to nearby pumping.

A.2.4 Monitoring Well Inspection and Maintenance

All monitoring wells were inspected in 2014 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.2.5 References

DOE (U.S. Department of Energy), 1995. *Remedial Investigation Report for Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, March.

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), 2001. *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas*, Draft Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2006. *Fernald Groundwater Certification Plan*, Revision 2, Final, prepared by Fluor Fernald, Inc., August.

DOE (U.S. Department of Energy), 2014. *Fernald Preserve 2013 Site Environmental Report*, LMS/FER/S11109, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2015. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 8, Office of Legacy Management, January.

Table A.2-1. Geoprobe Location 13467

Easting '83:	**1346295**	feet
Northing '83:	**481602**	feet
Ground Elevation:	**551**	feet above mean sea level (AMSL)
Depth to Water Table:	**29.0**	feet below ground surface (BGS)
Water Table Elevation:	**522**	feet AMSL
Work Completed:	**5/29/2014**	

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	34	0-10	5.51	5.16	4.75	2.19	1.01	0.0507	0.0124	19.0	7.51	0.798	>1000	11.2	6.63
2	507	44	10-20	1.81	1.80	4.12	1.43	0.776	0.0557	0.0123	21.7	7.79	0.684	112	5.35	6.00
3	497	54	20-30	1.69	1.58	6.02	1.70	0.372	0.119	0.00360	17.3	7.15	0.652	11.3	4.65	3.78
4	487	64	30-40	2.52	1.61	7.36	0.085	0.302	0.0172	0.00279	18.9	7.51	0.679	80.4	5.54	5.48

[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 13480

Easting '83:	**1346423**	feet
Northing '83:	**481779**	feet
Ground Elevation:	**552**	feet above mean sea level (AMSL)
Depth to Water Table:	**30.5**	feet below ground surface (BGS)
Water Table Elevation:	**521**	feet AMSL
Work Completed:	**7/9/2014**	

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	36	0-10	2.85	7.48	5.12	0.600	0.877	0.0265	0.0185	18.9	6.63	0.933	>1000	545	7.97
2	506	46	10-20	1.68	1.81	-7.79	1.10	0.328	0.0309	0.0136	17.9	7.40	0.723	>1000	382	7.13
3	496	56	20-30	1.67	1.59	5.14	0.085	0.210	0.0223	0.0071	17.9	6.59	0.681	>1000	49.2	7.28
4	486	66	30-40	4.80	4.40	4.32	0.085	0.410	0.0110	0.00	15.0	7.17	0.720	>1000	185	6.01

[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 13469

Easting '83:	**1346781**	feet
Northing '83:	**481006**	feet
Ground Elevation:	**569**	feet above mean sea level (AMSL)
Depth to Water Table:	**48.5**	feet below ground surface (BGS)
Water Table Elevation:	**520**	feet AMSL
Work Completed:	**5/19/2014**	

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] (°C)	pH[a] (SU)	Specific Conductance[a] (mS/cm)	Turbidity (NTU)	Turbidity[a] (NTU)	Dissolved Oxygen[a] (mg/L)
1	515	54	0-10	39.6	33	-0.314	1.11	0.550	0.0386	0.00734	14.9	6.79	0.793	>1000	5.93	6.92
2	505	64	10-20	4.54	3.57	-2.34	1.17	0.194	0.0201	0.00445	12.9	7.11	0.643	>1000	2.66	6.24
3	495	74	20-30	4.55	2.42	-3.05	0.457	0.232	0.0187	0.00700	11.6	6.95	0.746	>1000	11.9	4.68
4	485	84	30-40	1.00	<1.00	-3.91	0.256	0.365	0.0187	0.00837	13.6	7.14	0.664	>1000	3.23	5.20

[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 12618D

Easting '83:	**1347182**	feet
Northing '83:	**480412**	feet
Ground Elevation:	**579**	feet above mean sea level (AMSL)
Depth to Water Table:	**58.5**	feet below ground surface (BGS)
Water Table Elevation:	**520**	feet AMSL
Work Completed:	**5/15/2014**	

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] (°C)	pH[a] (SU)	Specific Conductance[a] (mS/cm)	Turbidity (NTU)	Turbidity[a] (NTU)	Dissolved Oxygen[a] (mg/L)
1	515	64	0-10	26.9	23.9	1.19	0.660	0.303	0.0826	0.00573	13.0	5.80	0.733	>1000	16.3	7.02
2	505	74	10-20	16.1	12.8	-0.0886	1.180	0.383	0.0352	0.00647	13.0	6.53	0.706	>1000	46.8	7.88
3	495	84	20-30	8.35	6.16	-2.20	0.640	0.130	0.0304	0.00480	12.9	6.80	0.706	>1000	>1000	6.41
4	485	94	30-40	9.81	9.21	-6.90	0.520	0.133	0.0202	0.00150	13.0	6.74	0.604	>1000	>1000	5.83

[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.2-5. Geoprobe Location 13468

Easting '83:	**1346993**	feet
Northing '83:	**479937**	feet
Ground Elevation:	**570**	feet above mean sea level (AMSL)
Depth to Water Table:	**50.0**	feet below ground surface (BGS)
Water Table Elevation:	**520**	feet AMSL
Work Completed:	**6/3/2014**	

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	515	55	0-10	159	14.3	6.76	1.10	>1000	422	7.56
2	505	65	10-20	63.4	14.0	6.96	0.864	>1000	179	7.98
3	495	75	20-30	24.4	15.4	6.61	0.734	>1000	57.3	7.28
4	485	85	30-40	15.4	14.6	6.78	0.595	>1000	222	7.13

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

Table A.2-6. Geoprobe Location 12827A

Easting '83: 1348274 feet
Northing '83: 477921 feet
Ground Elevation: 568 feet above mean sea level (AMSL)
Depth to Water Table: 49 feet below ground surface (BGS)
Water Table Elevation: 519 feet AMSL
Work Completed: 6/18/2014

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	44	0-10	369	15.1	6.68	0.797	>1000	236	6.85
2	504	54	10-20	44.3	17.7	7.22	0.682	>1000	42.3	7.14
3	494	64	20-30	26.3	16.4	7.11	0.689	>1000	999	7.62
4	484	74	30-40	21.1	16.1	7.01	0.650	>1000	105	7.42
5	474	84	40-50	10.8	17.8	7.58	0.593	>1000	214	4.54

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

Table A.2-7. Geoprobe Location 12405A

Easting '83:	**1348496**	feet
Northing '83:	**477964**	feet
Ground Elevation:	**577**	feet above mean sea level (AMSL)
Depth to Water Table:	**57.0**	feet below ground surface (BGS)
Water Table Elevation:	**520**	feet AMSL
Work Completed:	**5/27/2014**	

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	515	62	0-10	28.6	17.6	6.96	1.13	>1000	64.4	7.20
2	505	72	10-20	16.4	15.4	6.85	0.679	>1000	133	5.51
3	495	82	20-30	10.3	15.6	7.08	0.648	>1000	116	6.48
4	485	92	30-40	17.2	15.9	7.09	0.629	>1000	368	4.60

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

Table A.2-8. Geoprobe Location 12828A

Easting '83:	**1348328**	feet
Northing '83:	**477803**	feet
Ground Elevation:	**576**	feet above mean sea level (AMSL)
Depth to Water Table:	**55.0**	feet below ground surface (BGS)
Water Table Elevation:	**521**	feet AMSL
Work Completed:	**6/16/2014**	

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^0C)	pH filtered[a] (SU)	Specific Conductance filtered[a] (mS/cm)	Turbidity unfiltered (NTU)	Turbidity filtered[a] (NTU)	Dissolved Oxygen filtered[a] (mg/L)
1	516	60	0-10	270	17.2	7.29	0.810	>1000	450	6.88
2	506	70	10-20	38.8	16.7	7.56	0.640	>1000	266	5.30
3	496	80	20-30	14.5	16.6	7.49	0.614	>1000	>1000	5.20
4	486	90	30-40	3.80	16.5	7.45	0.638	>1000	56.0	3.65
5	476	100	40-50	<1.00	15.5	7.47	0.626	>1000	32.7	3.85

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

Table A.2-9. Geoprobe Location 13355A

Easting '83:	**1348982**	feet
Northing '83:	**477358**	feet
Ground Elevation:	**568**	feet above mean sea level (AMSL)
Depth to Water Table:	**51.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**7/1/2014**	

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^0C)	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	57	0-10	38.9	16.9	6.78	0.624	>1000	482	7.82
2	502	67	10-20	30.4	16.2	6.80	0.677	>1000	107	8.06
3	492	77	20-30	13.0	16.7	6.96	0.722	>1000	23.5	6.88
4	482	87	30-40	5.40	15.4	6.77	0.682	>1000	>1000	6.22

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

Table A.2-10. Geoprobe Location 13470

Easting '83:	**1349157**	feet
Northing '83:	**477150**	feet
Ground Elevation:	**575**	feet above mean sea level (AMSL)
Depth to Water Table:	**58.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**5/13/2014**	

Sample Point	Elevation (ft AMSL)	Depth (ft BGS)	Sample Interval (ft)	Uranium filtered[a] (μg/L)	Temperature filtered[a] (^0C)	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	58	0-10	103	16.4	7.24	0.802	>1000	999	7.94
2	502	68	10-20	77.8	16.4	7.32	0.822	>1000	252	7.90
3	492	78	20-30	12.4	16.1	7.57	0.684	>1000	29.2	5.89
4	482	88	30-40	1.10	15.9	7.33	0.650	>1000	15.0	3.88
5	472	98	40-50	<1.0	15.8	7.57	0.644	>1000	201	3.24

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

Table A.2-11. Geoprobe Location 13471

Easting '83:	**1349306**	feet
Northing '83:	**477403**	feet
Ground Elevation:	**575**	feet above mean sea level (AMSL)
Depth to Water Table:	**58.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**4/29/2014**	

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	64	0-10	205	14.7	7.45	0.790	>1000	111	5.69
2	502	74	10-20	36.2	15.7	7.39	0.816	>1000	29.0	5.41
3	492	84	20-30	18.2	14.6	7.51	0.779	>1000	13.7	3.84
4	482	94	30-40	14.0	14.6	7.56	0.694	>1000	500	5.31
5	472	104	40-50	1.6	15.6	7.61	0.718	>1000	26.9	4.93

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

Table A.2-12. Geoprobe Location 13472

Easting '83:	**1349429**	feet
Northing '83:	**477824**	feet
Ground Elevation:	**573**	feet above mean sea level (AMSL)
Depth to Water Table:	**56.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**5/1/2014**	

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	62	0-10	183	12.6	6.73	1.49	>1000	361	8.29
2	502	72	10-20	97.3	12.9	6.73	1.12	>1000	999	5.70
3	492	82	20-30	94.3	13.6	6.98	0.887	>1000	235	5.00
4	482	92	30-40	25.2	12.8	7.19	0.724	>1000	17.2	5.50

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

Table A.2-13. Geoprobe Location 13473

Easting '83:	**1349415.661**	feet
Northing '83:	**476602.668**	feet
Ground Elevation:	**579**	feet above mean sea level (AMSL)
Depth to Water Table:	**61**	feet below ground surface (BGS)
Water Table Elevation:	**518**	feet AMSL
Work Completed:	**6/5/2014**	

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	66	0-10	1.20	14.7	7.35	0.926	>1000	999	7.56
2	503	76	10-20	2.40	15.3	7.33	1.01	>1000	932	6.23
3	493	86	20-30	58.6	14.5	7.28	0.907	>1000	125	5.34
4	483	96	30-40	64.7	14.6	7.34	0.885	>1000	255	5.13
5	473	106	40-50	8.50	15.0	7.40	0.872	>1000	999	5.41

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

Table A.2-14. Geoprobe Location 13474

Easting '83:	**1349554**	feet
Northing '83:	**477435**	feet
Ground Elevation:	**575**	feet above mean sea level (AMSL)
Depth to Water Table:	**56.5**	feet below ground surface (BGS)
Water Table Elevation:	**519**	feet AMSL
Work Completed:	**5/28/2014**	

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	62	0-10	142	15.7	6.79	1.36	>1000	682	6.40
2	504	72	10-20	74.1	15.3	6.82	1.11	>1000	258	4.75
3	494	82	20-30	67.6	15.6	6.80	0.991	>1000	599	4.96
4	484	92	30-40	108	15.2	6.93	0.840	>1000	684	5.19
5	474	102	40-50	72.8	15.6	7.25	0.725	>1000	668	4.89
6	464	112	50-60	29.6	15.9	7.04	0.550	>1000	999	4.97

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

Table A.2-15. Geoprobe Location 13475

Easting '83:	**1349669**	feet
Northing '83:	**477645**	feet
Ground Elevation:	**576**	feet above mean sea level (AMSL)
Depth to Water Table:	**58.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**6/30/2014**	

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	64	0-10	23.0	16.2	7.02	1.25	>1000	881	5.88
2	502	74	10-20	44.5	17.1	7.14	1.10	>1000	47.8	4.91
3	492	84	20-30	58.1	17.1	7.21	1.06	>1000	206	5.13
4	482	94	30-40	35.2	17.3	7.35	1.02	>1000	30.1	4.76
5	472	104	40-50	7.90	17.4	7.30	0.891	>1000	360	5.52

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

Table A.2-16. Geoprobe Location 13476

Easting '83:	1348671	feet
Northing '83:	477236	feet
Ground Elevation:	571	feet above mean sea level (AMSL)
Depth to Water Table:	50.5	feet below ground surface (BGS)
Water Table Elevation:	521	feet AMSL
Work Completed:	6/9/2014	

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	516	56	0-10	22.1	15.2	6.51	0.735	>1000	237	7.52
2	506	66	10-20	11.1	14.7	7.50	0.695	>1000	1000	4.77
3	496	76	20-30	5.10	14.3	7.60	0.673	>1000	1000	6.91
4	486	86	30-40	8.10	14.3	7.61	0.636	>1000	960	5.50

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

Table A.2-17. Geoprobe Location 13479

Easting '83:	1349186	feet
Northing '83:	478304	feet
Ground Elevation:	570	feet above mean sea level (AMSL)
Depth to Water Table:	55.5	feet below ground surface (BGS)
Water Table Elevation:	514	feet AMSL
Work Completed:	7/7/2014	

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	509	61	0-10	29.0	17.4	6.90	0.889	>1000	262	5.53
2	499	71	10-20	17.9	16.8	7.34	0.829	>1000	28.8	5.34
3	489	81	20-30	16.4	16.4	6.99	0.915	>1000	>1000	5.94
4	479	91	30-40	10.5	16.7	7.00	0.876	>1000	130	5.26
5	469	101	40-50	6.20	17.5	7.19	0.738	>1000	526	5.28

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

Table A.2-18. Geoprobe Location 13235B

Easting '83:	1348047	feet
Northing '83:	475819	feet
Ground Elevation:	536	feet above mean sea level (AMSL)
Depth to Water Table:	17	feet below ground surface (BGS)
Water Table Elevation:	519	feet AMSL
Work Completed:	4/21/2014	

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	22	0-10	15.5	15.3	7.22	0.707	>1000	54.1	9.10
2	504	32	10-20	17.2	19.0	7.76	0.864	>1000	226	6.20
3	494	42	20-30	7.80	17.8	7.61	0.800	>1000	65.8	5.65

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

Table A.2-19. Geoprobe Location 13478

Easting '83:	**1347992**	feet
Northing '83:	**475515**	feet
Ground Elevation:	**539**	feet above mean sea level (AMSL)
Depth to Water Table:	**21**	feet below ground surface (BGS)
Water Table Elevation:	**518**	feet AMSL
Work Completed:	**4/24/2014**	

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	513	26	0-10	26.2	18.2	7.30	0.926	>1000	>1000	7.94
2	503	36	10-20	13.3	16.4	7.38	0.814	>1000	365	6.60
3	493	46	20-30	9.70	14.9	7.67	0.767	>1000	69.7	5.46
4	483	56	30-40	6.50	14.5	7.54	0.812	>1000	26.3	4.60
5	473	66	40-50	4.20	13.9	7.51	0.689	>1000	802	4.71
6	463	76	50-60	<1.00	14.4	7.59	0.749	>1000	57.0	5.33

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

Table A.2-20. Geoprobe Location 13238B

Easting '83:	**1348082**	feet
Northing '83:	**475397**	feet
Ground Elevation:	**537**	feet above mean sea level (AMSL)
Depth to Water Table:	**19.5**	feet below ground surface (BGS)
Water Table Elevation:	**518**	feet AMSL
Work Completed:	**4/22/2014**	

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	25	0-10	3.10	17.7	7.60	0.816	>1000	>1000	11.0
2	503	35	10-20	22.2	16.1	7.66	0.839	>1000	262	11.1
3	493	45	20-30	19.7	14.6	7.54	0.754	>1000	642	9.53

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

Table A.2-21. Geoprobe Location 13234B

Easting '83:	**1349045**	feet
Northing '83:	**475201**	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:	**5/5/2014**	

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	15.6	14.8	7.21	1.09	>1000	12.1	6.61
2	501	79	10-20	28.4	14.5	7.37	0.820	>1000	17.5	4.46
3	491	89	20-30	11.6	14.6	7.55	0.682	>1000	19.5	4.14

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

Table A.2-22. Geoprobe Location 13308C

Easting '83: 1348968 feet
Northing '83: 474569 feet
Ground Elevation: 584 feet above mean sea level (AMSL)
Depth to Water Table: 67 feet below ground surface (BGS)
Water Table Elevation: 517 feet AMSL
Work Completed: 4/23/2014

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	72	0-10	24.9	13.8	6.99	0.793	>1000	462	7.02
2	502	82	10-20	55.6	13.9	7.28	0.749	>1000	999	5.26
3	492	92	20-30	37.4	14.5	7.31	0.743	>1000	777	5.63
4	482	102	30-40	1.20	15.5	7.25	0.773	>1000	715	4.69

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

Table A.2-23. Geoprobe Location 13421B

Easting '83:	**1349311**	feet
Northing '83:	**476025**	feet
Ground Elevation:	**571**	feet above mean sea level (AMSL)
Depth to Water Table:	**53**	feet below ground surface (BGS)
Water Table Elevation:	**518**	feet AMSL
Work Completed:	**5/20/2014**	

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	58	0-10	6.40	15.8	6.83	0.971	>1000	242	7.03
2	503	68	10-20	111	15.2	6.97	0.812	>1000	200	3.81
3	493	78	20-30	253	15.0	6.96	0.738	>1000	944	5.74
4	483	88	30-40	93.6	15.8	6.97	0.707	>1000	728	5.81
5	473	98	40-50	4.90	15.8	7.12	0.753	>1000	353	5.54
6	463	108	50-60	15.6	16.2	7.00	0.762	>1000	85.2	4.11
7	453	118	60-70	9.80	16.7	6.78	0.781	>1000	999	4.02

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

Table A.2-24. Geoprobe Location 13423A

Easting '83:	**1349406**	feet
Northing '83:	**476024**	feet
Ground Elevation:	**571**	feet above mean sea level (AMSL)
Depth to Water Table:	**51.5**	feet below ground surface (BGS)
Water Table Elevation:	**519**	feet AMSL
Work Completed:	**6/17/2014**	

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	57	0-10	<1.0	17.5	7.54	0.946	>1000	95.1	7.55
2	504	67	10-20	22.4	17.2	7.16	0.845	>1000	43.4	4.85
3	494	77	20-30	1.40	17.0	7.23	0.764	>1000	19.9	4.63
4	484	87	30-40	47.2	17.3	7.50	0.718	>1000	49.4	5.59
5	474	97	40-50	12.2	18.3	7.78	0.737	>1000	20.2	4.73

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

Table A.2-25. Geoprobe Location 13477

Easting '83:	**1349241**	feet
Northing '83:	**475822**	feet
Ground Elevation:	**580**	feet above mean sea level (AMSL)
Depth to Water Table:	**63**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**5/6/2014**	

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	68	0-10	1.40	14.1	7.29	1.07	>1000	152	8.24
2	502	78	10-20	31.8	14.4	7.33	0.923	>1000	12.7	7.23
3	492	88	20-30	58.6	14.4	7.39	0.813	>1000	999	6.11
4	482	98	30-40	2.60	14.1	7.64	0.714	>1000	24.1	4.50
5	472	108	40-50	2.70	15.2	7.51	0.786	>1000	340	5.03

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

Table A.2-26. Geoprobe Location 13425A

Easting '83:	**1349039**	feet
Northing '83:	**475679**	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:	**5/7/2014**	

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	8.00	16.1	7.06	0.952	>1000	824	6.92
2	501	78	10-20	20.8	17.0	7.40	0.910	>1000	104	6.10
3	491	88	20-30	36.9	15.8	7.12	0.834	>1000	18.9	2.86
4	481	90	30-40	3.90	15.9	7.06	0.810	>1000	995	4.75
5	471	108	40-50	<1.00	16.8	7.22	0.745	>1000	221	4.85

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

Table A.2-27. Geoprobe Location 13237B

Easting '83:	**1348861**	feet
Northing '83:	**475804**	feet
Ground Elevation:	**576**	feet above mean sea level (AMSL)
Depth to Water Table:	**58.5**	feet below ground surface (BGS)
Water Table Elevation:	**517**	feet AMSL
Work Completed:	**5/8/2014**	

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	64	0-10	30.4	19.0	6.97	1.01	>1000	1000	8.58
2	502	74	10-20	29.5	17.7	7.54	0.941	>1000	28.2	7.03
3	492	84	20-30	22.5	17.3	7.42	0.812	>1000	13.1	7.19
4	482	94	30-40	25.5	17.5	7.50	0.793	>1000	734	6.59
5	472	104	40-50	13.9	16.4	7.46	0.722	>1000	1000	6.20

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

Table A.2-28. Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2014 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	71	12.0	462	121	104	Up
2046	70	20	907	148	204	No Trend
2049	55	3.0	178	75.6	43.2	Down
2060	83	8.4	332	76.9	60.0	Down
2095	68	23.4	208	98.9	48.8	Down
23271	26	34.6	144	75.0	31.5	Down
23273	26	114	421	242	81	Down
23274	40	120	384	182	60	Down
23275	25	119	349	176	56	Up
23276	26	54.7	115	82.6	14.7	No Trend
23278	26	32.5	201	89.6	45.2	Down
23280	26	57.2	700	160	142	Down
23281	26	27.6	367	130	80	Down
2385	49	48.5	592	226	112	Down
2386	49	6.67	43.4	20.6	7.6	No Trend
2387	49	18.1	492	156	84	Up
2389	38	0.899	120	31.2	25.0	Up
2390	48	21.6	163	71.1	31.4	Down
2397	35	135	737	383	128	No Trend
2550	59	3.3	120	57.5	21.5	Down
2552	60	0.854	33	16.6	6.5	No Trend
2649	45	6.01	1110	200	300	Up
2880	49	0.4	64.9	20.1	23.6	Up
3069	75	0.5	398	122	95	Down
3095	69	2	94	26.5	17.4	No Trend
3821	42	7.95	152	22.6	29.6	Up
62433	38	32.9	845	312	208	Down
63285	26	74.9	277	200	47	No Trend
63287	26	47.1	316	149	69	Down
6880	36	55.7	145	85.8	22.8	Down
6881	36	17.5	60.5	26.3	7.2	No Trend
82369_C1	5	12.1	210	127	76	No Trend
83269_C2	4	25.1	38.5	31.0	5.6	Up
82369_C3	3	24.0	30.7	28.4	NA	NA
82372_C1	6	33.5	62.4	43.7	10.8	No Trend
82433_C3	28	42.6	506	195	140	Down
83117_C1	28	440	1620	826	288	Down
83117_C2	14	33.4	330	130	115	Down
83117_C4	14	66.1	111	84.6	13.1	No Trend
83124_C1	42	102	1070	486	211	No Trend
83124_C2	22	27.8	103	52.2	18.4	Down
83124_C4	14	25.4	62.2	40.0	9.5	Up
83124_C5	14	24.4	61.4	50.0	8.8	No Trend
83294_C1	22	98.5	287	193	50	Up
83294_C2	33	188	575	364	90	Down
83294_C3	17	20.5	539	286	163	Down
83295_C2	22	85.9	178	134	32	No Trend
83295_C3	18	66.7	175	127	36	Down
83295_C4	15	35.8	199	98.3	58.9	Down
83295_C5	14	42.4	155	76.9	32.2	Down
83295_C6	14	3.4	64.4	33.1	21.4	Up

Table 28 (continued). Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium with 2014 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]
83296_C1	11	56.7	135	84.7	22.6	No Trend
83337_C1	20	871	2660	1690	560	Up
83337_C2	30	2.67	835	158	194	No Trend
83338_C1	13	454	1100	596	168	No Trend
83340_C1	14	13.2	44.8	28.6	9.2	Up
83346_C2	12	10.7	70.7	39.5	14.4	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 2014 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 2014.

Table A.2-29. 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, 2014)						
3924	620	1.8	180	29.6	14.9	Down
3925	620	0.5	84	23.9	7.9	Down
3926	610	1.5	42.4	25.2	8.1	Up
3927	613	1.0	17	2.63	1.09	Up
South Plume Optimization Module (August 9, 1998, through December 31, 2014)						
32308	543	18.4	100	52.7	15.9	Down
32309	555	22.3	123	53.3	19.6	Down
South Field Module (July 13, 1998, through December 31, 2014)						
31550	571	16.2	128	50.4	18.4	Down
31560	598	12.1	183	57.3	37.6	Down
31561	571	18.1	114[d]	39.9	10.3	Down
32276	614	15.6	290	97.1	63.1	Down
32446	466	24.5	168	58.9.	19.9	Down
32447	489	21.9	302	103	54	Down
33061	369	15.5	98.5	44.8	14.7	Down
33262	327	20.7	110	45.6	13.8	Down
33264	320	15.8	364	78.2	41.1	Down
33265	311	6.5	96.5	21.0	7.7	Down
33266	308	4.0	105	15.0	10.4	Down
33298	277	10.1	76.2	50.7	10.6	Down
33326	227	13.2	62.2	24.8	6.9	Down
Waste Storage Area Module (May 8, 2002, through December 31, 2014)						
32761	359	21.2	161	58.6	32.5	Down
33062	375	10.2	236	65.9	44.2	Down
33334	180	8.5	50	16.2	7.0	Down
33347	183	7.0	126	26.6	19.1	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.

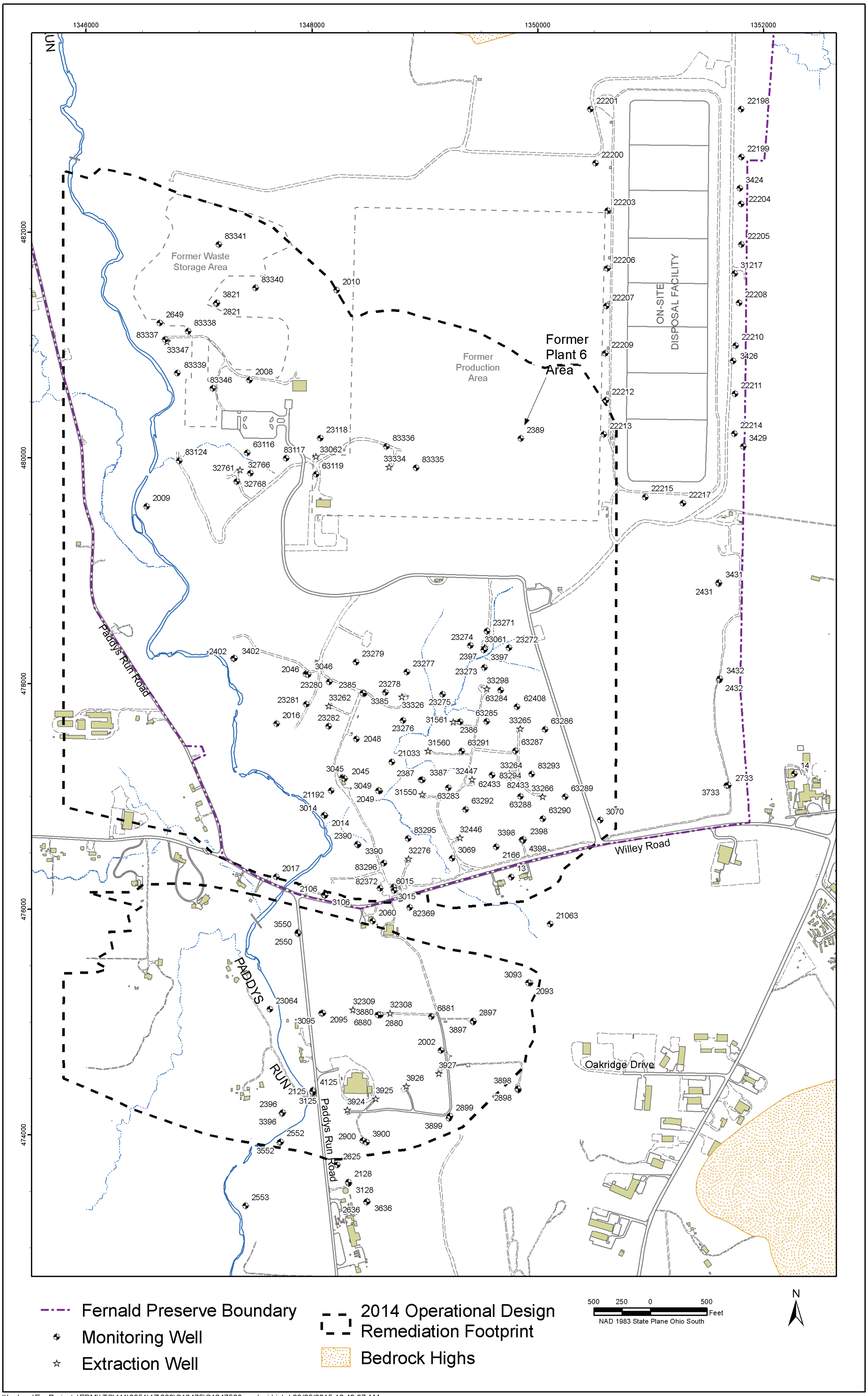

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Figure A.2-1. IEMP Water Quality Monitoring Wells and Extraction Wells

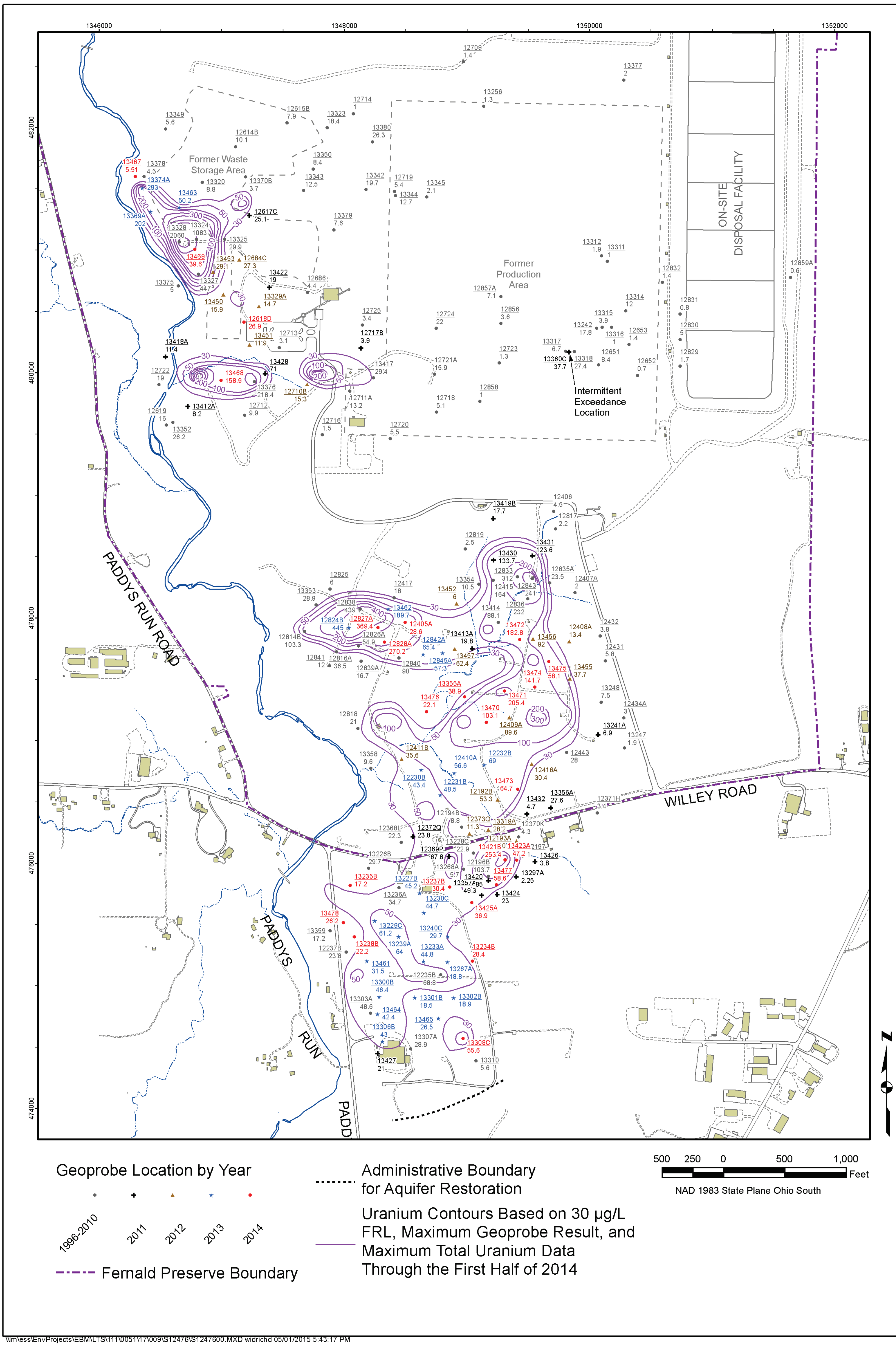

Figure A.2-2A. Direct-Push Data and Maximum Total Uranium Plume Through the First Half of 2014

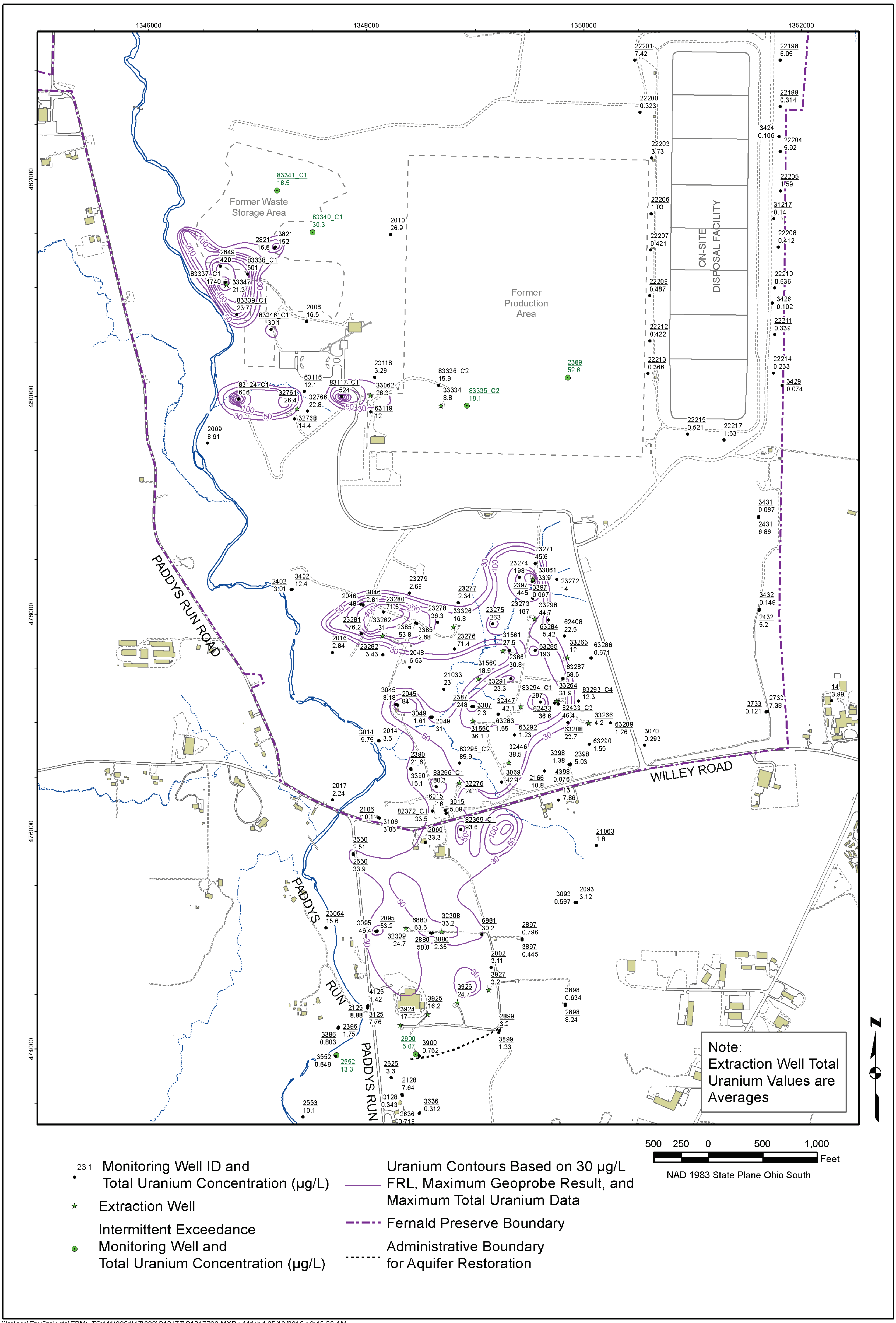

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Figure A.2-2B. Monitoring Well Data and Maximum Total Uranium Plume Through the First Half of 2014

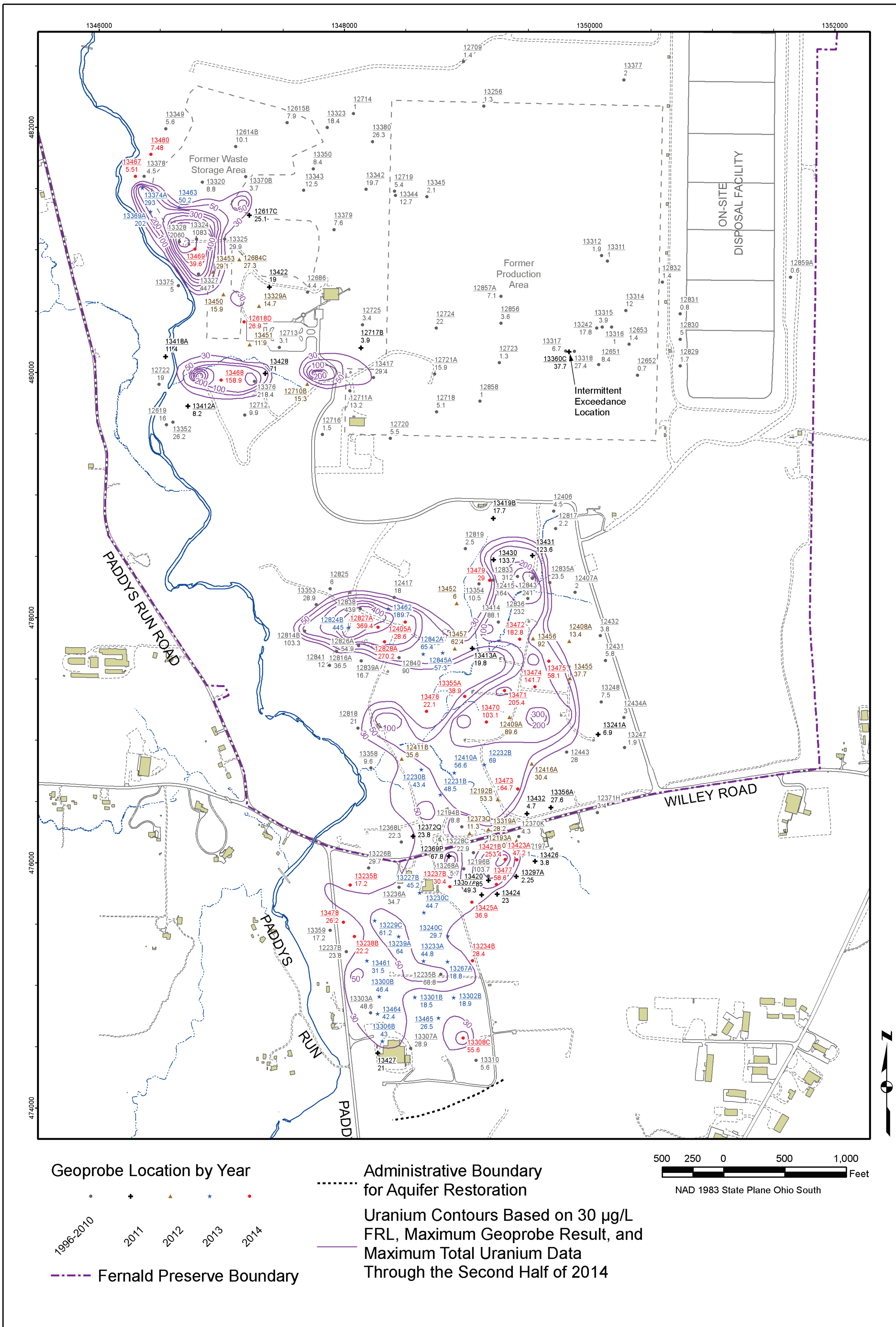

Figure A.2-3A. Direct-Push Data and Maximum Total Uranium Plume Through the Second Half of 2014

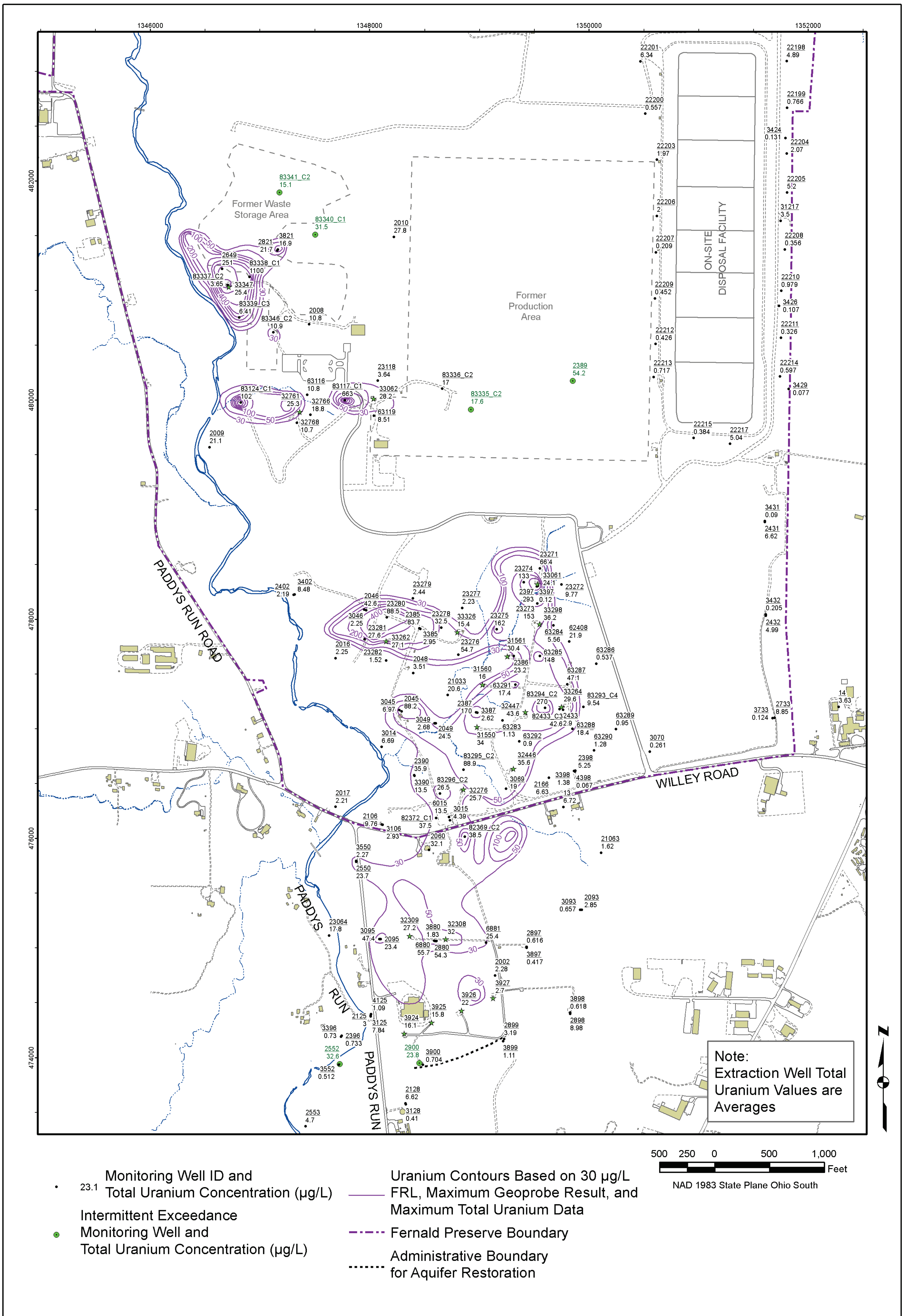

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Figure A.2-3B. Monitoring Well Data and Maximum Detected Total Uranium Plume Through the Second Half of 2014

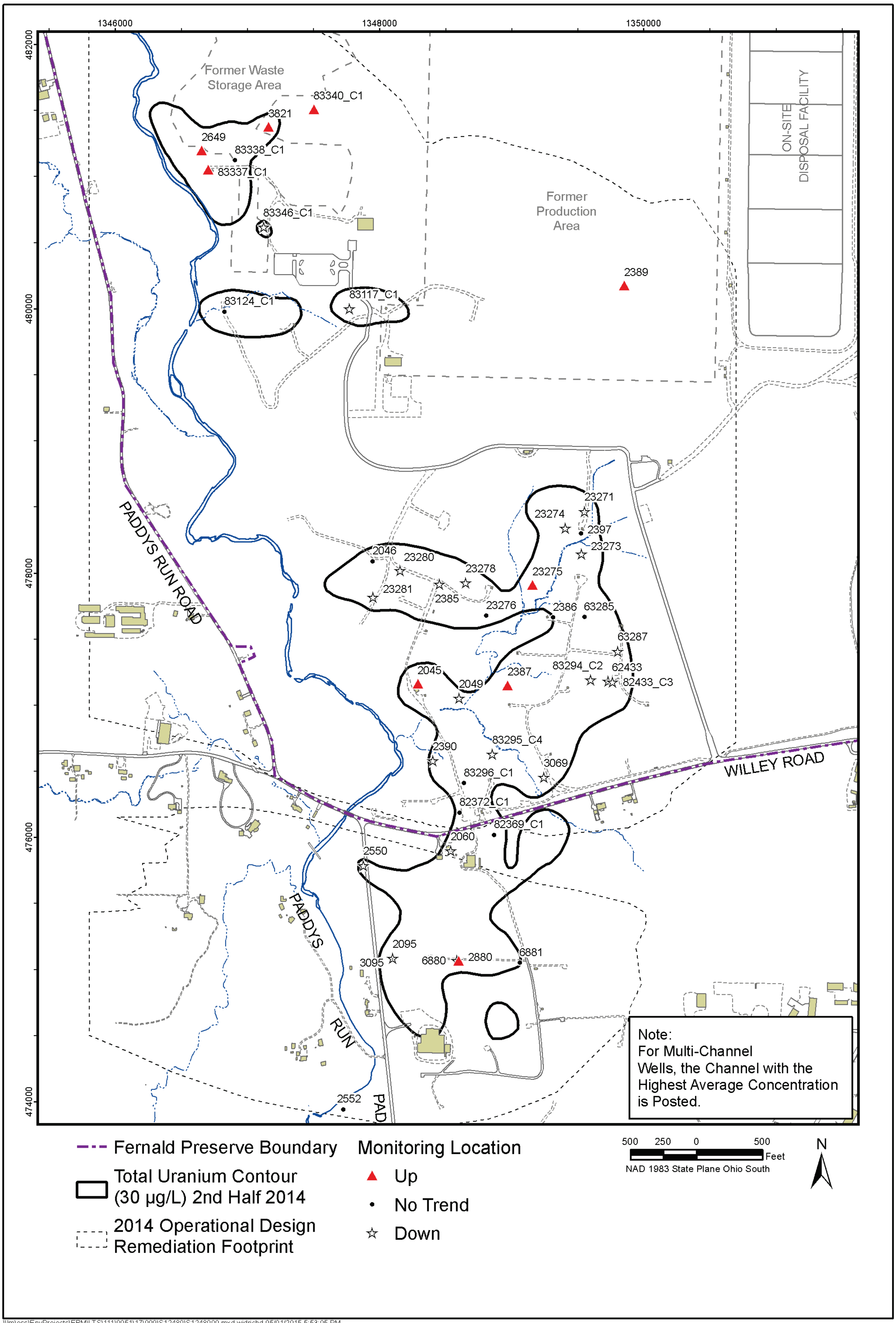
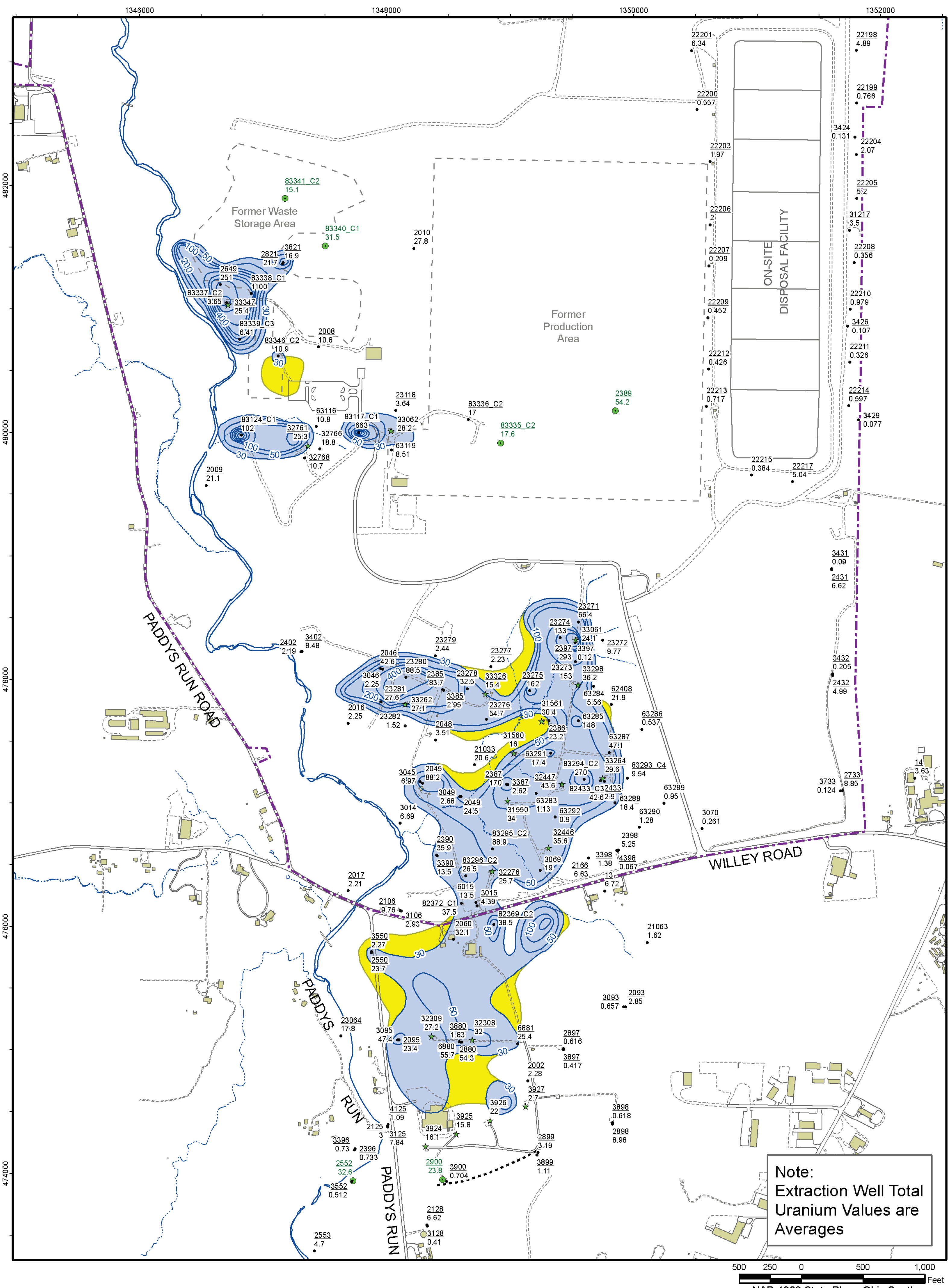


Figure A.2-4. Monitoring Wells with 2014 Exceedances for Total Uranium with Up, Down, or No Significant Trends



23.1 Monitoring Well ID and Total Uranium Concentration (ug/L)

Intermittent Exceedance Monitoring Well and Total Uranium Concentration (ug/L)

Extraction Well

Uranium Contours Based on 30 µg/L FRL, Maximum Geoprobe Result, and Maximum Total Uranium Data

Fernald Preserve Boundary

Administrative Boundary for Aquifer Restoration

Extent of the Maxium Total Uranium 30 µg/L Contour through Second Half 2013

Extent of the Maxium Total Uranium 30 µg/L Contour through Second Half 2014

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Figure A.2-5. Monitoring Well Data Through the Second Half of 2014 with Maximum Total Uranium Plume Footprint Through the Second Half of 2013 and 2014

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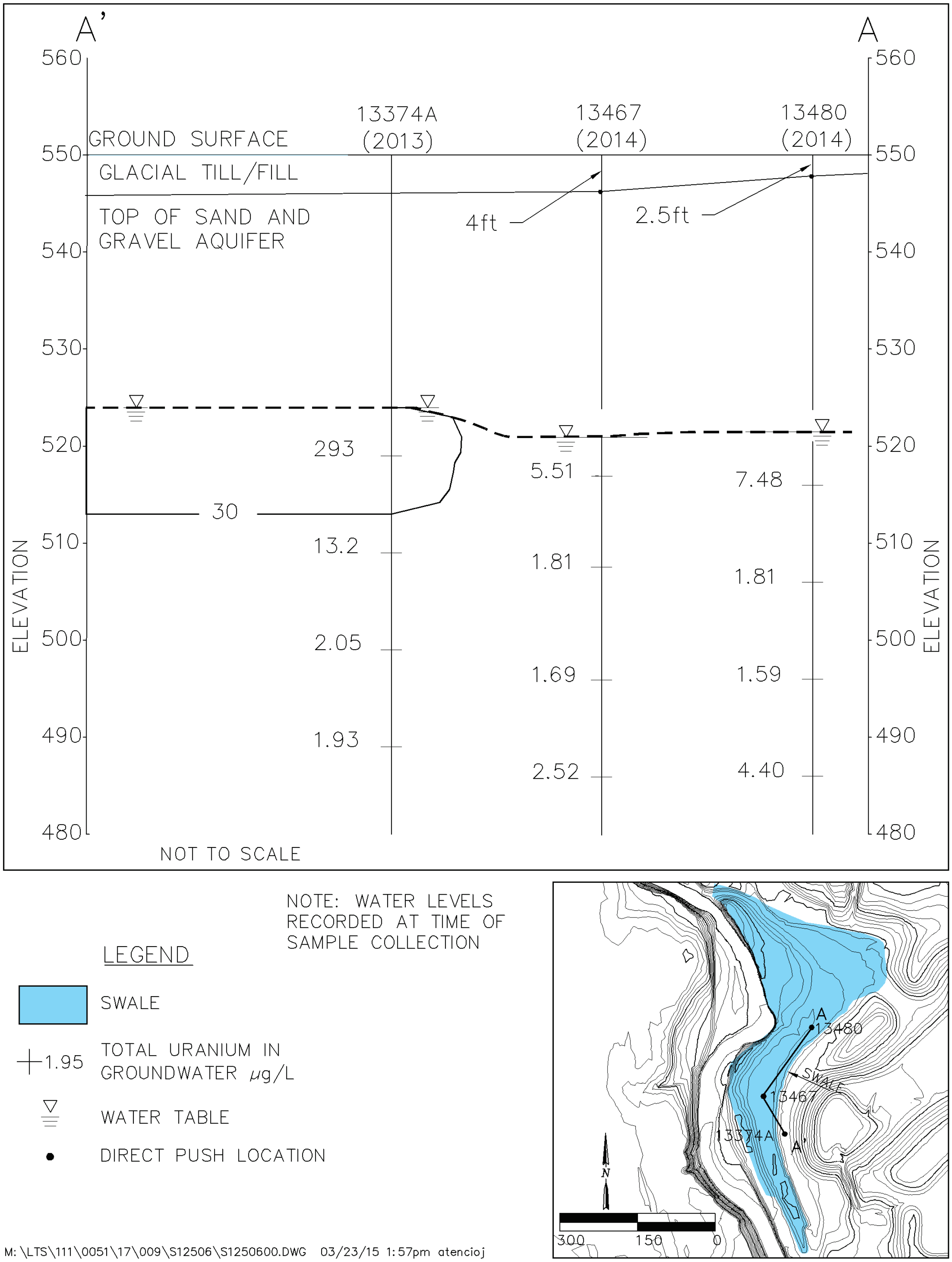

Figure A.2-6. Updated Conceptual Model for Lithology Beneath the Waste Storage Area Swale

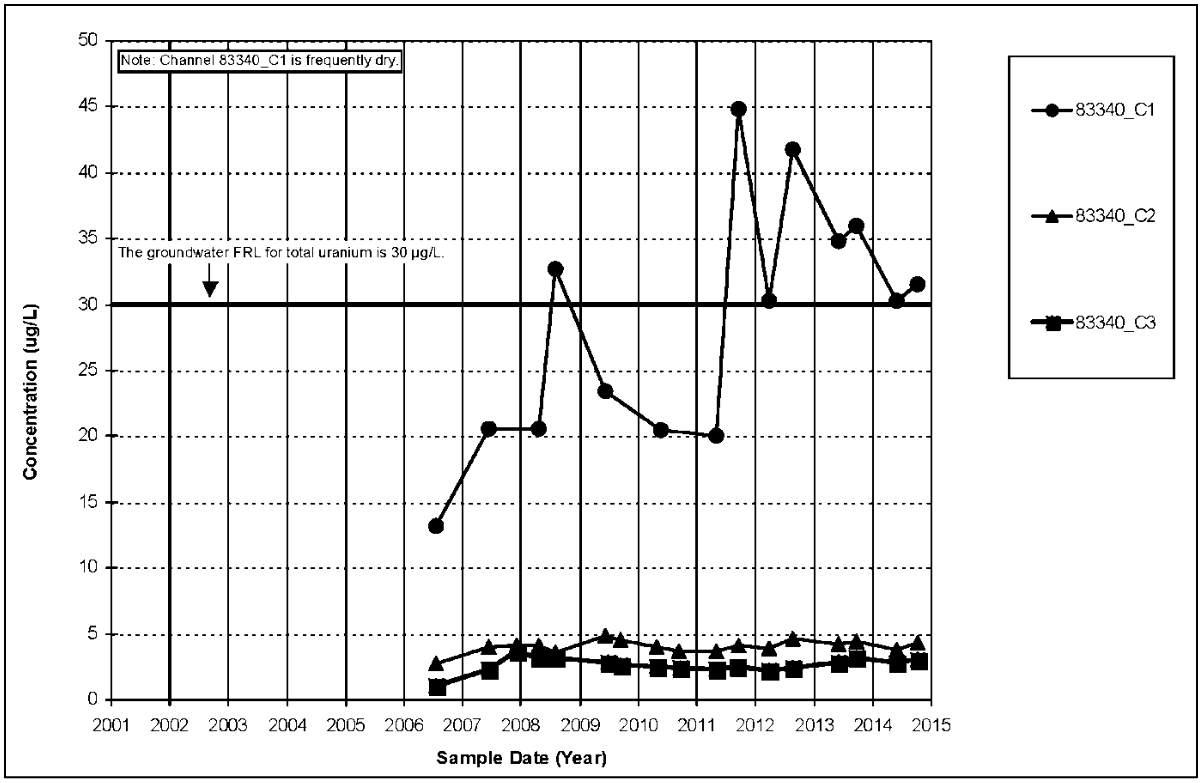

Figure A.2-7. Total Uranium Concentration Versus Time Plot for Monitoring Well 83340

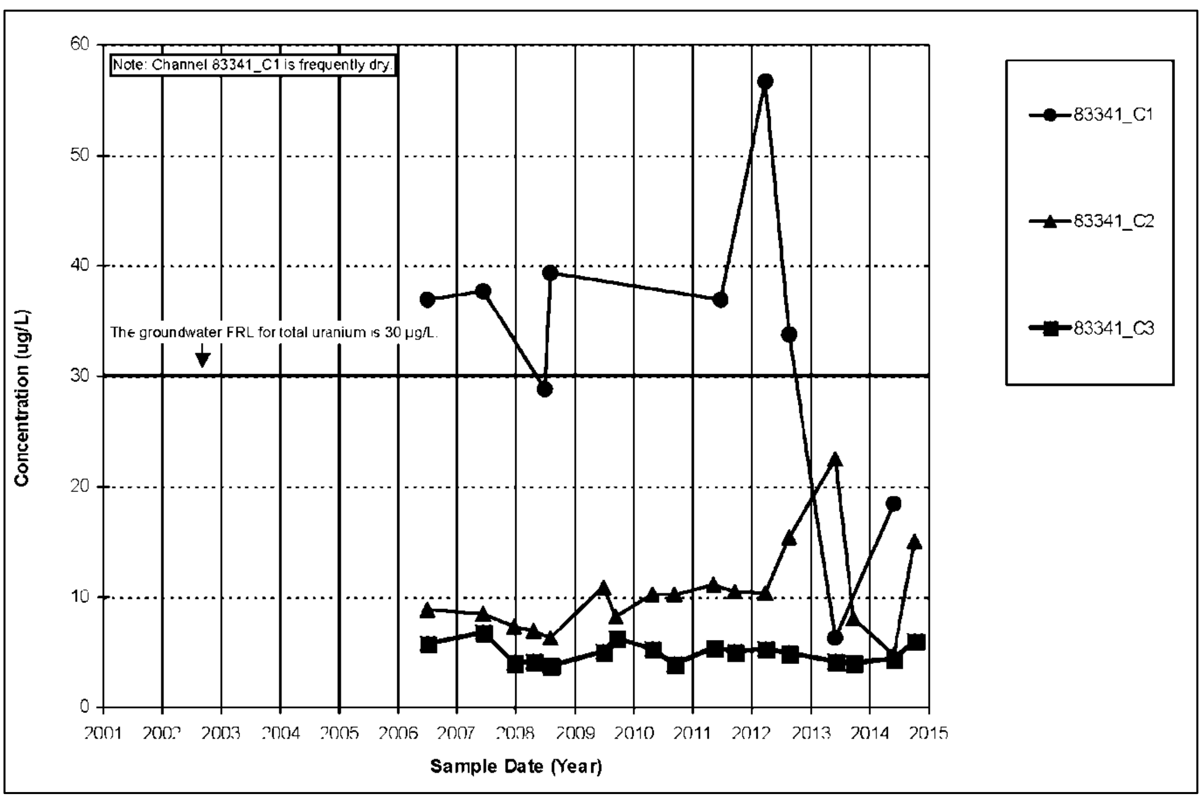

Figure A.2-8. Total Uranium Concentration Versus Time Plot for Monitoring Well 83341

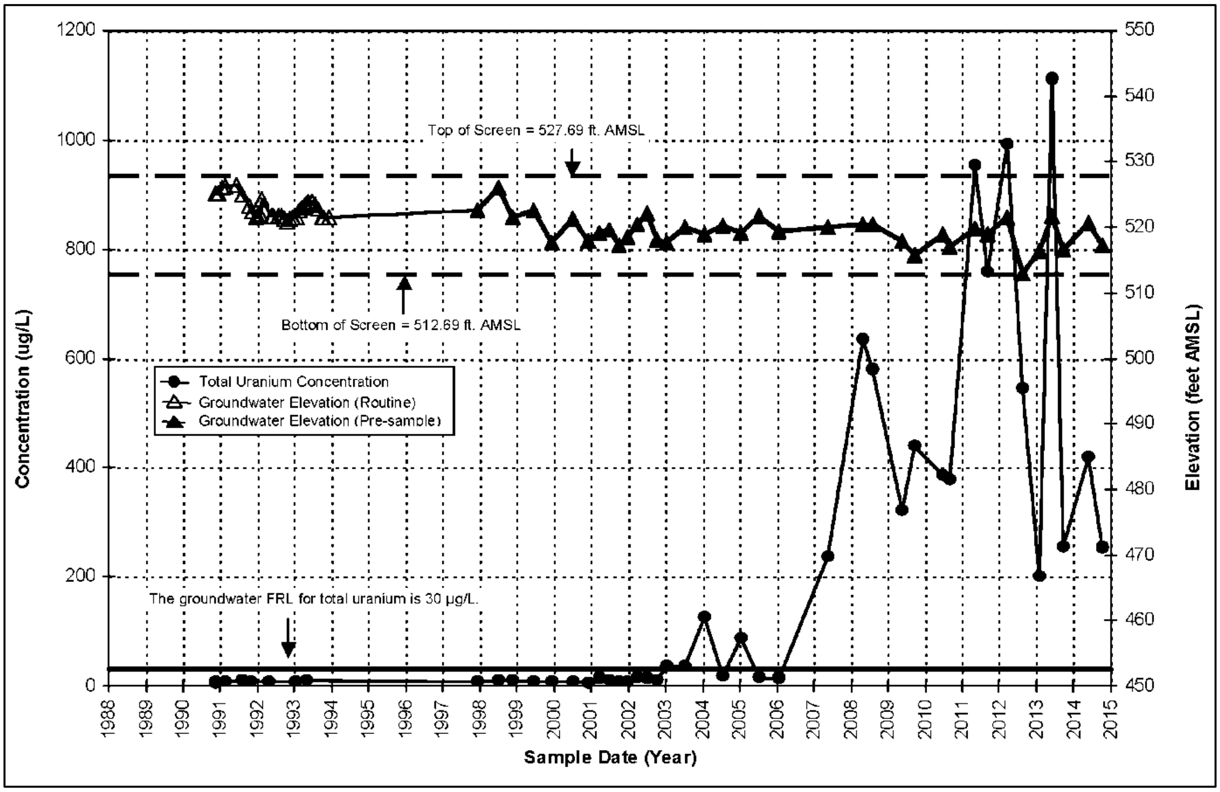

Figure A.2-9. Total Uranium Concentration Versus Time Plot for Monitoring Well 2649

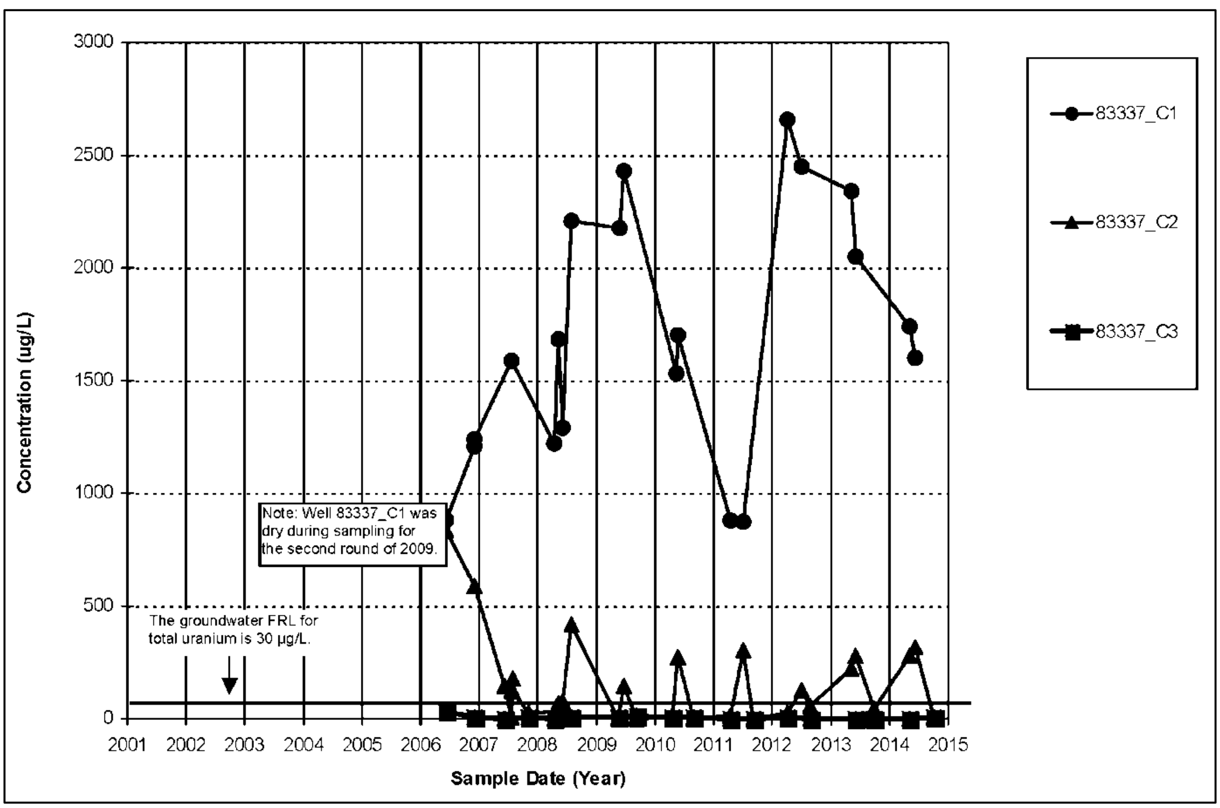

Figure A.2-10. Total Uranium Concentration Versus Time Plot for Monitoring Well 83337

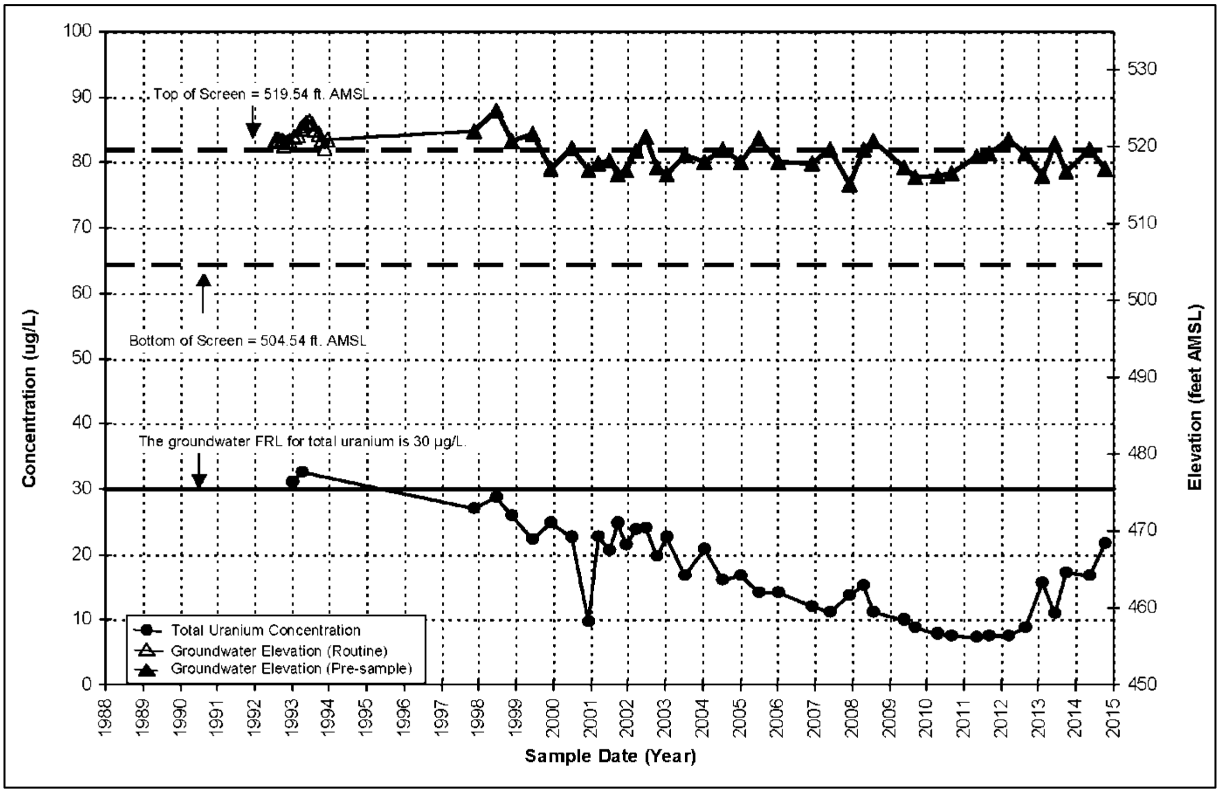

Figure A.2-11. Total Uranium Concentration Versus Time Plot for Monitoring Well 2821

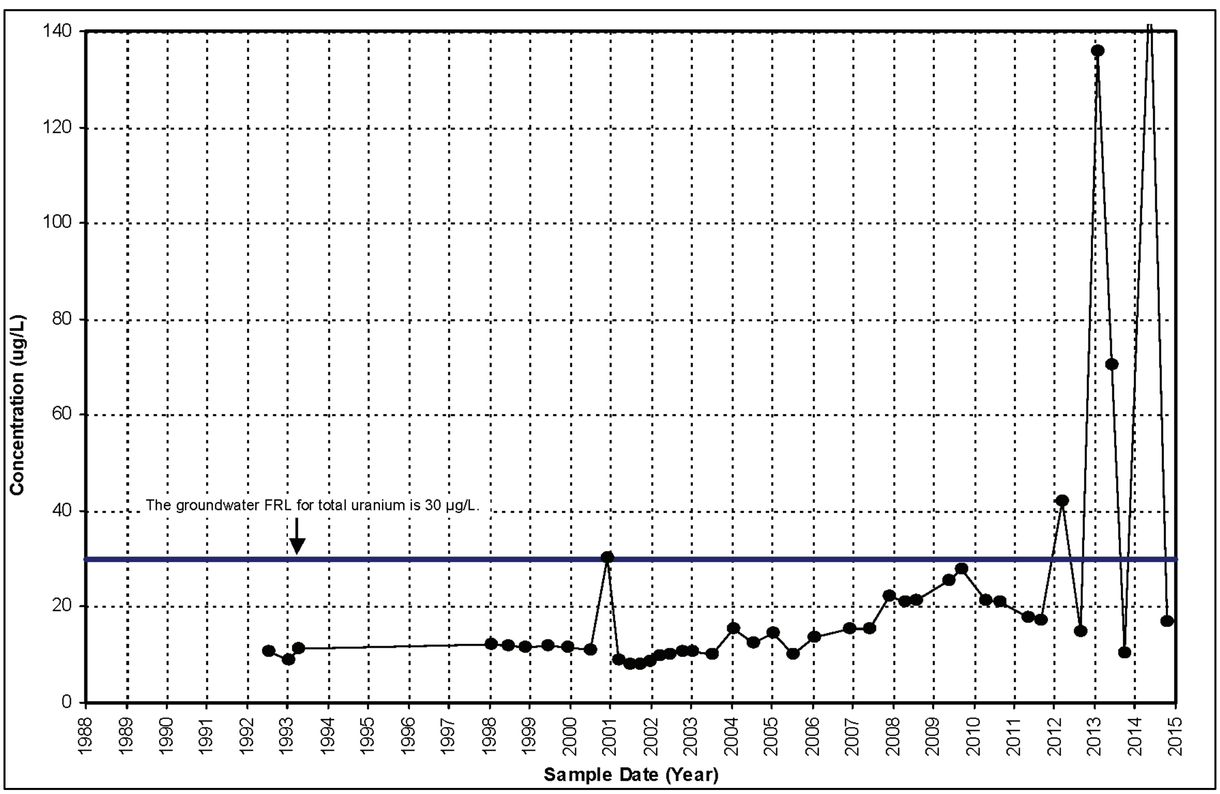

Figure A.2-12. Total Uranium Concentration Versus Time Plot for Monitoring Well 3821

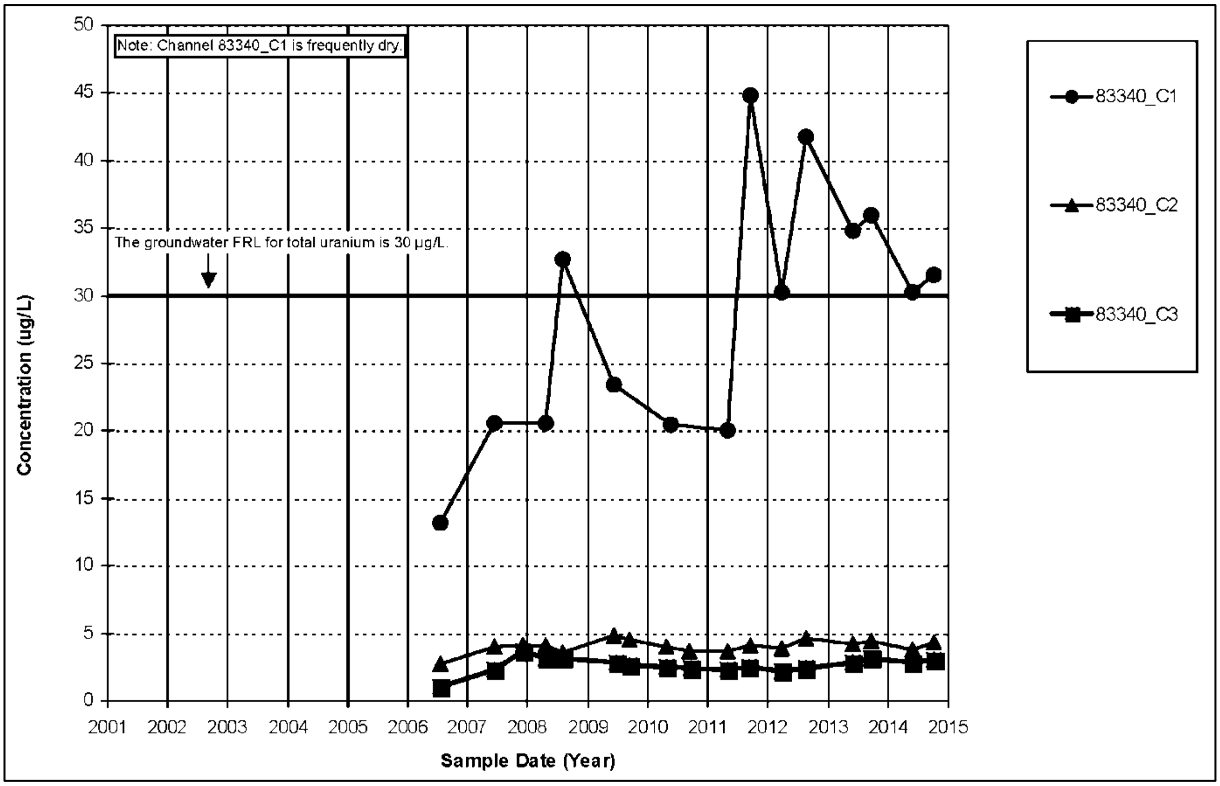

Figure A.2-13. Total Uranium Concentration Versus Time Plot for Monitoring Well 83340

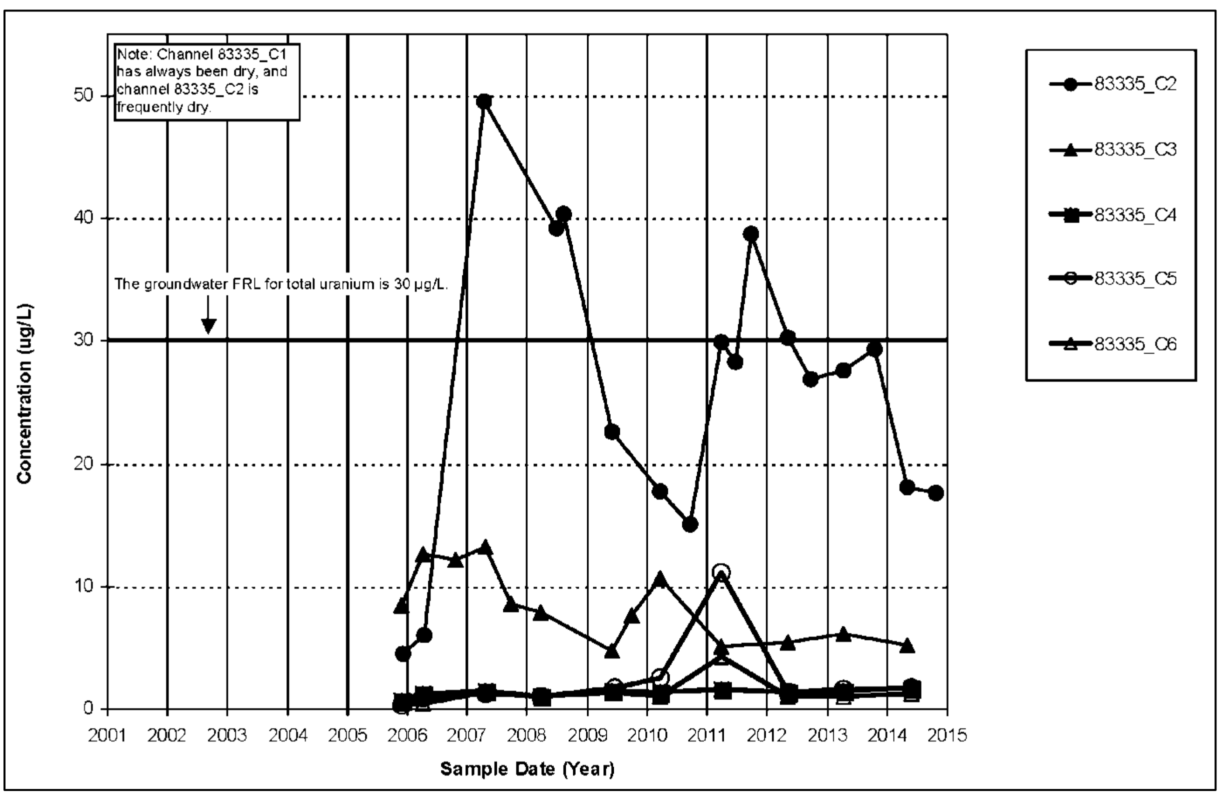

Figure A.2-14. Total Uranium Concentration Versus Time Plot for Monitoring Well 83335

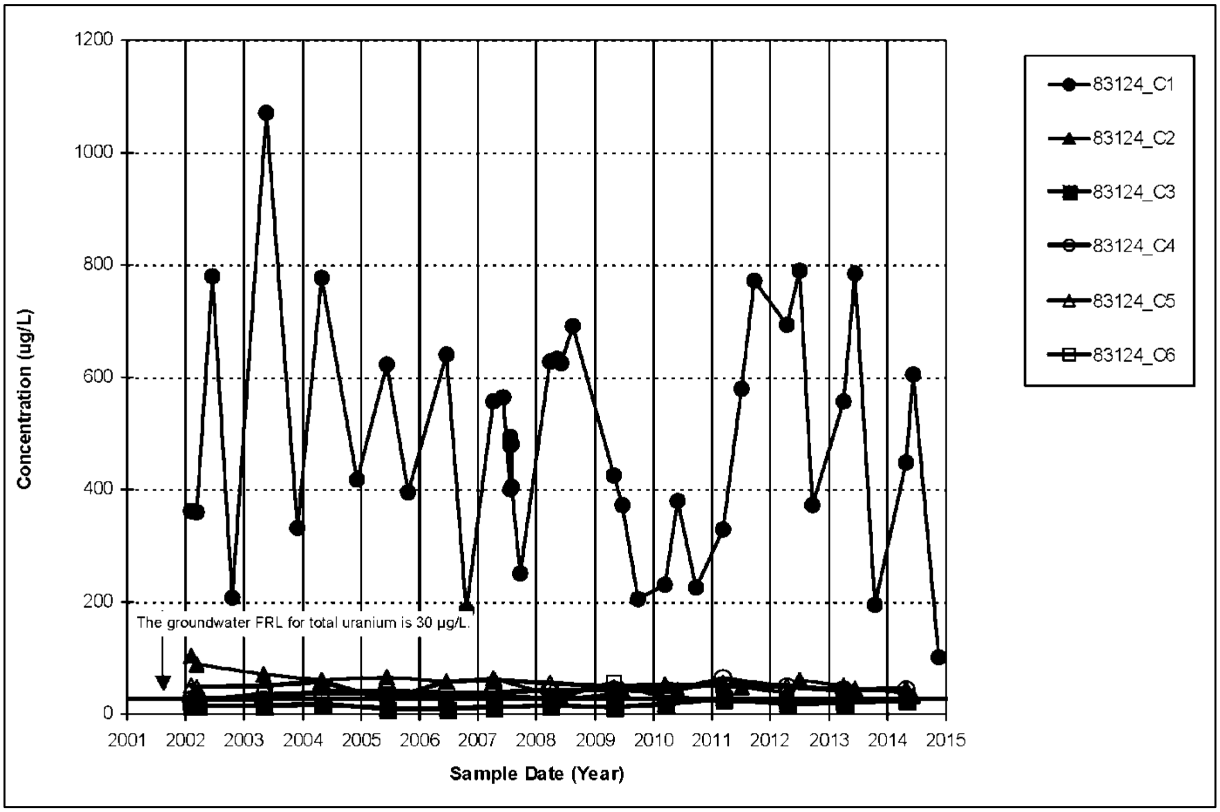

Figure A.2-15. Total Uranium Concentration Versus Time Plot for Monitoring Well 83124

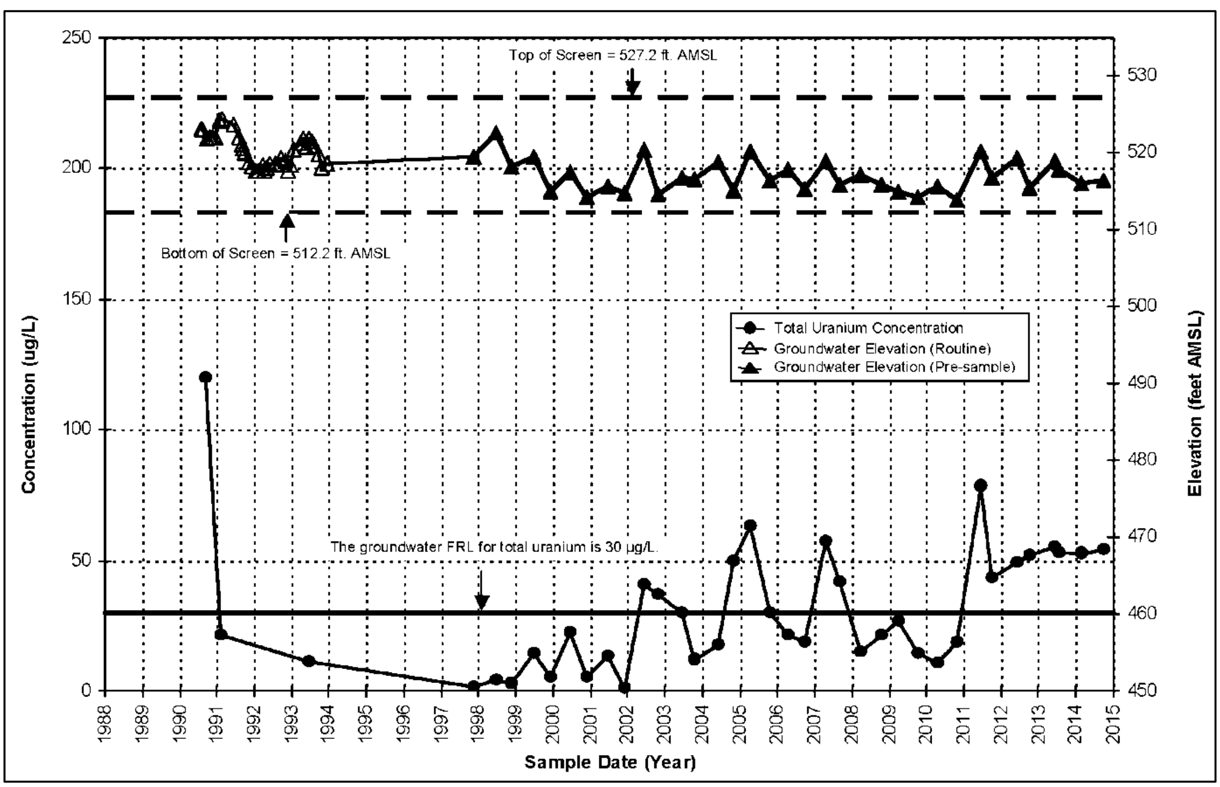

Figure A.2-16. Total Uranium Concentration Versus Time Plot for Monitoring Well 2389

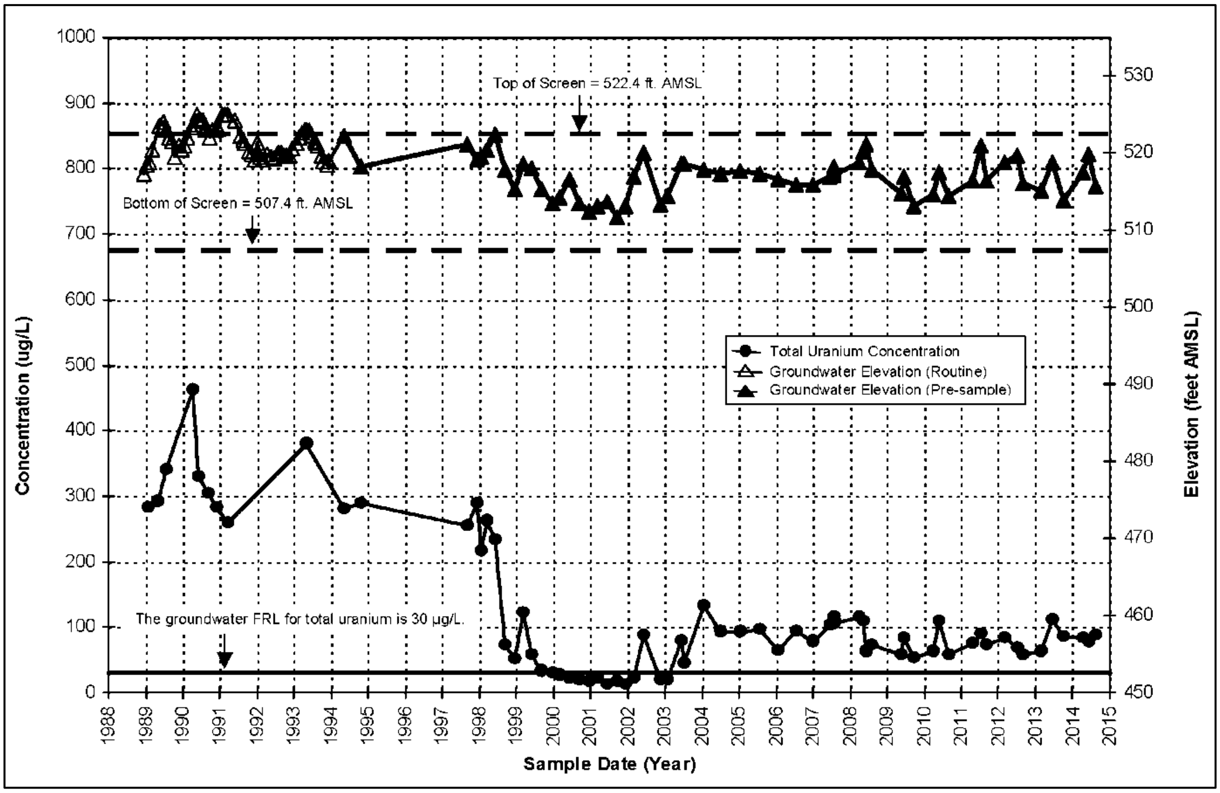

Figure A.2-17. Total Uranium Concentration Versus Time Plot for Monitoring Well 2045

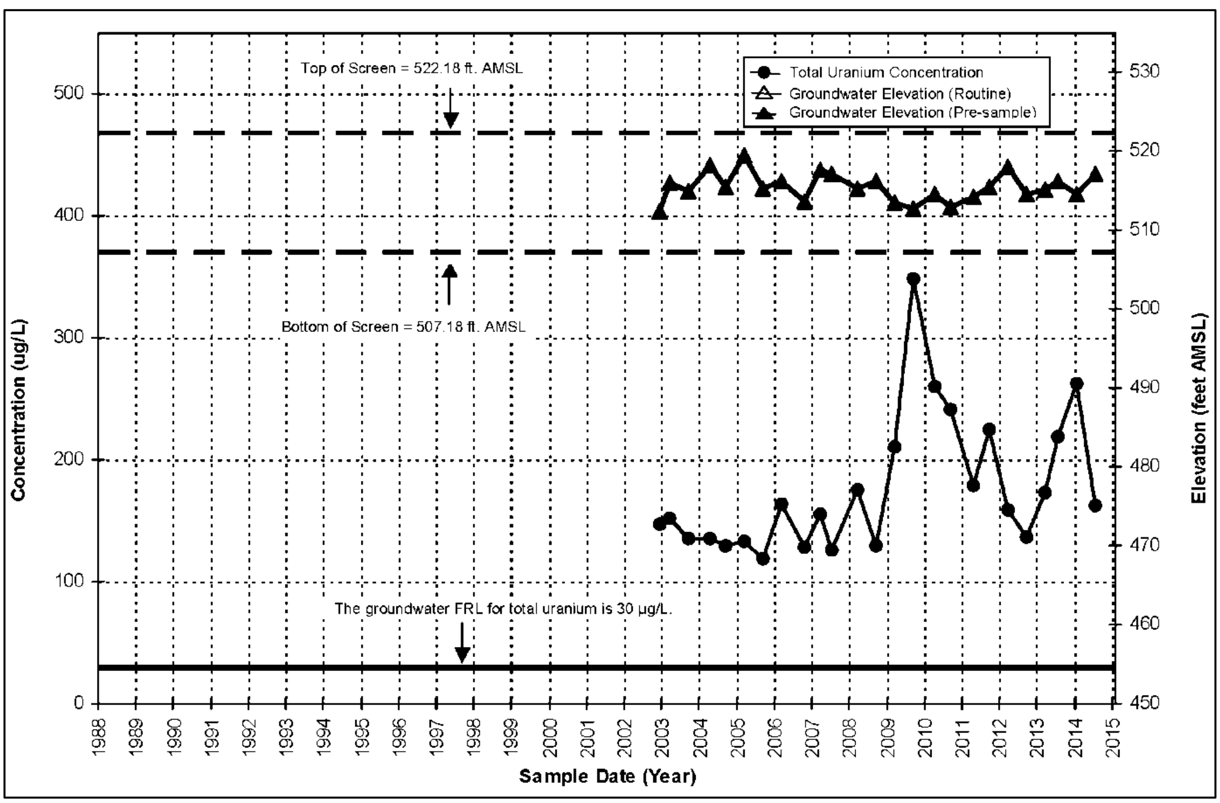

Figure A.2-18. Total Uranium Concentration Versus Time Plot for Monitoring Well 23275

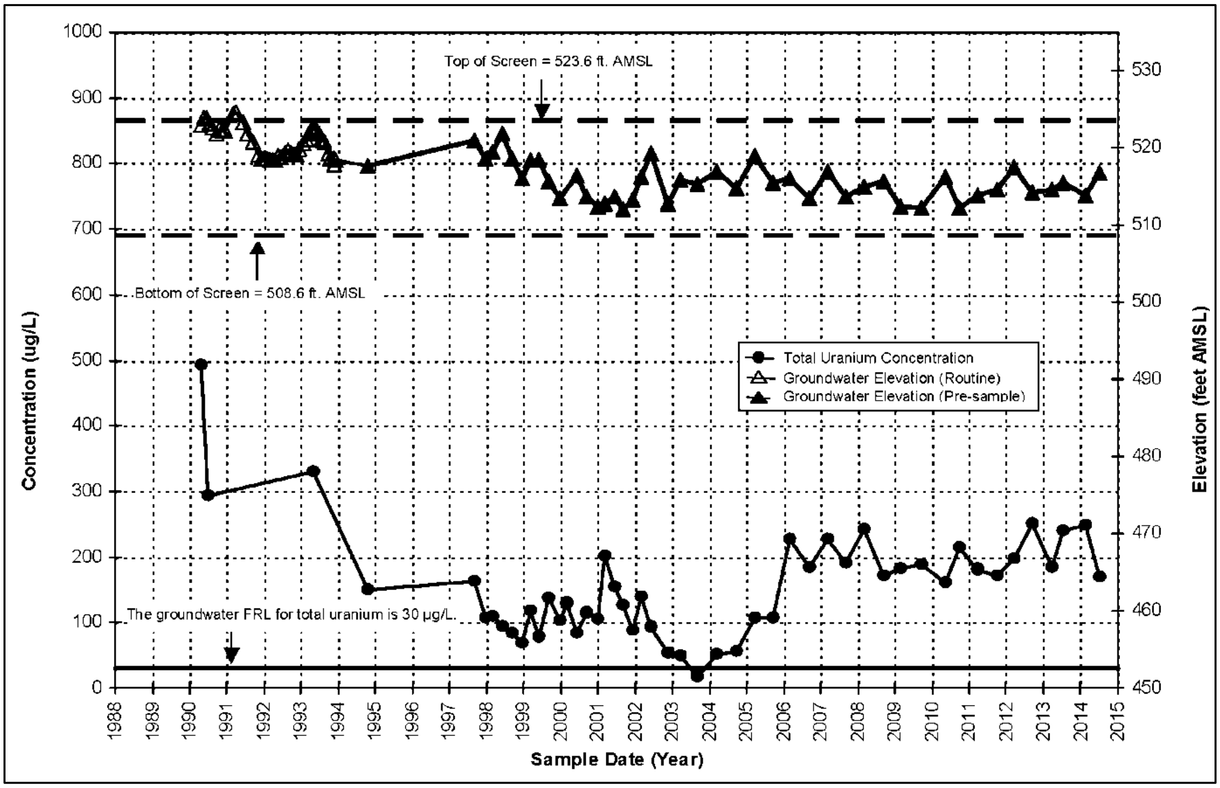

Figure A.2-19. Total Uranium Concentration Versus Time Plot for Monitoring Well 2387

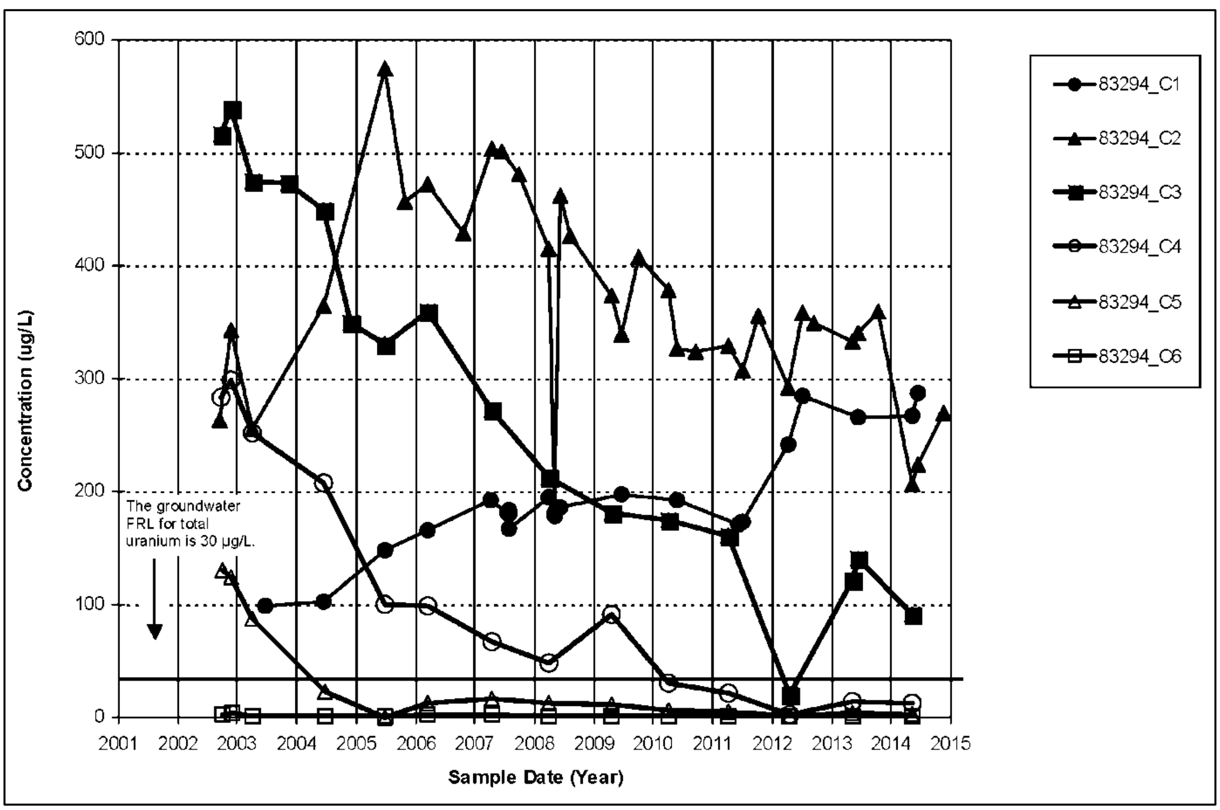

Figure A.2-20. Total Uranium Concentration Versus Time Plot for Monitoring Well 83294

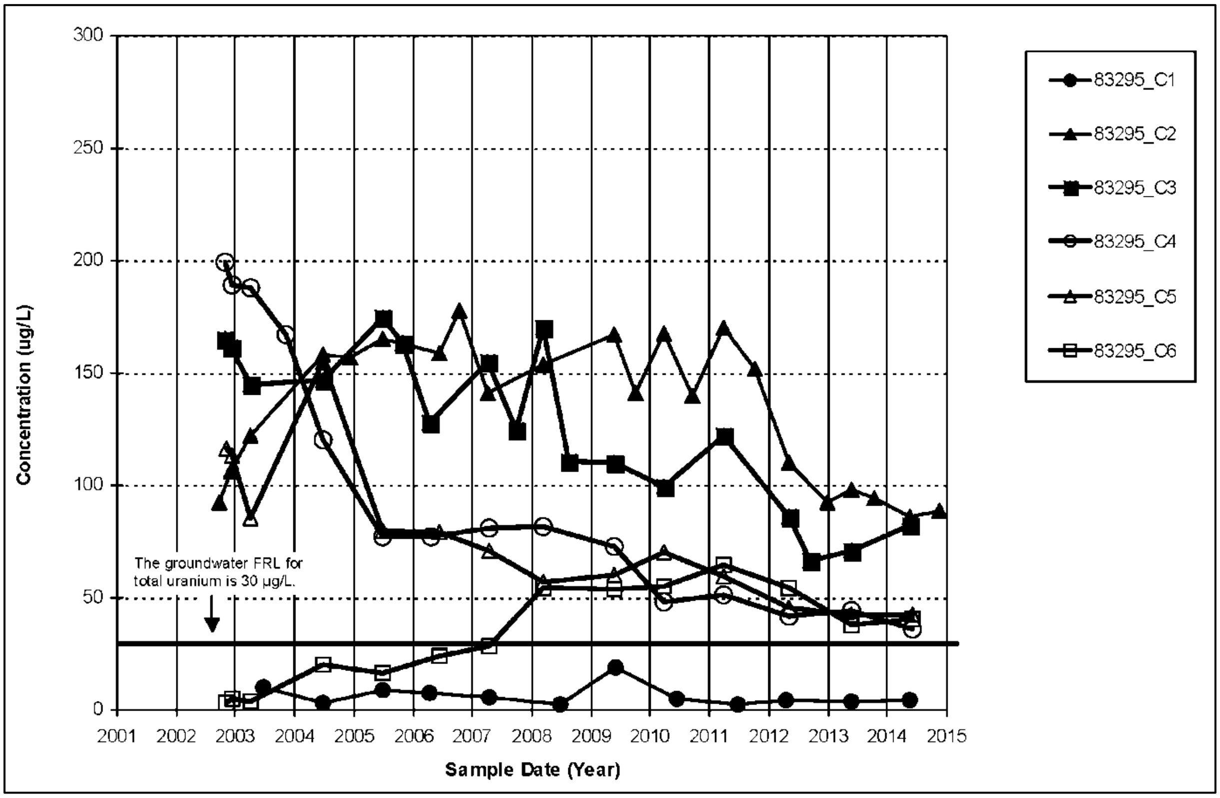

Figure A.2-21. Total Uranium Concentration Versus Time Plot for Monitoring Well 83295

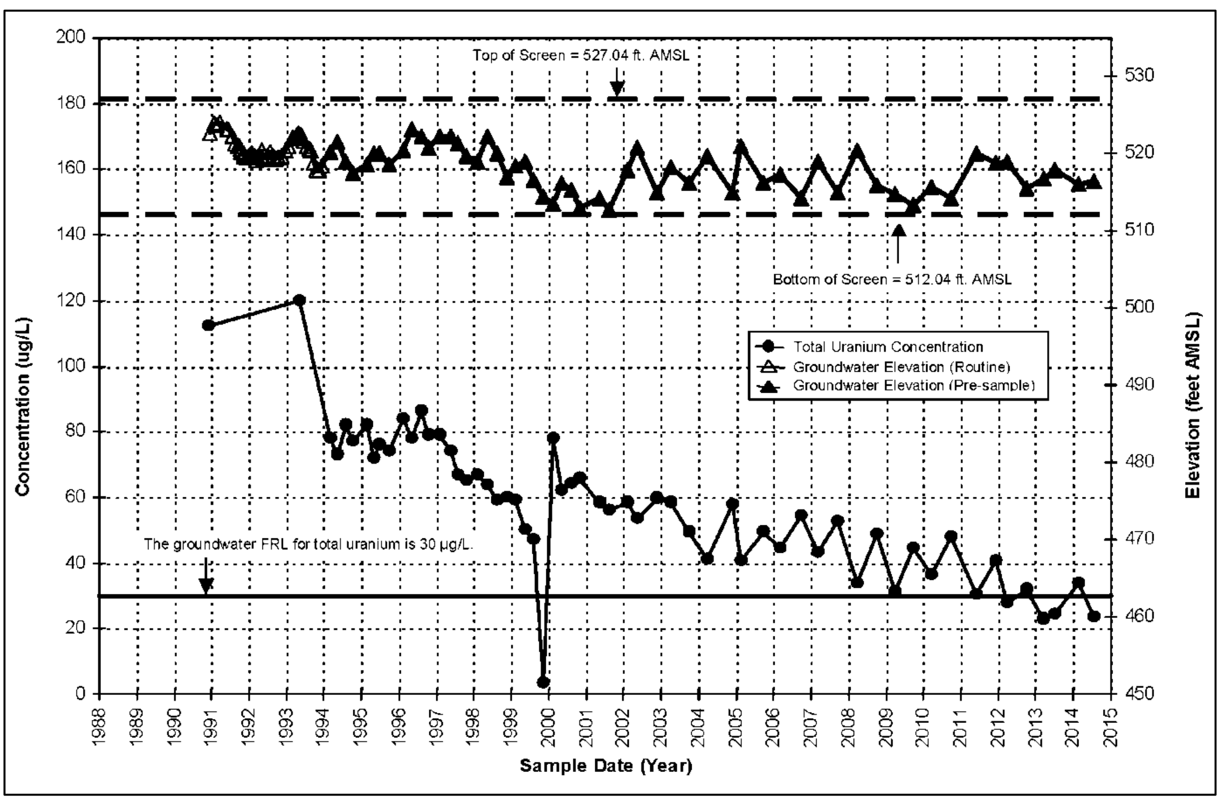

Figure A.2-22. Total Uranium Concentration Versus Time Plot for Monitoring Well 2550

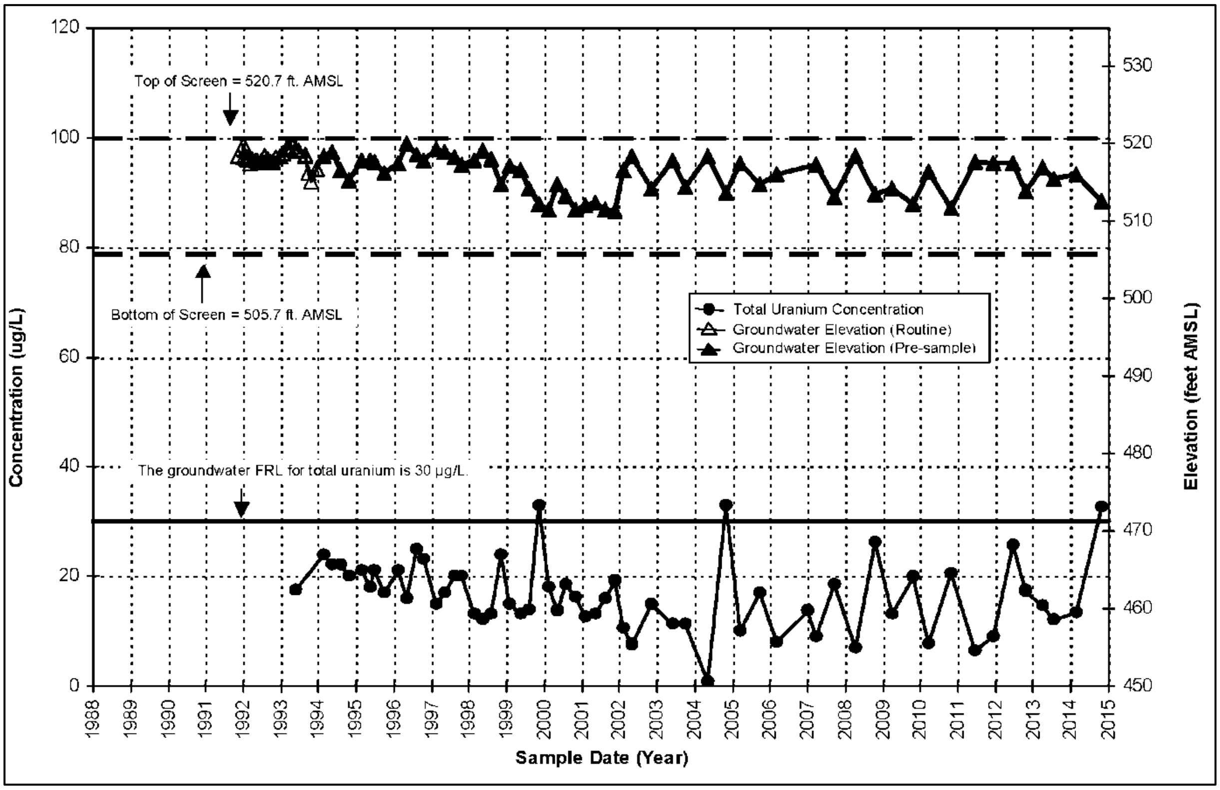

Figure A.2-23. Total Uranium Concentration Versus Time Plot for Monitoring Well 2552

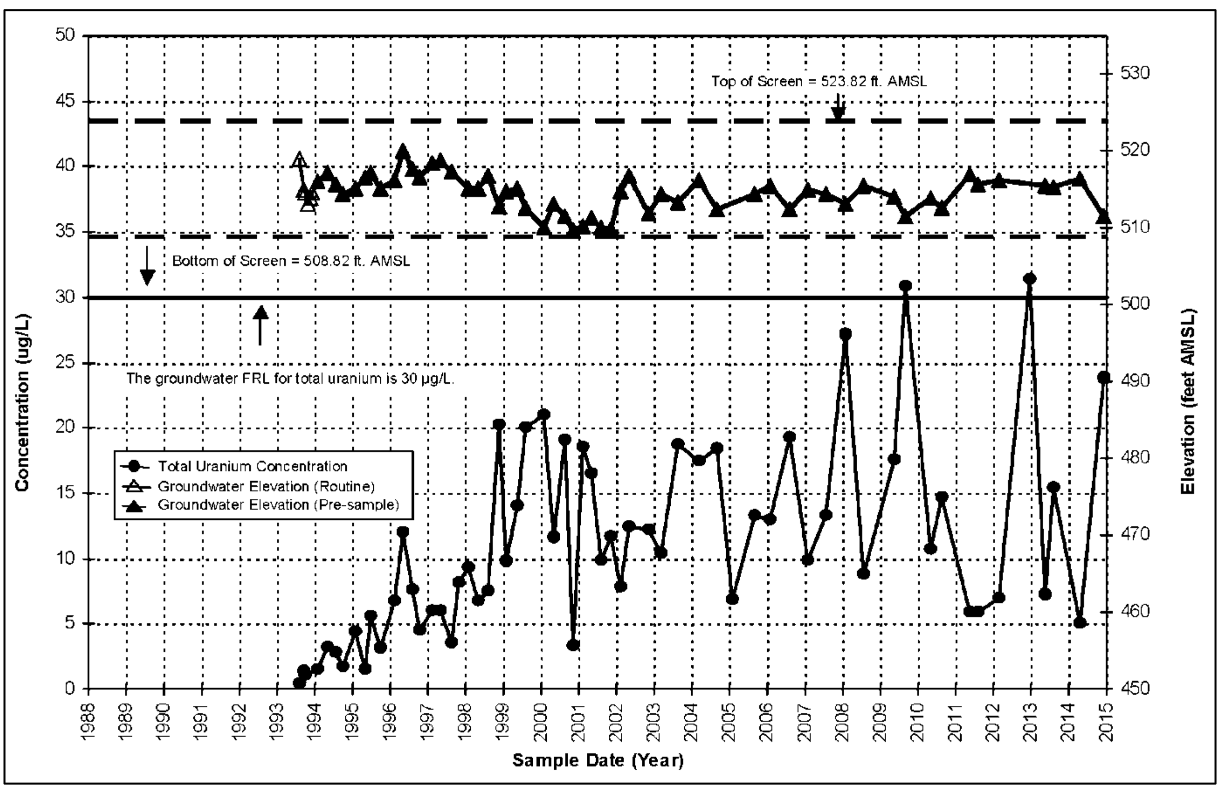

Figure A.2-24. Total Uranium Concentration Versus Time Plot for Monitoring Well 2900

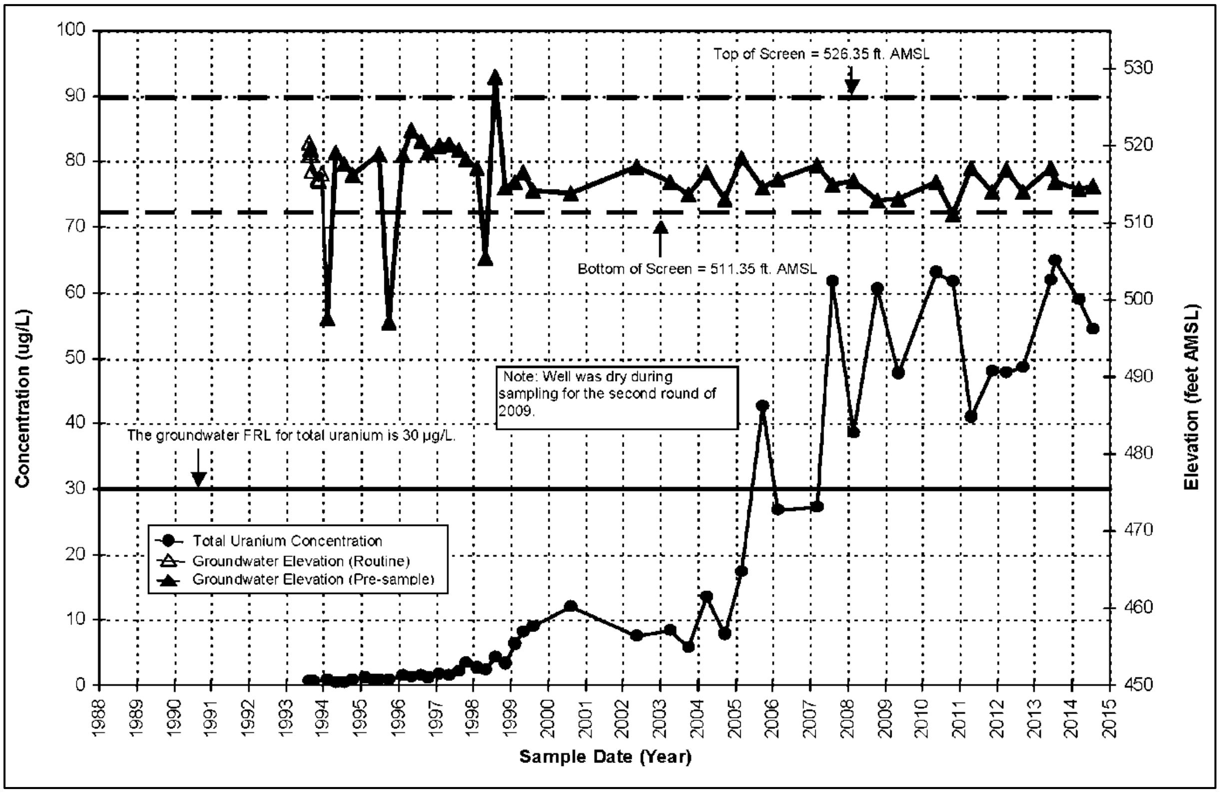

Figure A.2-25. Total Uranium Concentration Versus Time Plot for Monitoring Well 2880

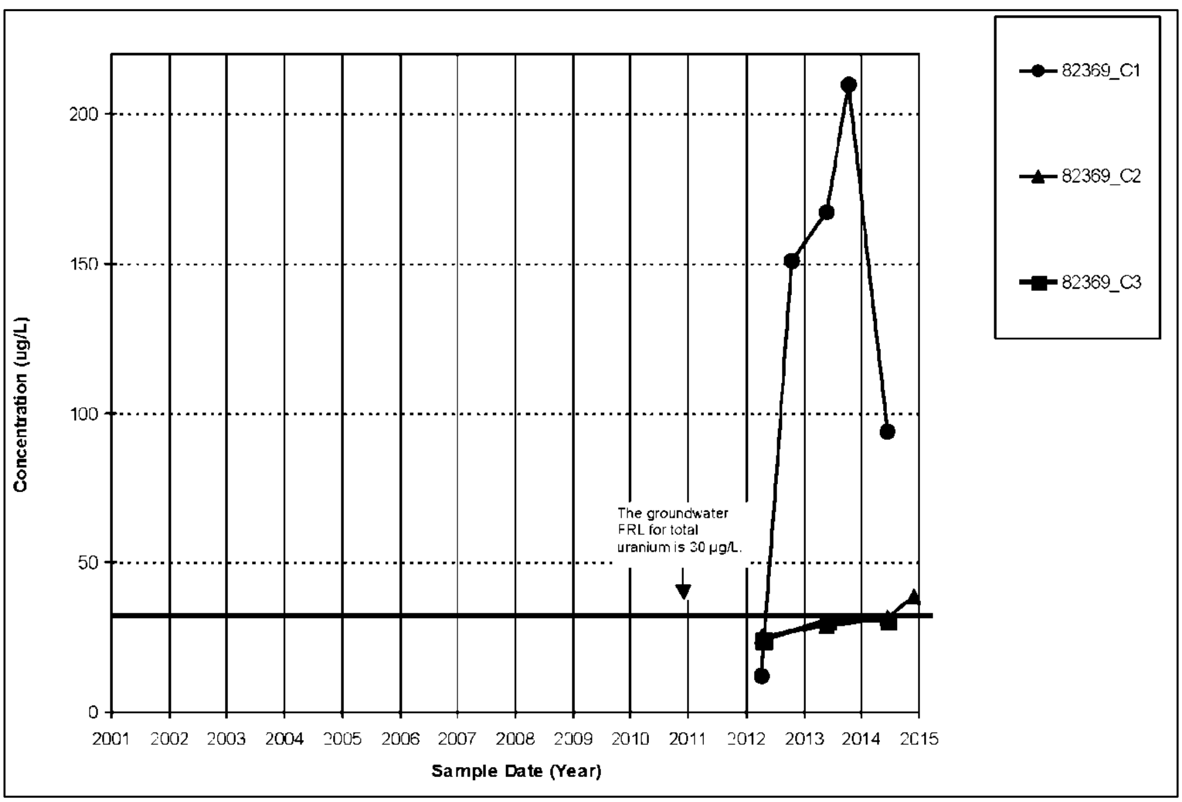

Figure A.2-26. Total Uranium Concentration Versus Time Plot for Monitoring Well 82369

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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 2014 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.
- Model predicted design particle track 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 2014 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 2015). 179 monitoring wells were available for measurement. During the second quarter of 2014, 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 (2014)	Number of Days	Average Water Level (ft amsl)
1	January 8 to January 9	2	514.99
2	April 28 to April 29	2	518.28
3	August 18 to August 21	4	516.49
4	November 10 to November 14	4	513.91

ft amsl = feet above mean sea level

Fourteen monitoring wells and the uppermost sampling interval in twelve multi-channel monitoring wells were not measured at various times in 2014 because the wells were dry or inaccessible. A summary is provided below.

Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
80	Inaccessible			
2014	Dry		Dry	Dry
2108	Dry			
2128				Dry
2384	Dry			Dry
2544	Inaccessible		Inaccessible	Inaccessible
2545	Inaccessible		Inaccessible	Inaccessible
2546	Inaccessible		Inaccessible	Inaccessible
2625	Inaccessible		Inaccessible	Inaccessible
2636	Inaccessible		Inaccessible	Inaccessible
2702	Inaccessible		Inaccessible	Inaccessible
2898	Inaccessible			
21192	Dry	Dry	Dry	Dry
22303	Dry			Dry
82369_C1				Dry
82372_C1				Dry
83293_C1	Dry	Dry		Dry
83295_C1	Dry		Dry	Dry
83335_C1	Dry	Dry	Dry	Dry
83336_C1	Dry	Dry	Dry	Dry
83337_C1	Dry			Dry
83338_C1	Dry			Dry
83339_C1	Dry			Dry
83340_C1	Dry			
83341_C1	Dry	Dry		Dry
83346_C1	Dry			Dry

The 2014 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 particle tracks that were created using target system pumping rates defined in the new 2014 Operational Design. The pumping rates reported in Figures A.3-1 through A.3-4 are averages of the actual pumping rates during the measurement period.

The new 2014 Operational 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 2014 Operational 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 cleanup. 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 2014, the flow direction in the vicinity of the On-Site Disposal Facility (OSDF) was generally northeast to south/southwest in the first and second quarters, and more north to south in the third and fourth quarter. These flow directions are influenced by active pumping taking place for the groundwater remediation which is predicted to last until 2035 (based on the new 2014 Operational Design and a July 2014 implementation). 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 2014, as recorded at the Butler County Regional Airport. Cumulative precipitation in 2014 was 40.01 inches.

Average annual water table fluctuations and yearly ranges for 2006 through 2014 are as follows:

Year	Average Fluctuation (feet)	Fluctuation Range (feet)
2014	5.14	1.21 to 6.35
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 particle track interpretations and contoured water table gradients indicate that the 30-µg/L total uranium plume was being captured in 2014.

A.3.2 Annual Planned Well Field Shutdown

The entire well field (excluding the South Plume recovery wells) was shut down from May 19 to June 17 as planned to allow water levels to recover to non-pumping elevations. Routine quarterly water level measurements were not collected in 2014 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 2014 (at each transducer), are presented below.

Planned Shutdown: May 19 to June 16

Location	Just Prior to Shutdown 5/19/2014	Just Prior to Restart 6/16/2014	Water Level Rise (feet)
2045	518.55	520.07	1.52
2046	519.20	520.49	1.29
2649	519.93	522.12	2.19
23274	518.00	519.95	1.95
63119	518.13	520.19	2.06
22302	517.08	519.11	2.03
23118	518.55	520.53	1.98
22301	517.65	519.47	1.82
22303	517.28	518.90	1.62
32763	518.45	NM	NM
62433	516.68	519.33	2.65

NM = not measured

The water level rise measurements indicate that during the shutdown, the water level rise ranged from 1.29 feet (ft) to 2.65 ft.

Figure A.3-8 shows water levels verses precipitation from May 25, 2007, through January 13, 2015. 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 2014 resulted in a water level rise of approximately:

- 6.74 ft in the former WSA (monitoring well 2649);
- 5.50 ft in the west side of the South Field (monitoring well 2046); and
- 4.58 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 2014 shutdown. The results of the 2014 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 2014 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 2014 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 three of the six 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 if it is not dry. If the targeted channel is dry, the next deeper channel is sampled. No sample was collected from monitoring well 83124_C2 in the second half of 2014.

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.

The last column of Table A.3-2 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-25 (9.1 µg/L).

Extraction wells EW-33, EW-30, EW-26, and EW-24 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. Four wells (RW-6, EW-15a, EW-17a, and EW-21a) were involved with pump/motor issues just after startup, and some samples were missed at these wells as a result.

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 January 13, 2015. 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), 2015. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 8, Office of Legacy Management, January.

Table A.3-1. Uranium Concentrations at Monitoring Wells Before, During, and After the 2014 Wellfield Shutdown

Well	Easting	Northing	First Half 2014 Pre-Shutdown Concentrations		Pre-Start-Up Concentrations June 2014		Second Half 2014 Post-Shutdown Concentrations[a]	
			Date	Uranium (µg/L)	Date	Uranium (µg/L)	Date	Uranium (µg/L)
2045	1348291	477159	4/9/2014	84.0	6/10/2014	77.3	8/13/2014	88.2
2046	1347950	478088	2/6/2014	48.0	6/10/2014	45.4	7/14/2014	42.6
23274	1349406	478337	1/29/2014	161	6/10/2014	198	7/16/2014	133
83124_C1	1346826	479977	4/30/2014	449	6/11/2014	606	11/20/2014	102
83124_C2	1346826	479977	4/30/2014	37.2	6/11/2014	34.0	NA	NA
83294_C1	1349599	477190	5/6/2014	267	6/11/2014	287	11/20/2014	DRY
83294_C2	1349599	477190	5/6/2014	206	6/11/2014	224	11/20/2014	270
83337_C1	1346704	481052	5/8/2014	1740	6/10/2014	1600	10/1/2014	DRY
83337_C2	1346704	481052	5/8/2014	276	6/10/2014	317	10/1/2014	3.65

[a]NA = not applicable

Table A.3-2. Uranium Concentration at Extraction Wells During 2014 Well Field Shutdown

Extraction Well Identication	May 5, 2014 Uranium Concentration (µg/L)	Uranium Concentration (µg/L) After Well Field Re-Start [a, b]							Maximum Post Re-Start Minus May 5 Uranium Concentration (µg/L)
		6/16/2014	6/17/2014	6/18/2014	6/19/2014	Minimum	Maximum	Range	
RW-1	18.5	14.1	14.5	14.4	17.7	14.1	17.7	3.6	-0.8
RW-2	18.7	15.9	16.9	13.2	17.6	13.2	17.6	4.4	-1.1
RW-3	29.1	23.5	22.8	25.6	22.4	22.4	25.6	3.2	-3.5
RW-4	3.7	2.5	3.5	3.0	3.5	2.5	3.5	1.0	-0.2
RW-6[c]	35.3	OFF LINE	OFF LINE	OFF LINE	OFF LINE	OFF LINE	OFF LINE	OFF LINE	OFF LINE
RW-7[c]	24.0	22.3	23.5	24.0	26.3	22.3	26.3	4.0	2.3
EW-15A[c]	32.2	OFF LINE	38.7	31.3	34.8	31.3	38.7	7.4	6.5
EW-17A	18.1	OFF LINE	16.0	18.6	17.3	16.0	18.6	2.6	0.5
EW-18	40.4	35.7	38.5	35.7	34.8	34.8	38.5	3.7	-1.9
EW-19	22.6	19.0	19.8	21.2	20.7	19.0	21.2	2.2	-1.4
EW-20[c]	30.4	25.4	25.6	26.0	25.8	25.4	26.0	0.6	-4.4
EW-21A[c]	50.3[d]	OFF LINE	50.3	55.1	52.6	50.3	55.1	4.8	4.8
EW-22	29.1	15.6	20.7	23.5	26.6	15.6	26.6	11.0	-2.5
EW-23[c]	48.1	34.1	39.1	45.3	44.3	34.1	45.3	11.2	-2.8
EW-24[c]	41.8	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-25	36.9	46.0	44.8	42.5	36.9	36.9	46.0	9.1	9.1
EW-26	31.9	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-27	31.4	28.6	28.5	27.7	27.4	27.4	28.6	1.2	-2.8
EW-30[c]	35.3	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB
EW-33	26.2	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB	REHAB

Shading indicates uranium concentration after well field re-start was greater than May 5 uranium concentration.

[a] OFFLINE = well offline for maintenance

[b] REHAB = well offline to undergo rehabilitation

[c] Extraction well pump rate increased upon wellfield re-start.

[d] Sample collected on May 18, 2014.

Shutdown began on 5/19/2014 at 7:00 AM and ended on 6/17/14 at 7:00 AM for a duration of 28 days

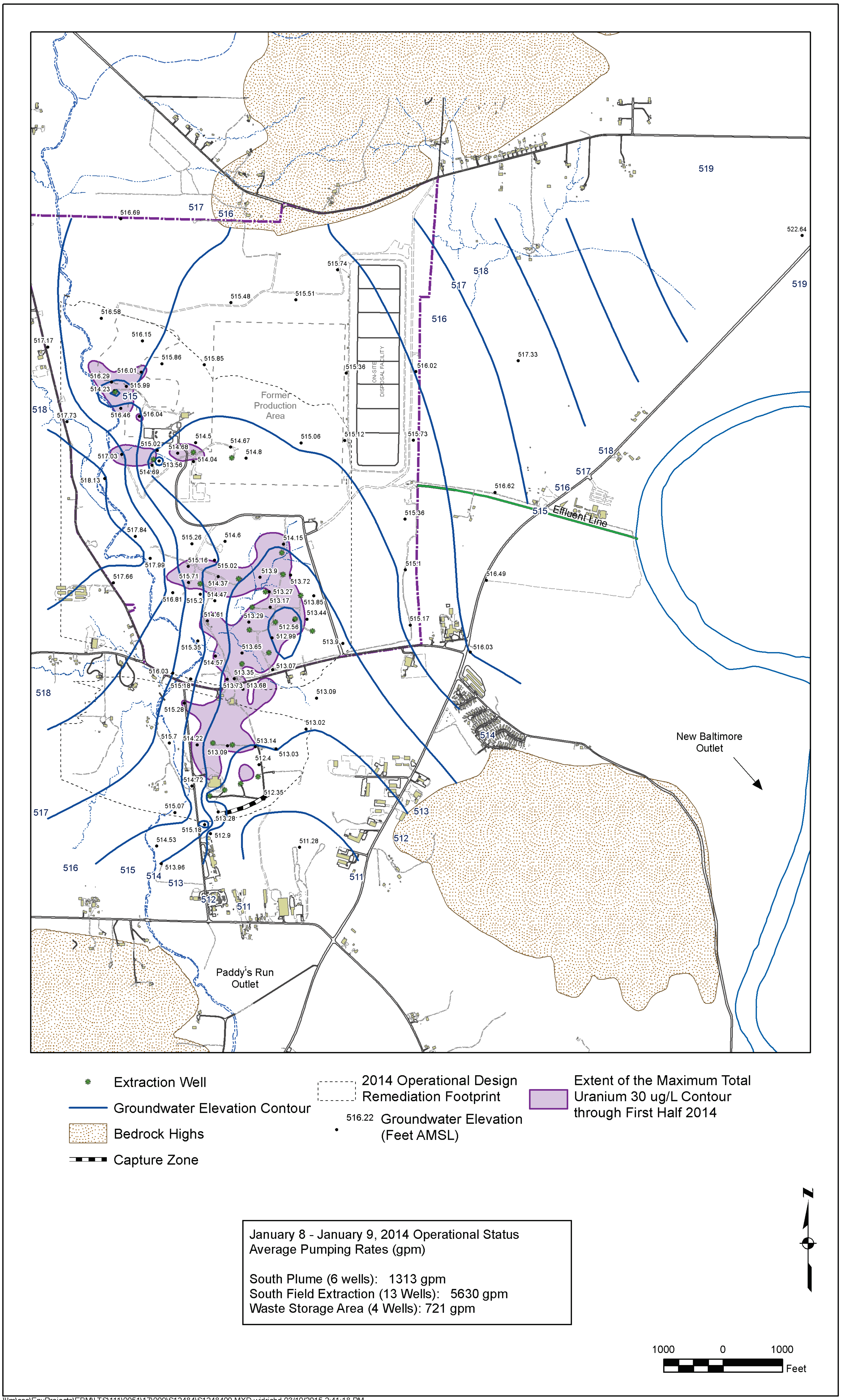

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Figure A.3-1. Routine Groundwater Elevation Map, First Quarter 2014 (January 8 and January 9, 2014)

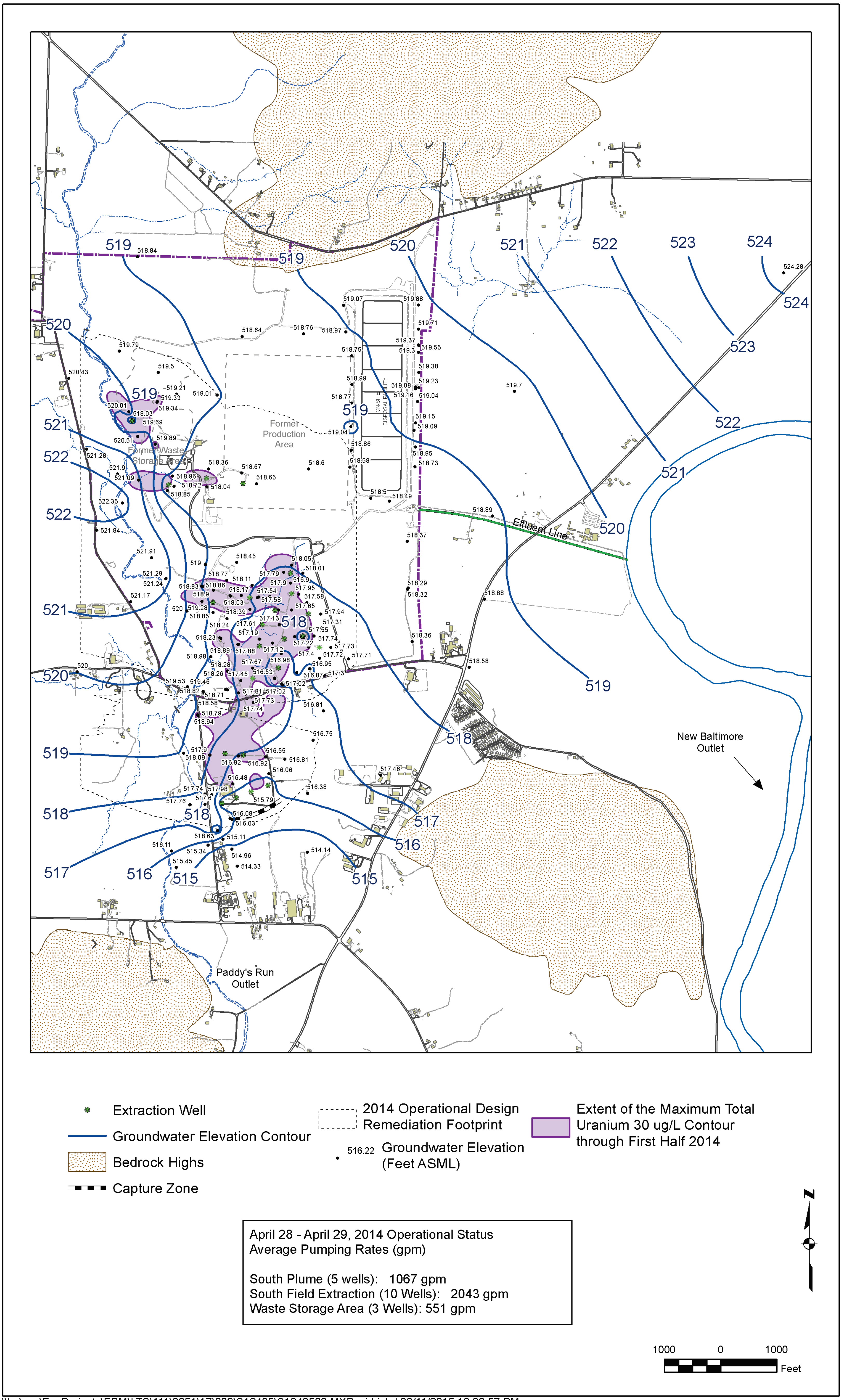

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Figure A.3-2. Routine Groundwater Elevation Map, Second Quarter 2014 (April 28 and April 29, 2014)

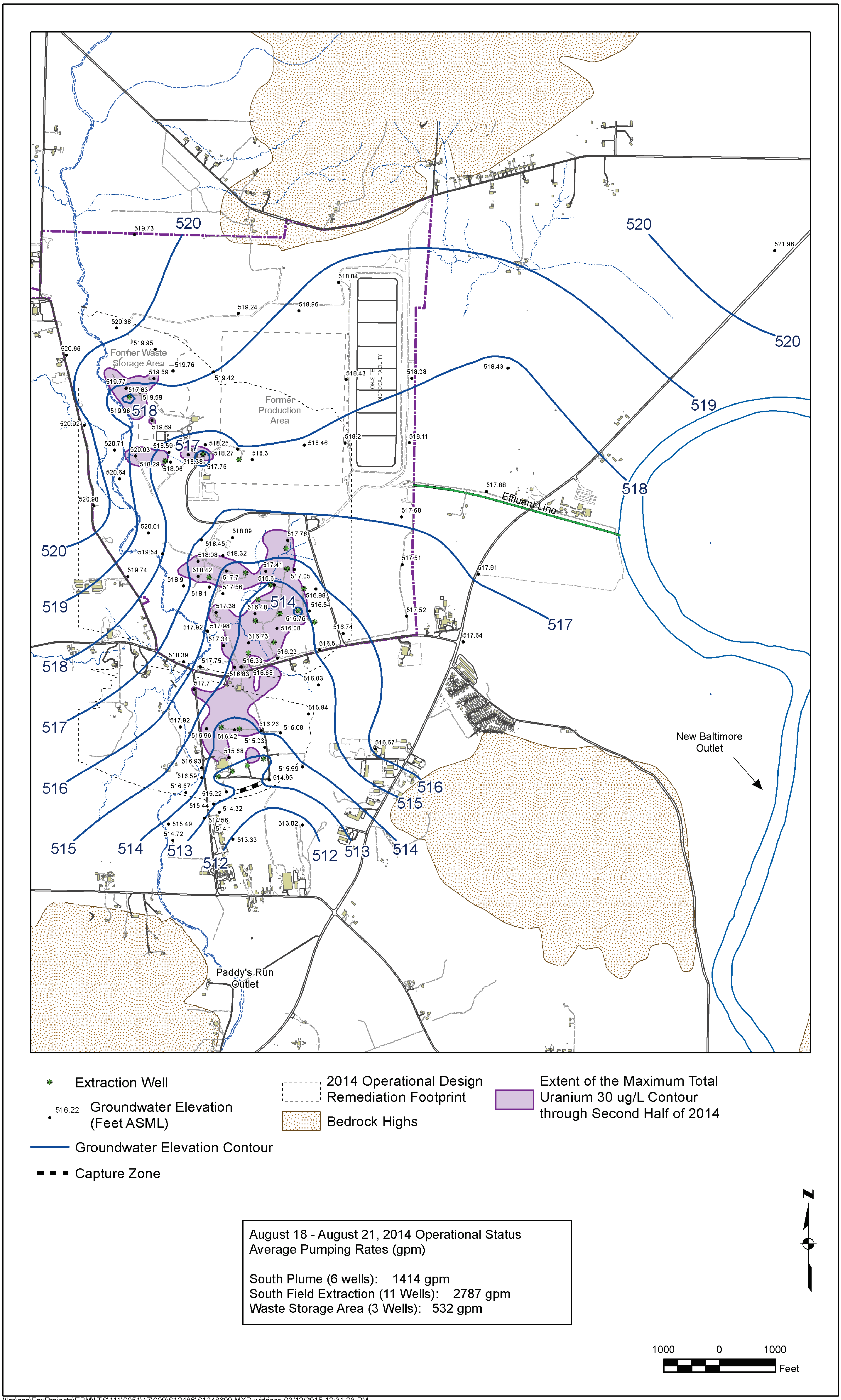

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Figure A.3-3. Routine Groundwater Elevation Map, Third Quarter 2014 (August 18 Through August 21, 2014)

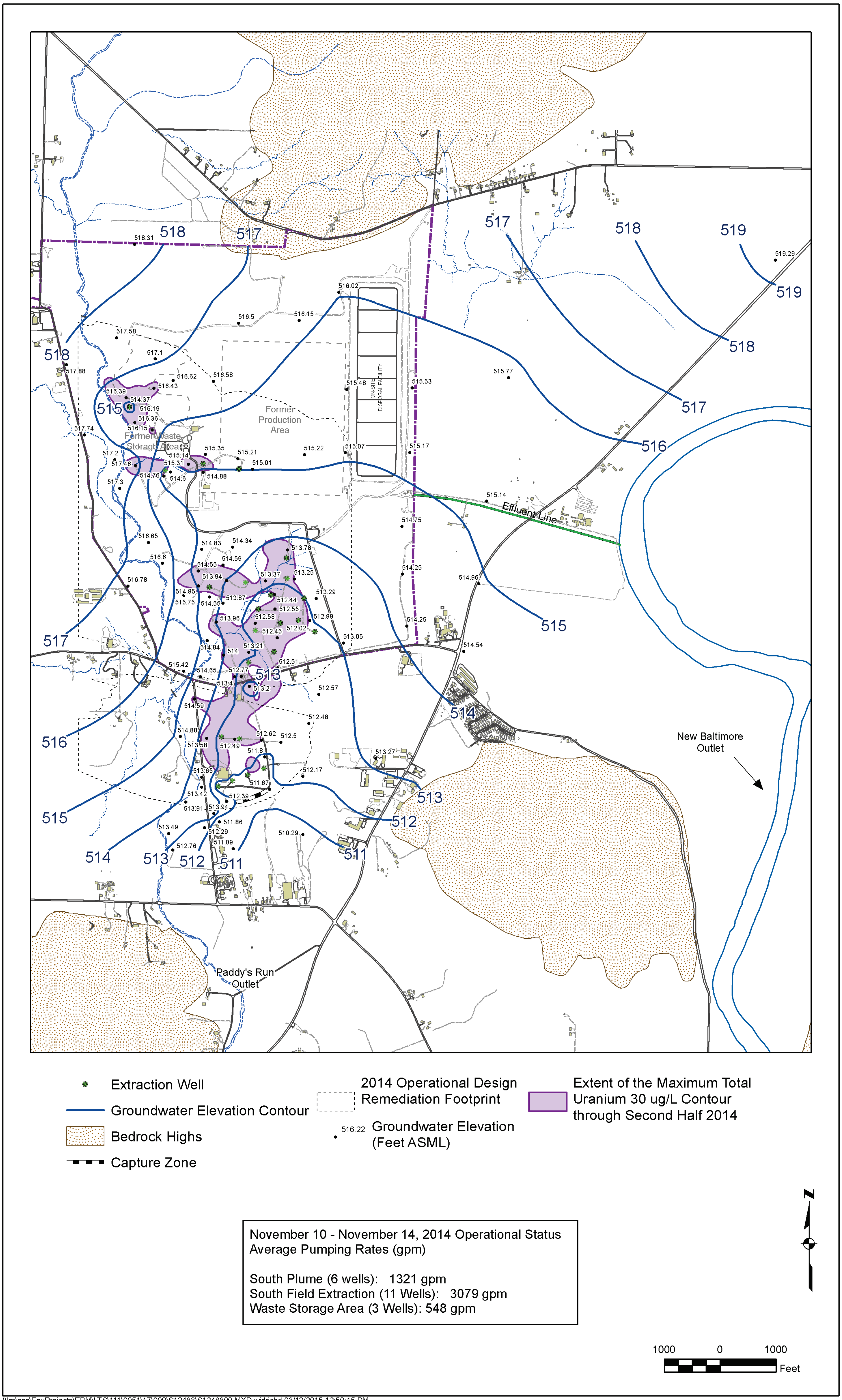

Figure A.3-4. Routine Groundwater Elevation Map, Fourth Quarter 2014 (November 10 Through November 14)

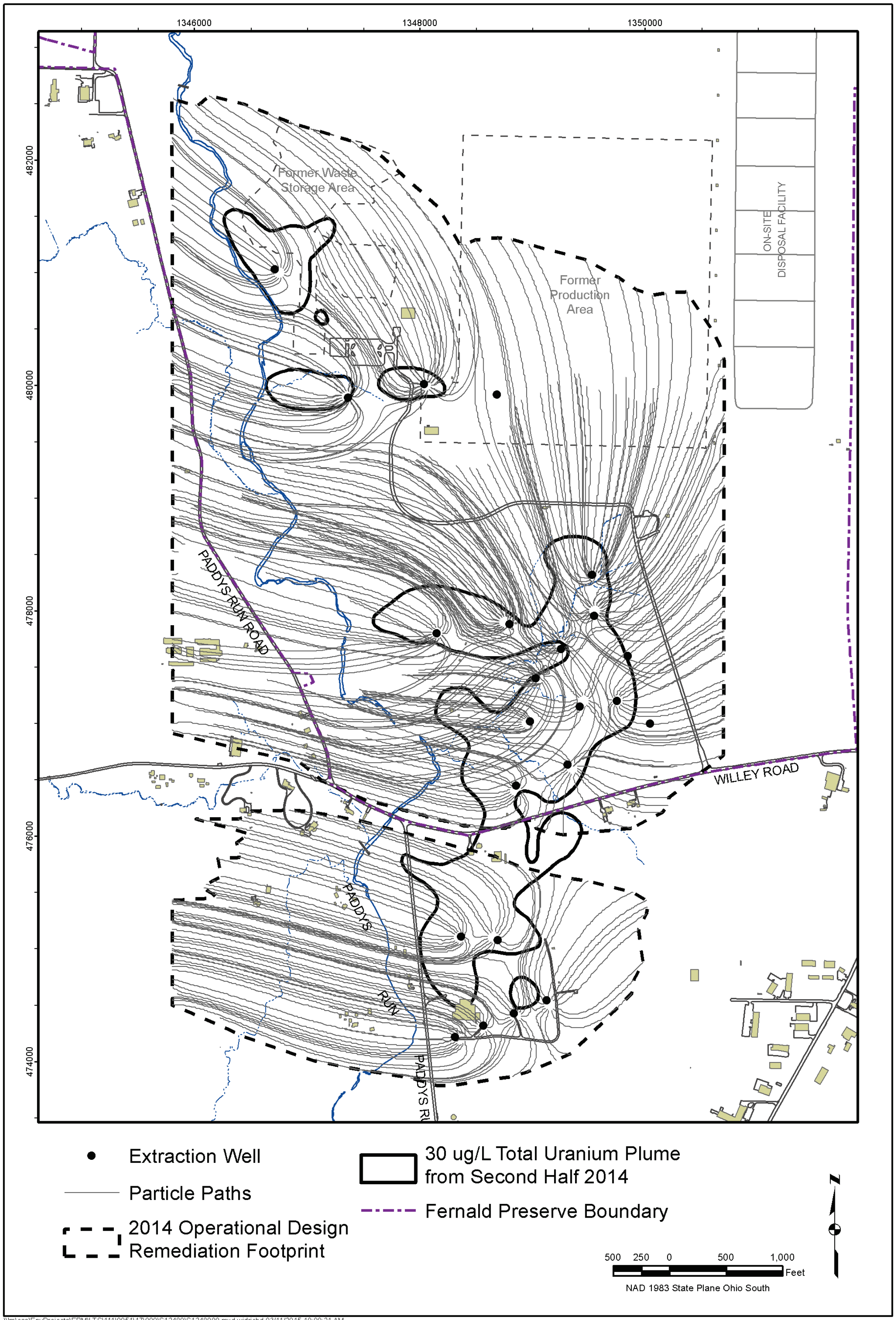

Figure A.3-5. 2014 Operational Design Adjustment Remediation Footprint

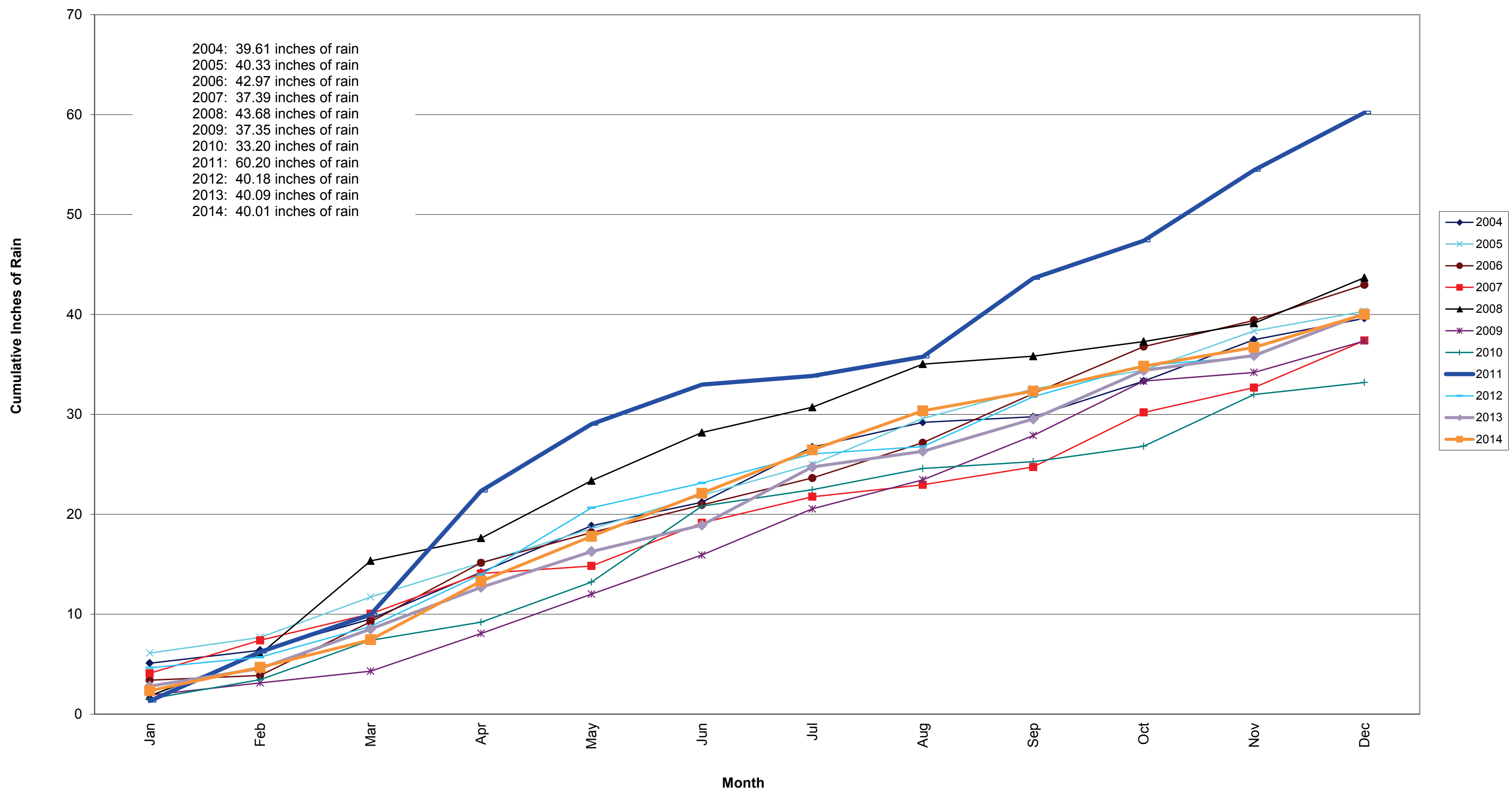

Figure A.3-6. Cumulative Annual Precipitation: 2004 through 2014 as Recorded at the Butler County Regional Airport

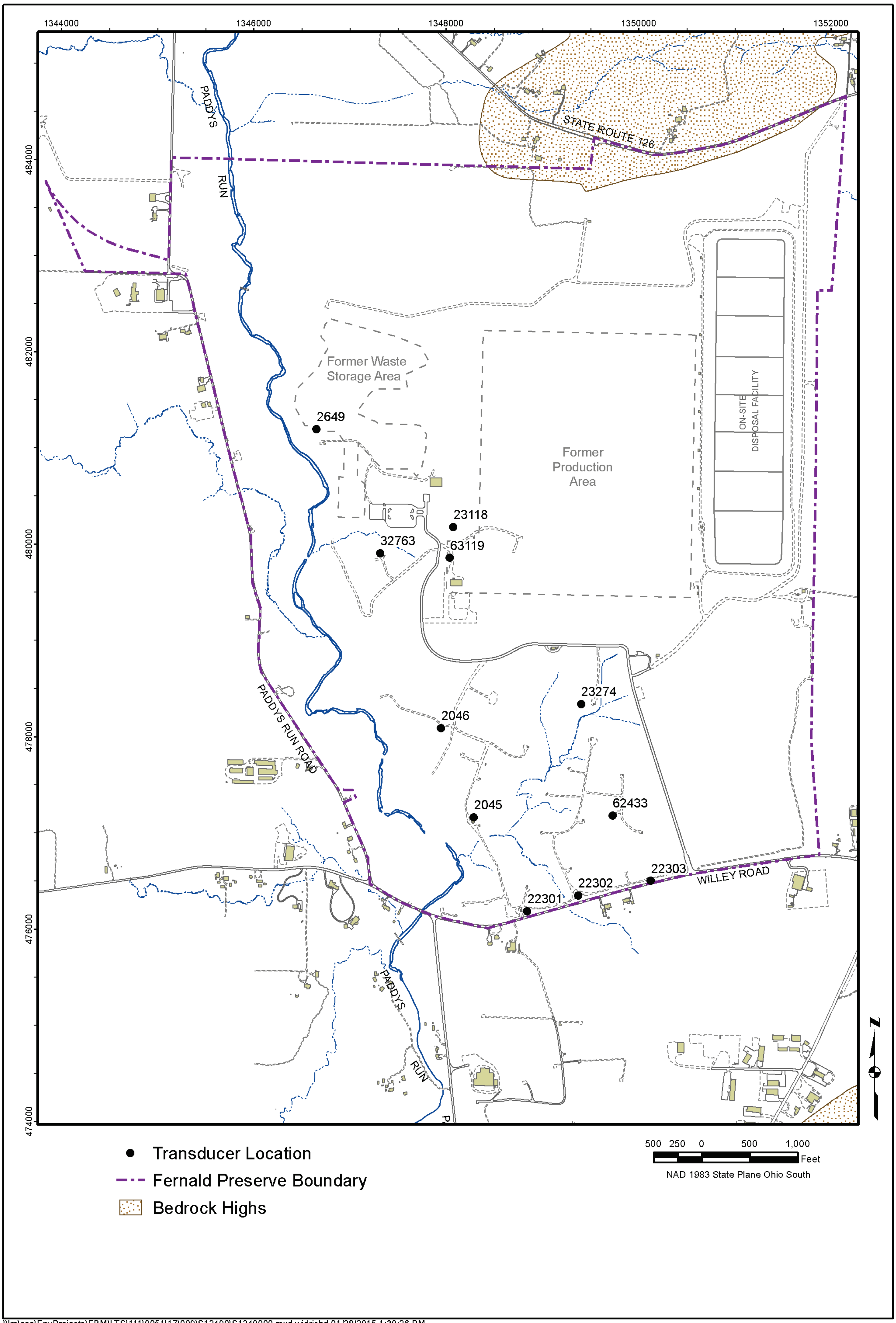

Figure A.3-7. Transducer Locations for the 2014 Operational Shutdown

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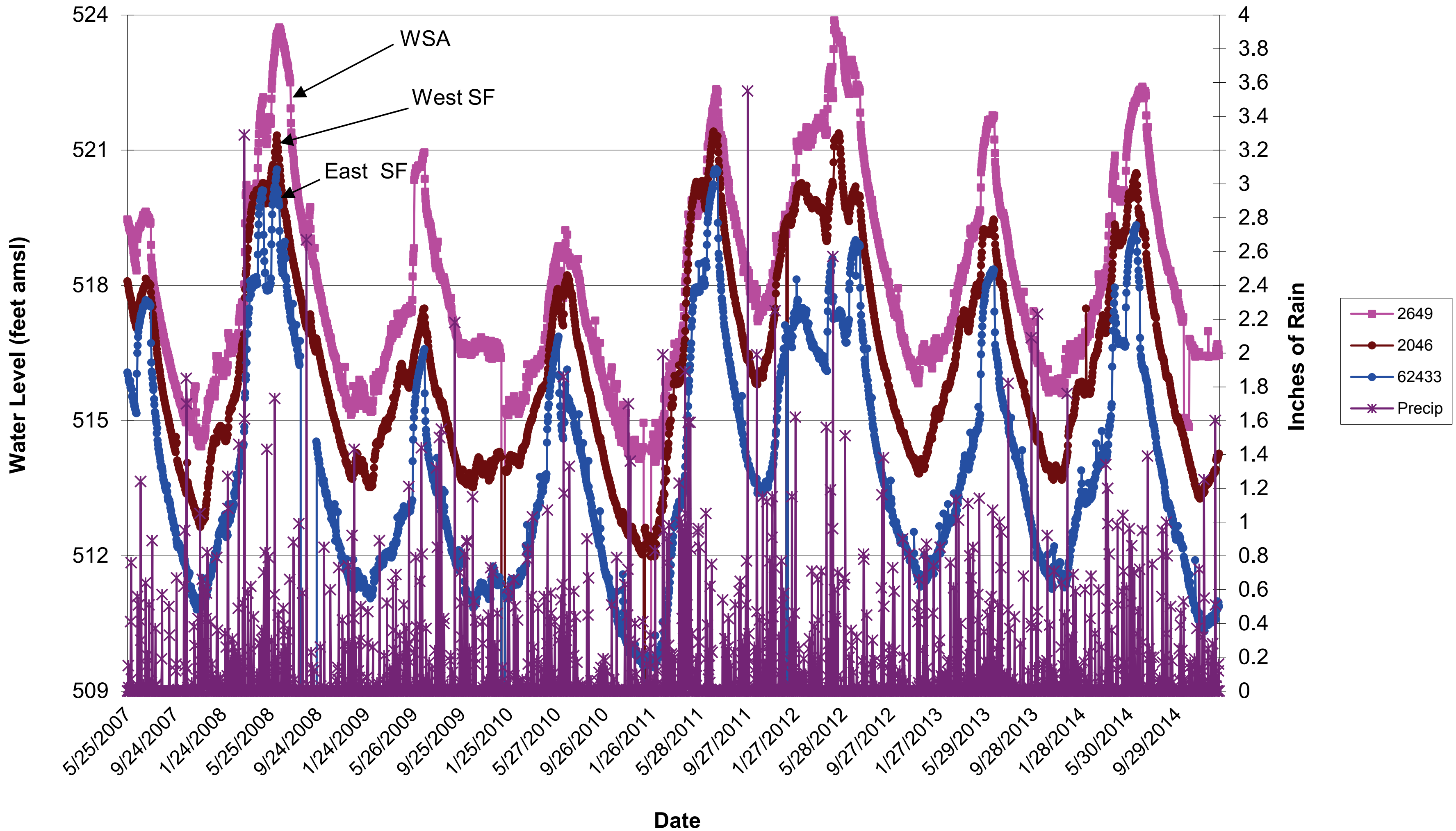

Figure A.3-8. Water Levels Versus Precipitation May 25, 2007 Through January 13, 2015

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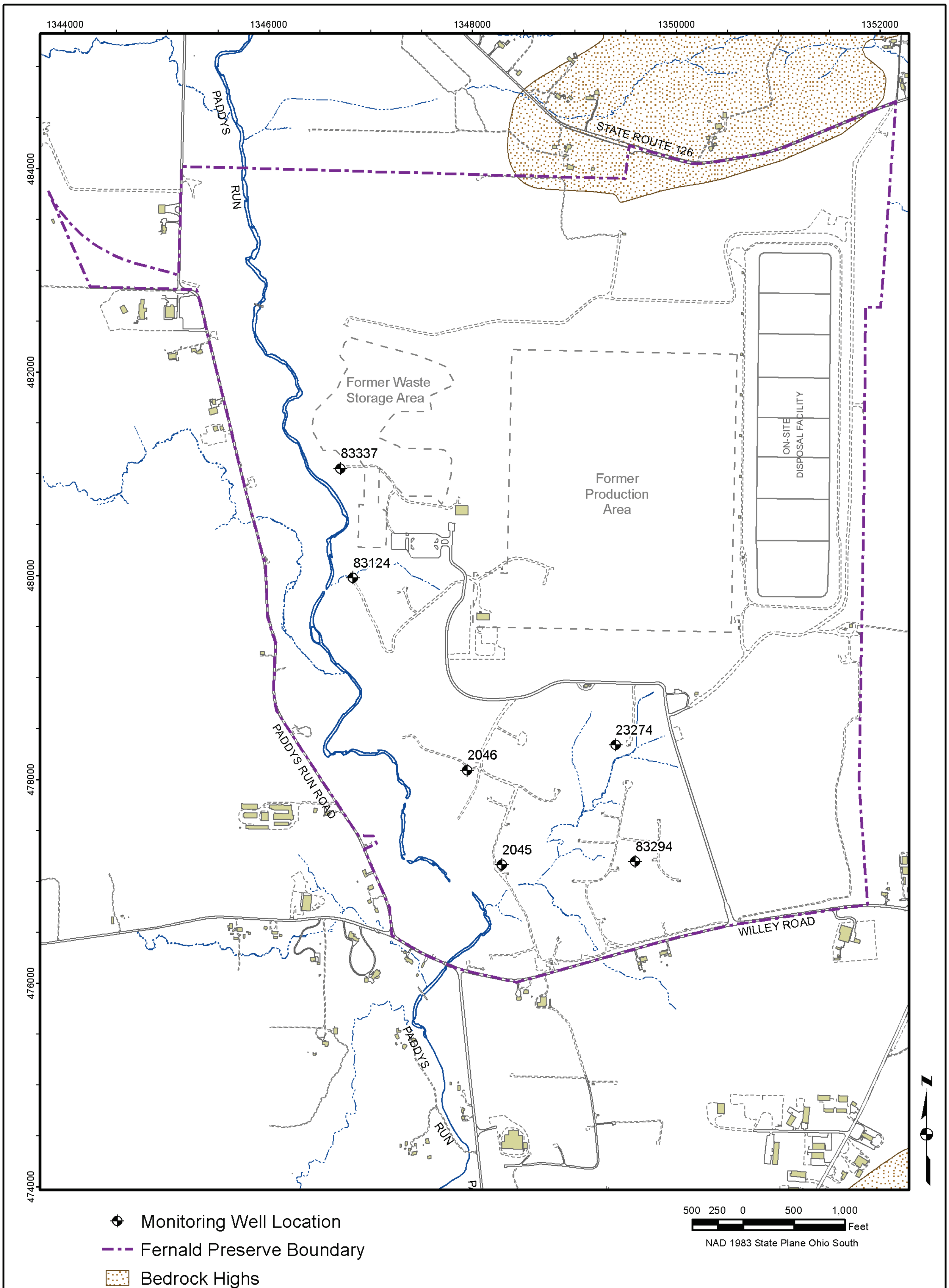

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Figure A.3-9. Monitoring Well Locations for the 2014 Operational Shutdowns

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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 2014 collected under the Integrated Environmental Monitoring Plan (IEMP) which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (DOE 2015). The purpose of the evaluation is to:

- Identify 2014 non-uranium FRL exceedances (Section A.4.1).
- Determine the persistence of non-uranium FRL exceedances outside the new 2014 Operational Design remediation footprint (Section A.4.2).
- Present conclusions (Section A.4.3).

A.4.1 Non-Uranium FRL Exceedances for 2014

Table A.4-1 shows the summary statistics and trend analysis for the 2014 non-uranium FRL exceedances from monitoring wells both inside and outside the 2014 Operational Design remediation footprint. As indicated in Table A.4-1, five non-uranium FRL constituents had one or more FRL exceedances during 2014. Figure A.4-1 identifies the location of these FRL exceedances.

Figure A.4-1 shows that the non-uranium FRL exceedances in 2014 for monitoring wells were located in the former Waste Storage Area (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 2014 Operational Design remediation footprint. Those along the eastern property boundary and in the PRRS area were located outside the 2014 Operational 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 since 1997. The first column in Table A.4-2 lists the groundwater FRL constituents monitored in 2014. 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 2014; 5 had exceedances. The following table summarizes the 2014 non-uranium monitoring information:

Constituent	Monitoring Program	2014 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	No exceedances
Manganese	Property/Plume Boundary, Waste Storage Area	Exceedances in former WSA wells, and along the eastern site boundary
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	No exceedances
Zinc	Property/Plume Boundary	Exceedances along the eastern site boundary and in the PRRS area

A.4.1.1 Direct-Push Sampling Results for 2014

In 2014, four direct-push sampling locations in the former WSA were sampled for non-uranium constituents specified in the IEMP for the former WSA (locations 12618D, 13467, 13469, and 13480). These locations are identified in Attachment A.2, Figure A.2-5. Direct-push sampling results for 2014 are provided for locations 12618D, 13467, 13469, and 13480 in Tables A.2-4, A.2-1, A.2-3, and A.2-2, respectively. Non-uranium results are discussed below.

<u>Location 12618D</u>

This direct-push location was sampled previously in 1999, 2004, and 2011. The location sampled in 1999 was identified as 12618. The location sampled in 2004 was identified as 12618B. The location sampled in 2011 was identified as 12618C. The sample collected in 2014 was identified as location 12618D. Direct-push sampling results for location 12618D are provided in Table A.2-4. The location is identified in Figure A.2-3A. Non-uranium concentrations from all sampling dates are provided below. The data indicates that in 2014, no non-uranium FRL exceedances were detected.

Constituent (Units)	Groundwater FRL	12618 (1999)	12618B (2004)	12618C (2011)	12618D (2014)
Technetium-99 (pCi/L)	94	<2.1	6.9	<0.688	1.19
Nitrate/Nitrite (mg/L)	11	NS	2.79	2.89	1.18
Manganese (mg/L)	0.90	NS	**1.99**	0.644	0.383
Molybdenum (mg/L)	0.1	NS	0.0231	0.0241	0.0826
Nickel (mg/L)	0.1	NS	0.0658	0.0126	0.00647

Bold indicates concentrations above FRL.
NS = not sampled
mg/L = milligrams per liter
pCi/L = picocuries per liter

As indicated above, in 2014, no non-uranium FRL exceedances were detected.

<u>Location 13467</u>
Direct-push sampling results for location 13467 are provided in Table A.2-1. The location is identified in Figure A.2-3A. An FRL exceedance for manganese and molybdenum were measured. A manganese concentration of 1.01 milligrams per liter (mg/L) was measured which exceed the manganese FRL of 0.90 mg/L and a molybdenum concentration of 0.119 mg/L exceeded the molybdenum FRL of 0.1 mg/L.

<u>Location 13469</u>
Direct-push sampling results for location 13469 are provided in Table A.2-3. The location is identified in Figure A.2-3A. The data indicates that no non-uranium FRL exceedances were detected in 2014.

<u>Location 13480</u>
Direct-push sampling results for location 13480 are provided in Table A.2-2. The location is identified in Figure A.2-3A. The data indicates that no non-uranium FRL exceedances were detected in 2014.

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 2014 Non-Uranium FRL Exceedances Outside the 2014 Operational Design Remediation Footprint

This section presents an evaluation of the persistence of non-uranium FRL exceedances outside the 2014 Operational 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 was updated once again in 2014 to reflect capture during the time period modeled for the 2014 Operational Adjustment Design (DOE 2014). The footprint for the 2014 Operational Adjustment Design 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 2014 Operational 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 2013 requiring additional data to be collected through routine monitoring in 2014. The exceedances were for lead in well 2625; manganese in well 2625 and 2733; and zinc in well 2733. The non-uranium FRL exceedances for 2014 along with the possible persistent exceedances identified in 2013 are addressed below.

Figure A.4-1 and the shaded portion of Table A.4-1 identify the 2014 non-uranium FRL exceedances outside the 2014 Operational Design remediation footprint. In 2014, two constituents had one or more FRL exceedance at five wells located outside the 2014 Operational Design remediation footprint:

- Manganese at monitoring wells 22204, and 22217.
- Zinc at monitoring wells 22200, 22206, and 2625.

Table A.4-3 addresses possible persistent FRL exceedances that occur outside the 2014 Operational Design remediation footprint and includes the exceedances for 2014 listed in the bullets above, as well as those still being evaluated or deemed persistent from 2013. 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 exceedance for manganese at monitoring well 22204 was identified as being persistent in 2014. 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 lead FRL exceedance in monitoring well 2625 detected in the first half of 2013 was found to be not persistent in 2014.
- The manganese FRL exceedance at monitoring well 22204 was found to be persistent in 2013 remains persistent in 2014.
- The manganese FRL exceedance at monitoring well 22217 detected in the first half of 2014 requires that additional data be collected through routine monitoring in 2015 to determine the persistence of the exceedance.
- The manganese FRL exceedance at monitoring well 2625 in the first half of 2013 was found to be not persistent in 2014.
- The manganese FRL exceedance at monitoring well 2733 in the first half of 2013 and the first half of 2014 requires that additional data be collected through routine monitoring in 2015 to determine the persistence of the exceedance.
- The zinc FRL exceedance at monitoring well 2625 in the first half of 2014 requires that additional data be collected through routine monitoring in 2015 to determine the persistence of the exceedance.
- The zinc FRL exceedance at monitoring well 2733 in the first half of 2013 was found to be not persistent in 2014.
- The zinc FRL exceedance at monitoring well 22206 in the second half of 2014 requires that additional data be collected through routine monitoring in 2015 to determine the persistence of the exceedance.
- The zinc FRL exceedance at monitoring well 22200 in the second half of 2014 requires that additional data be collected through routine monitoring in 2015 to determine the persistence of the exceedance.

Figures A.4-2 through A.4-10 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 semiannually as reflected in Table A.4-3 and Figures A.4-2 through A.4-10.

The evaluation for persistence of non-uranium FRL exceedances in wells located outside the 2014 Operational Design remediation footprint in 2014 marks 18 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.

Manganese was a process chemical used in the Former Production Area. The manganese groundwater FRL is 0.90 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 well 22204.

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 2014 Operational Design and are within capture of the groundwater remediation system.
- One persistent non-uranium FRL exceedance outside the 2014 Operational Design footprint was identified in 2014; manganese at monitoring well 22204. The exceedance for manganese is attributed to a background definition issue. A change in the design of the aquifer remedy to address the manganese exceedance is not being considered at this time.
- Additional routine data to be collected in 2015 are required to evaluate exceedances for manganese and zinc identified in Table A.4-3.

A.4.4 References

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DOE (U.S. Department of Energy), 2015. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 8, Office of Legacy Management, January.

Table A.4-1. Summary Statistics and Trend Analysis for Non-Uranium Constituents with 2014 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 2014[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]
Manganese (0.90 mg/L)	2010	27	22	1	0.146	6.74	2.37	1.84	No Trend
	22204	45	40	4	0.418	3.01	1.39	0.48	No Trend
	22217	21	12	1	0.196	1.57	0.980	0.390	No Trend
Molybdenum (0.10 mg/L)	2649	29	29	2	0.178	1.26	0.520	0.250	No Trend
Nitrate + Nitrite as N (11 mg/L)[h]	2821	39	22	2	1.38	120	28.4	30.4	Up
	83338_C1	12	7	2	0.404	73.8	34.5	29.0	Up
	83338_C2	17	10	1	1.98	109	24.0	27.0	No Trend
	83340_C1	13	12	2	9.50	58.2	26.6	16.5	Down
	83340_C2	16	16	2	12.5	86.7	49.0	25.8	No Trend
	83340_C3	16	15	2	1.13	133	51.6	38.4	Down
	83341_C2	16	3	1	0.090	54.5	10.5	15.0	No Trend
Zinc (0.021 mg/L)					(mg/L)	(mg/L)	(mg/L)	(mg/L)	
	22200	21	4	1	0.00165	0.0457	0.0150	0.0120	No Trend
	22206	21	1	1	0.00165	0.0499	0.0090	0.0100	No Trend
	2625	12	8	1	0.00325	0.199	0.0470	0.0540	Up
Technetium-99 (94 pCi/L)					(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	
	2649	37	37	2	101	1660	600	456	No Trend
	83338_C1	12	7	2	10.1	321	139	120	Up
	83338_C2	17	11	1	7.12	587	149	140	No Trend
	83340_C1	13	13	2	147	817	290	175	No Trend

Notes: Shading indicates well is outside the 2014 Operational Design remediation footprint.
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 2014.
[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 2014.
[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 2014 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		2014	
				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	1	2
Antimony																																						
	22198	0	P/PB																									1	1									
	22199	0	P/PB																									1										
	22204	0	P/PB																									1										
	22205	0	P/PB																									1										
	22208	0	P/PB													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 2014 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		2014	
				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	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	1	
	22198	0	P/PB											1																								
	22201	0	OSDF																							1		1	1	1	2		1		1			
	22204	0	P/PB-OSDF												1			1	1	1	1	1	1	1	1	1	2	2	2	1	1	2	2	2	2	2	2	2
	22205	0	P/PB-OSDF																	1										1								
	22212	3	OSDF																													1						
	22214	0	P/PB-OSDF																													1						
	22215	3	OSDF																												1	1						
	22217	3	OSDF																								1		1	2		1	2	2	2		1	
	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	1	1

Table A.4-2 (continued). Groundwater FRL Exceedances From 1997 Through 2014 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		2014	
				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	1	2
Nickel																																						
	22198	0	P/PB					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											
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	1	1
	3821	1	WSA							1										1				1			1	1	1	1	1	1						
	83338_C1	1	WSA																										1		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		
	83340_C1	1	WSA																				1		1	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	1	1
	83340_C3	1	WSA																				1	1	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				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	1	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	WSA																										1		1	1	1		1		1	1
	83338_C2	1	WSA																					1				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	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 2014 Quarterly/Semiannually

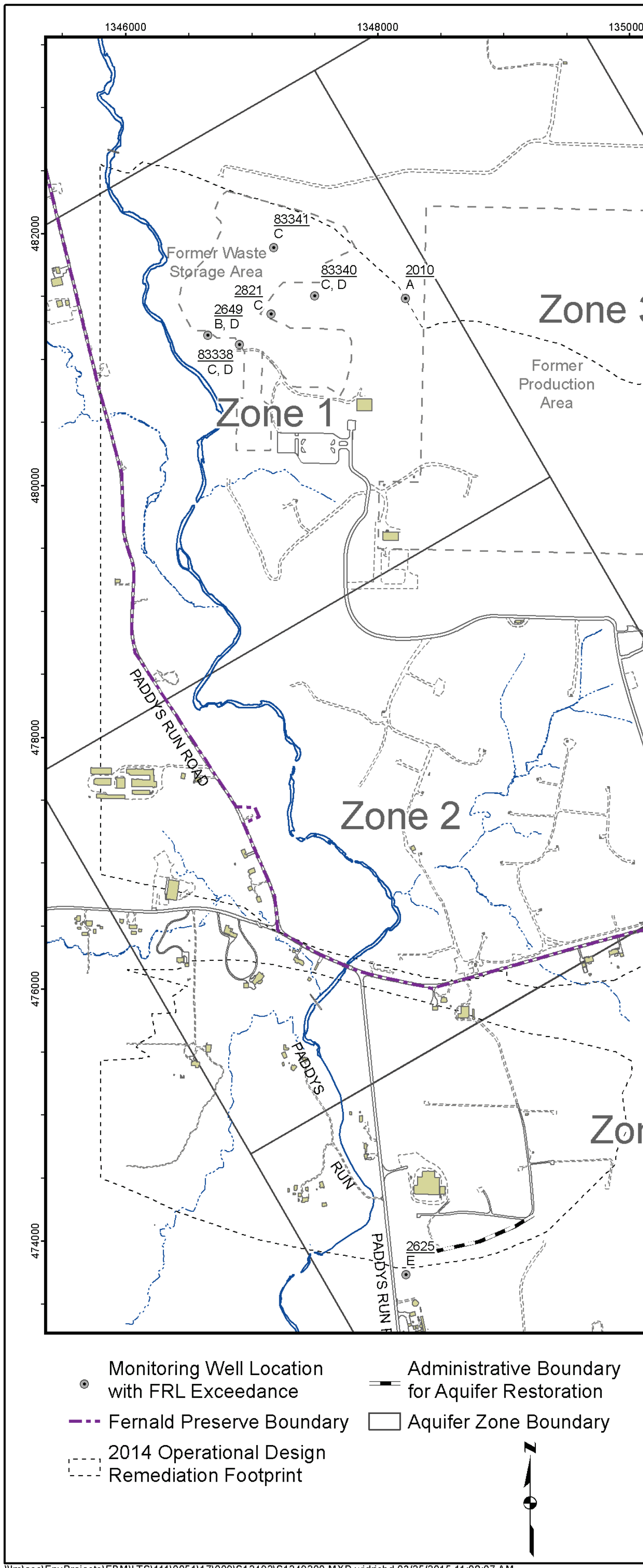
Constituent	Well[a]	Aquifer Zone	Project[b]	1997	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014	
				2[c]	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Zinc																																						
	22198	0	P/PB-OSDF																										1									
	22199	0	P/PB												1																							
	22200	0	OSDF																										1		1					1		1
	22204	0	P/PB-OSDF												1										1				1									
	22206	3	OSDF																																			1
	22210	0	P/PB-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	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 2014 Operational Design remediation footprint.
[a] A "1" denotes an exceedance for one of the two quarters and a "2" denotes an exceedance for both sampling events.
[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 2014 Operational Design Remediation Footprint

Constituent	Monitoring Well	Pertinent 2013 Results[a]	2014 FRL Exceedance		Evaluation Results for 2014	Figure Number
			First Half	Second Half		
Lead	2625	Additional Routine Data Required	No	No	Not Persistent	A.4-2
Manganese	22204[b]	**Persistent**	Yes	Yes[c]	**Persistent**	A.4-3
	22217	**Persistent**	Yes	No	Additional Routine Data Required	A.4-4
	2625	Additional Routine Data Required	No	No	Not Persistent	A.4-5
	2733	Additional Routine Data Required	Yes	No	Additional Routine Data Required	A.4-6
Zinc	2625	**Persistent**	Yes	No	Additional Routine Data Required	A.4-7
	2733	Additional Routine Data Required	No	No	Not Persistent	A.4-8
	22206	NA	No	Yes	Additional Routine Data Required	A.4-9
	22200	Not Persistent	No.	Yes	Additional Routine Data Required	A.4-10

[a] NA = not applicable.
[b] Sampled more than twice in 2014 because it is also sampled for OSDF monitoring program.
[c] 22204 was sampled twice in the second half of 2014. Both results were FRL exceedances for manganese.



KEY	FRL_EXCEEDANCE
A	Manganese
B	Molybdenum
C	Nitrate + Nitrite as Nitrogen
D	Technetium-99
E	Zinc

\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12492\S1249200.MXD widrichd 03/25/2015 11:08:07 AM

Figure A.4-1. Non-Uranium Constituents with 2014 Results Above FRLs

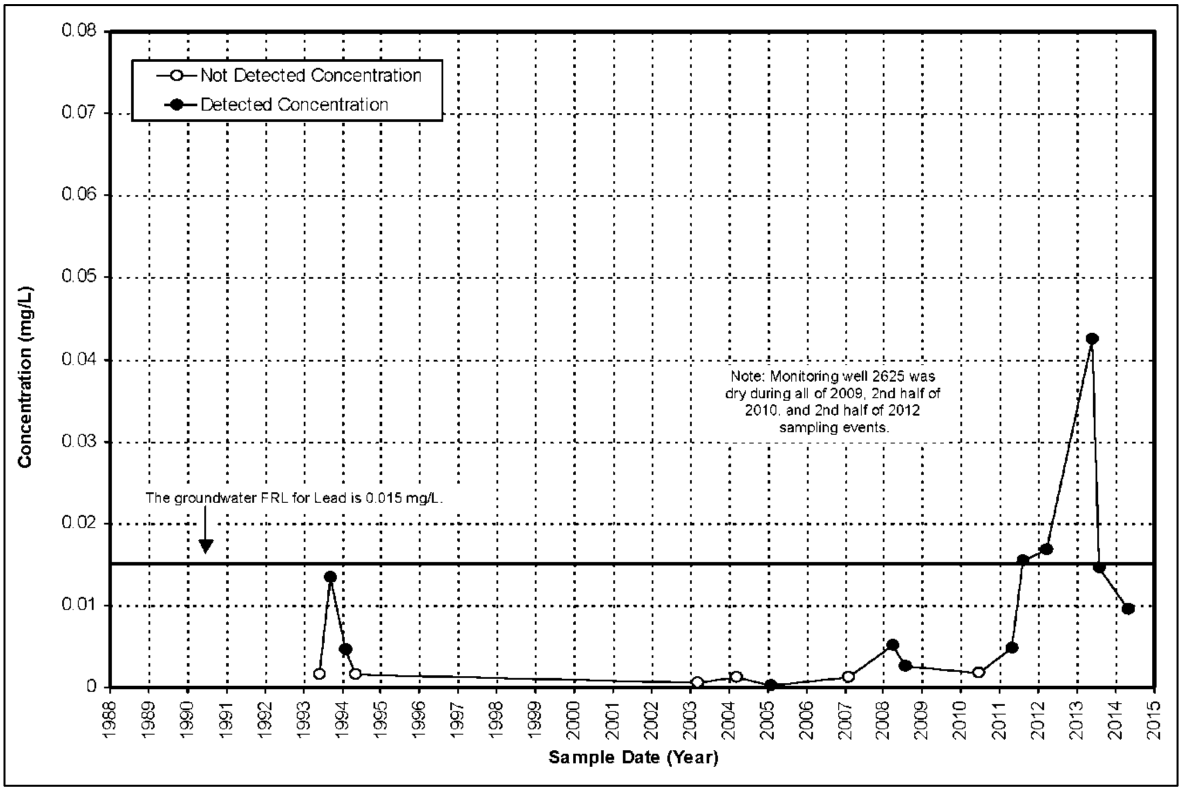


Figure A.4-2. Lead Concentration Versus Time Plot for Monitoring Well 2625

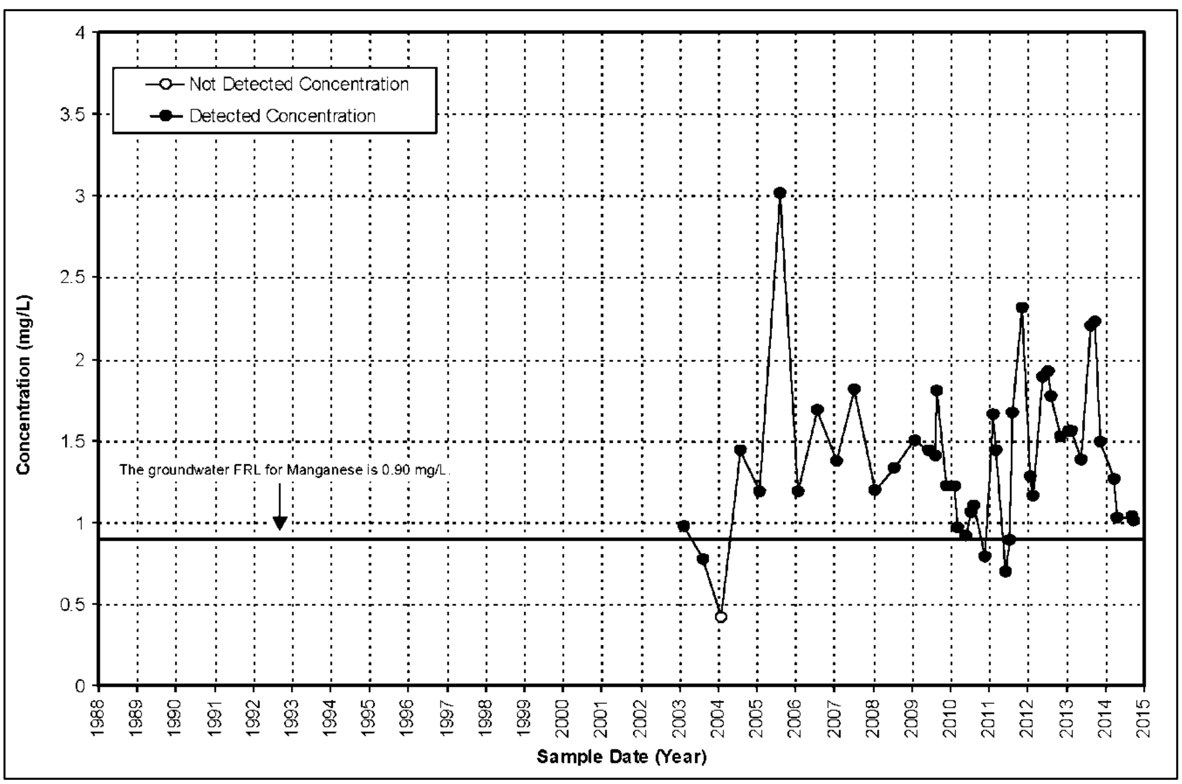


Figure A.4-3. Manganese Concentration Versus Time Plot for Monitoring Well 22204

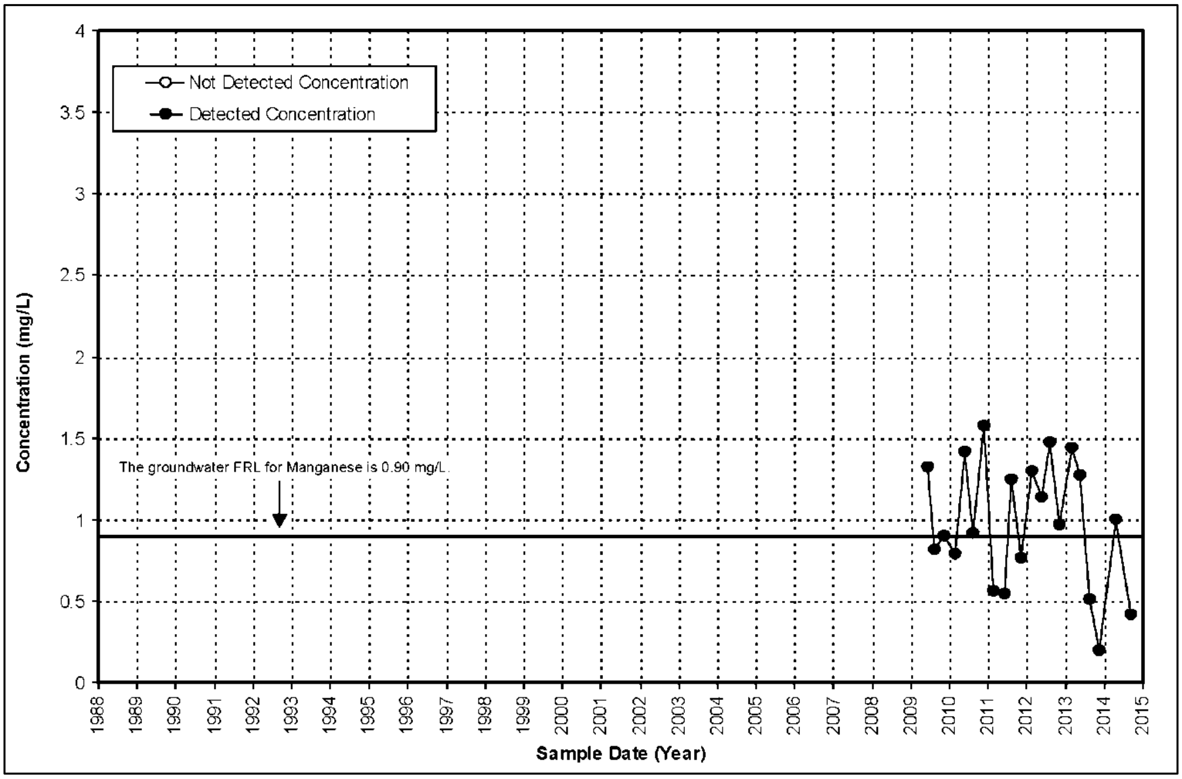


Figure A.4-4. Manganese Concentration Versus Time Plot for Monitoring Well 22217

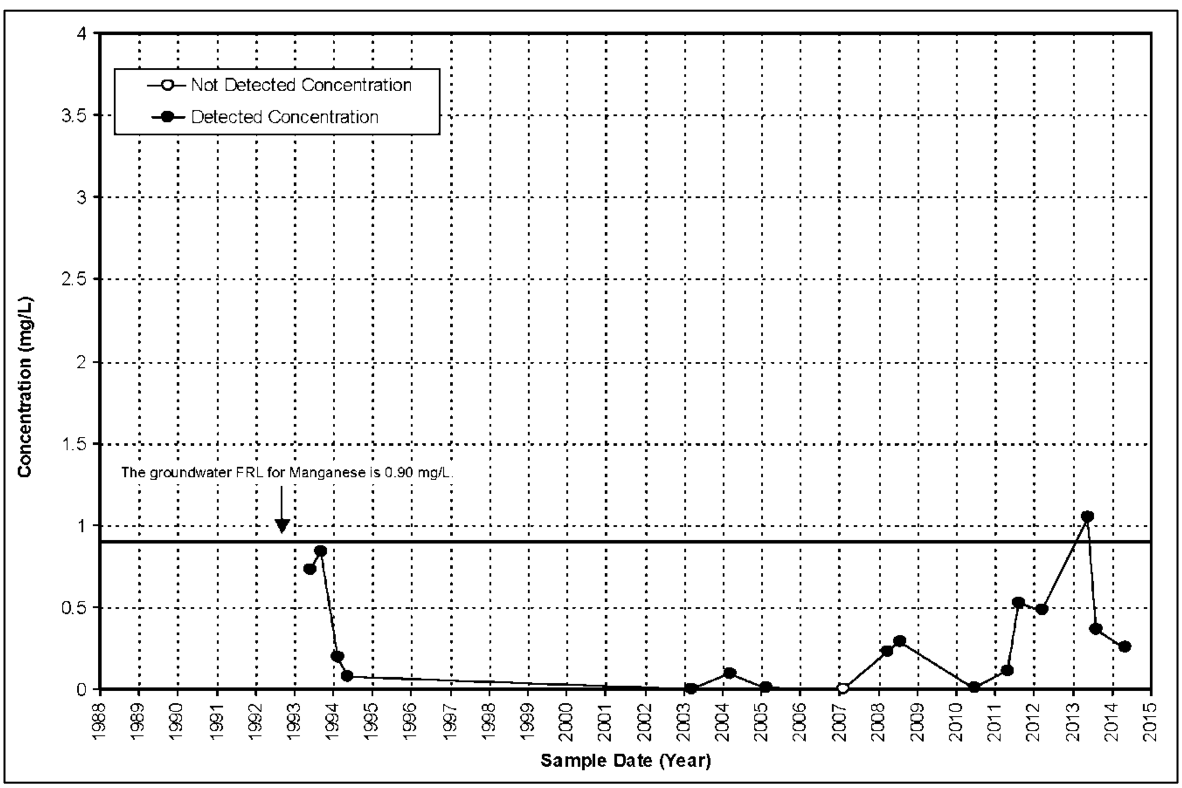


Figure A.4-5. Manganese Concentration Versus Time Plot for Monitoring Well 2625

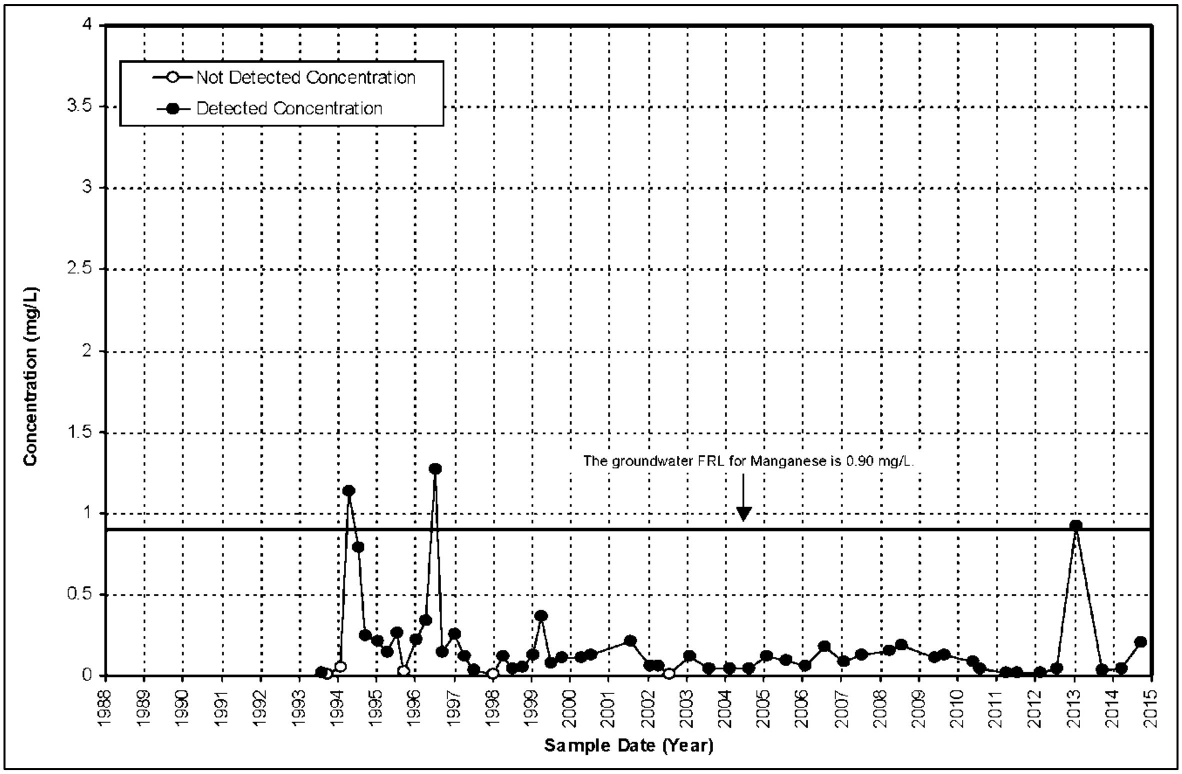


Figure A.4-6. Manganese Concentration Versus Time Plot for Monitoring Well 2733

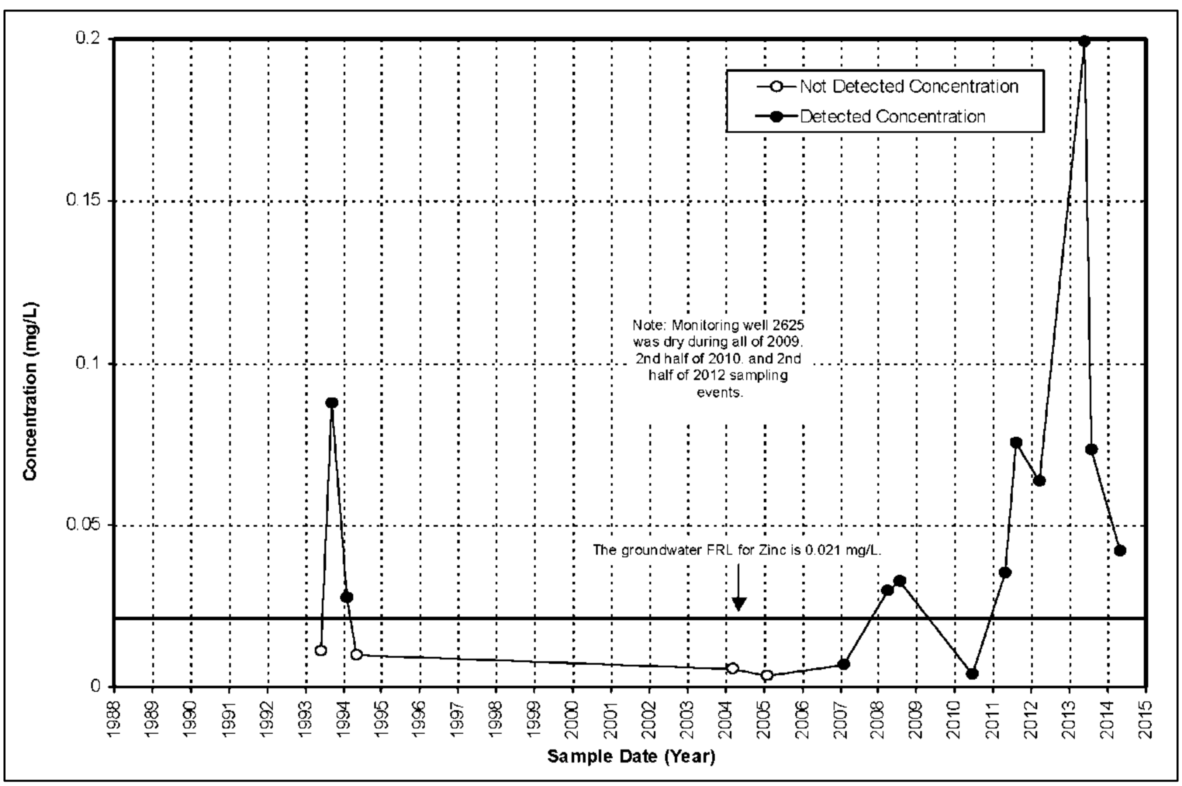


Figure A.4-7. Zinc Concentration Versus Time Plot for Monitoring Well 2625

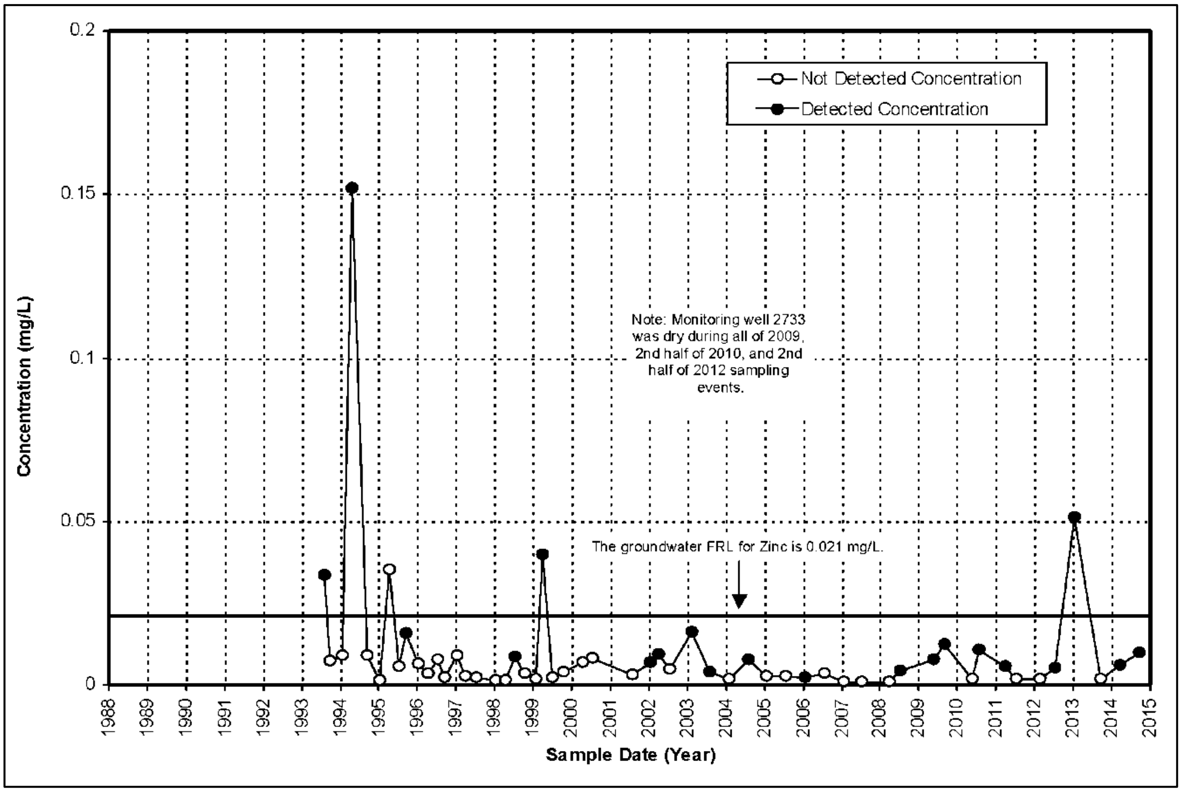


Figure A.4-8. Zinc Concentration Versus Time Plot for Monitoring Well 2733

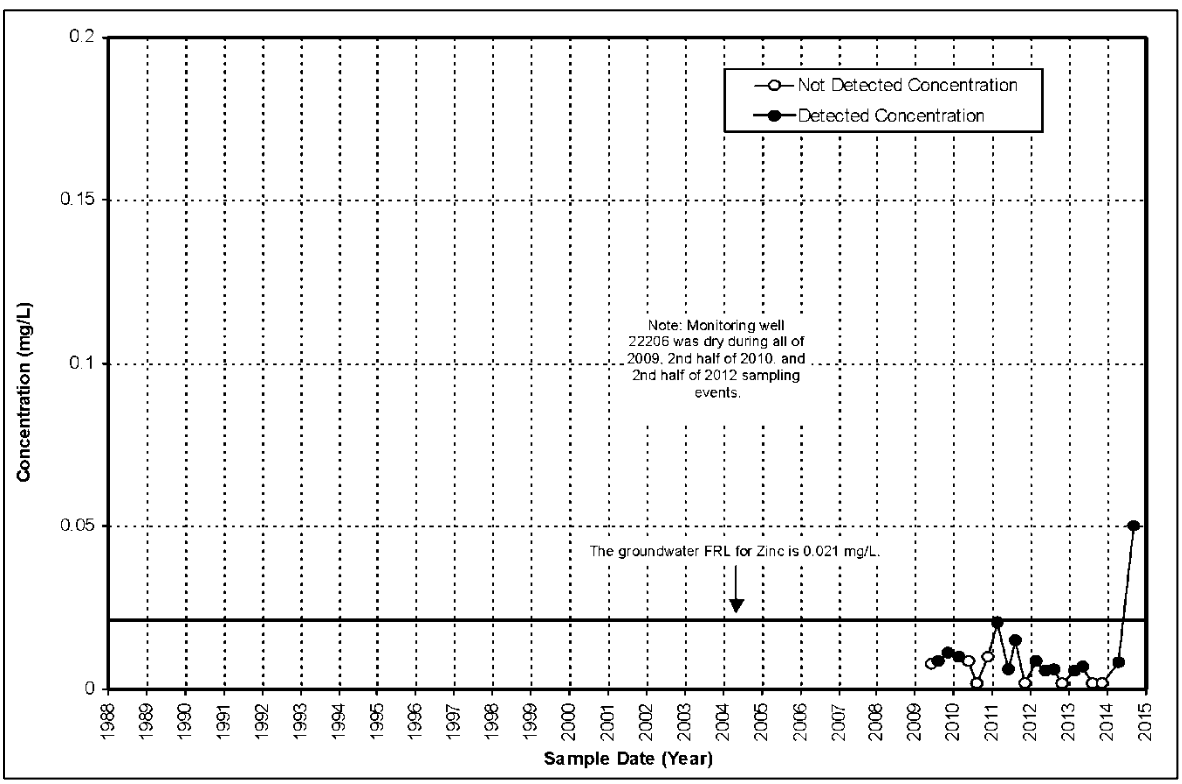


Figure A.4-9. Zinc Concentration Versus Time Plot for Monitoring Well 22206

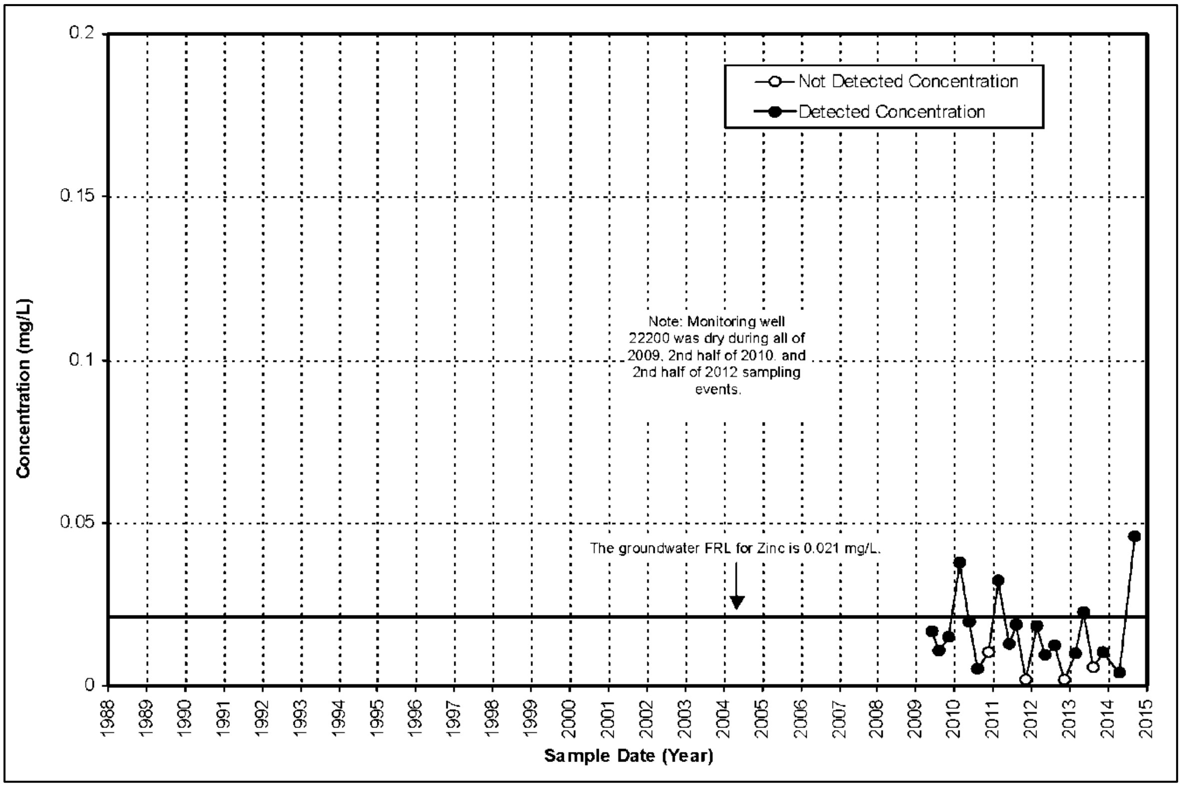


Figure A.4-10. Zinc Concentration Versus Time Plot for Monitoring Well 22220

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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
Ohio EPA	Ohio Environmental Protection Agency
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 2014. 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 2015). 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.

Facility Description

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).

Information Organization

The 2014 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/Evaluations (Section A.5.2),
- Cell Cap Inspections (Section A.5.3),
- Water Quality 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 2014, 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 2014. Figure A.5-4 is a graph that shows the annual leachate volume from 2007 through 2014. The data collected in 2014 indicate that 138,949 gallons of leachate were collected and pumped to the CAWWT Backwash Basin for subsequent treatment at the CAWWT. The total volume measured in 2014 represents a 3.3 percent decrease from the total volume measured in 2013 (143,733 gallons). The volume of precipitation that fell on the OSDF in 2014 was approximately 58.7 million gallons (40.01 inches of rain over 54.1 acres). The facility cap was designed to inhibit rainwater from infiltrating into the OSDF. Leachate collected in 2014 represents approximately 0.2 percent of the precipitation that fell on the OSDF in 2014, 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 3,883 gallons or approximately 5 percent (71,416 gallons for January–June 2014 versus 67,533 gallons for July–December 2014).

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, no LDS tanks were dry during all four quarters of 2014. The LDS of Cells 2, 3, and 4 were dry during three quarters of 2014. 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 2014 for the LDS in Cells 1, 2, 3, 4, and 5. From a sampling ability, the LDS in Cells 1, 2, 3, 4 and 5 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 2014 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	0.00	0.0
2	0.01	0.1
3	0.00	0.0
4	0.00	0.0
5	0.00	0.0
6	0.06	0.3
7	0.02	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:

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

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 2014. Quarterly apparent liner efficiencies (in percentages) are provided for Cells 1 through 8 below.

Apparent Liner Efficiency (percent), Quarterly for 2014

Quarter	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8
First	99.98	99.98	100	100	99.87	99.59	99.88	99.92
Second	99.93	100	99.96	99.98	99.97	99.28	99.97	99.86
Third	99.97	100	100	100	100	99.41	100	100
Fourth	99.98	100	100	100	100	99.83	100	99.97

A.5.1.4 HTW Water Yields

HTW water yields are monitored at each cell to document trends in perched-water purge volumes. In 2014, the HTWs were purged twice (i.e., April and September). 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:

- Semiannual 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 Semiannual Monitoring Summary Statistics

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (Ohio EPA) concurrence, the U.S. Department of Energy (DOE) changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014. 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 2014, 24 parameters were sampled semiannually 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 semiannually for arsenic, uranium, sodium, and sulfate. In addition, the LCS, LDS, and GMA wells of Cell 8 were sampled semiannually for technetium-99. Summary statistics for all of the parameters monitored semiannually 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 semiannually in the LCS, LDS, and the four parameters monitored semiannually in the HTW of each cell in 2014 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 Sub-attachments 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.

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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

One hundred and twenty-one Shewhart-CUSUM control charts were prepared in 2014 and are presented in Sub-attachments A.5.1 through A.5.8 for parameters monitored semiannually in the HTW and GMA wells in 2014 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, 78 control charts were prepared. In 2013, 127 control charts were prepared.

Of the 121 control charts presented, 116(96 percent) exhibit “in control” conditions, and 5 (4 percent) exhibit “Not in Control” conditions. The five “Not in Control” conditions were as follows:

- Cell 2 (potassium in monitoring well 22200),
- Cell 4 (zinc in monitoring well 22205),
- Cell 5 (TDS in monitoring well 22208 and calcium in monitoring well 22207), and
- Cell 6 (barium in well 22209).

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 through A.5.8 (Tables A.5.1-2 through A.5.8-2).

- One new Appendix I or PCB parameter (lead) was detected in the LCS of Cell 8 in 2014. Detection of lead in the LCS of Cell 8 in 2015 will trigger sampling for lead in the LDS of Cell 8 during the subsequent next sampling event.
- Cadmium was detected for the first time in the LCS of Cell 6 in 2013. Cadmium was not detected in the LCS of Cell 6 in 2014.

A.5.2.5 Additional LDS Monitoring

As stated in Appendix B of the GWLMP (DOE 2015) “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 has been dry since 2011. Ammonia has been detected in the LCS of Cell 3 every year since 2011.
- **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 has been dry since 2012. 1,1-dichloroethene was detected in the LCS of Cell 7 in 2011, but not in 2012, 2013, or 2014.
- **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 or 2014. 1,1-dichloroethene was detected in the LCS of Cell 8 in 2011, but not in 2012, 2013, or 2014.
- **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 or 2014.

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 2014 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 2014 (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 Sub-attachments 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 Stoller Newport News Nuclear, Inc., a wholly owned subsidiary of Huntington Ingalls Industries, Inc. 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 2014, inspections were conducted in March, June, September, and December. In 2014, there were no visual signs that the integrity of the cap had been compromised in any way.

A.5.4 Water Quality Monitoring Changes

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 2012). 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 2012). 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 was 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.

A.5.4.1 Monitoring Changes Implemented in 2011

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

- For 1 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 stemmed from an informal proposal made to DOE by Ohio EPA in February 2011 via email.

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 discontinued sampling for tritium. Quarterly sampling in the HTW continued 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.5.4.2 Monitoring Changes Implemented in 2014

Beginning in 2014:

- The sampling frequency was changed from quarterly to semiannually.
- Vanadium was removed from the semiannual monitoring list for Cell 5.

<u>Sampling Frequency Change</u>
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).

<u>Vanadium in Cell 5</u>
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 indicated that vanadium still only had 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.

<u>Specific findings are listed below:</u>

- LCS volumes continue to diminish with time, but the decline is decreasing. Total facility leachate volume in 2014 was 3.3 percent less than in 2013 (approximately 138,949 gallons compared to 143,733 gallons).
- There was not enough water in the LDS of Cells 1, 2, 3, 4, and 5 during 2014 to collect a water sample.
- The largest LDS maximum accumulation rate recorded in 2014 was 0.06 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 2014.
- 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 2014, 121data sets met the criteria for control Shewhart-CUSUM control charts. Of the 121 control charts presented for 2014, 116 (96 percent) exhibited “in control” conditions, and 5 (4 percent) exhibited “not in control” conditions.
- Annual LCS sampling for Appendix I and PCB parameters led to the following results.
  - One new Appendix I or PCB parameter (lead) was detected in the LCS of Cell 8. Detection of lead in the LCS of Cell 8 in 2015 will trigger sampling for lead in the LDS of Cell 8 during the subsequent next sampling event.
- In 2014, 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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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

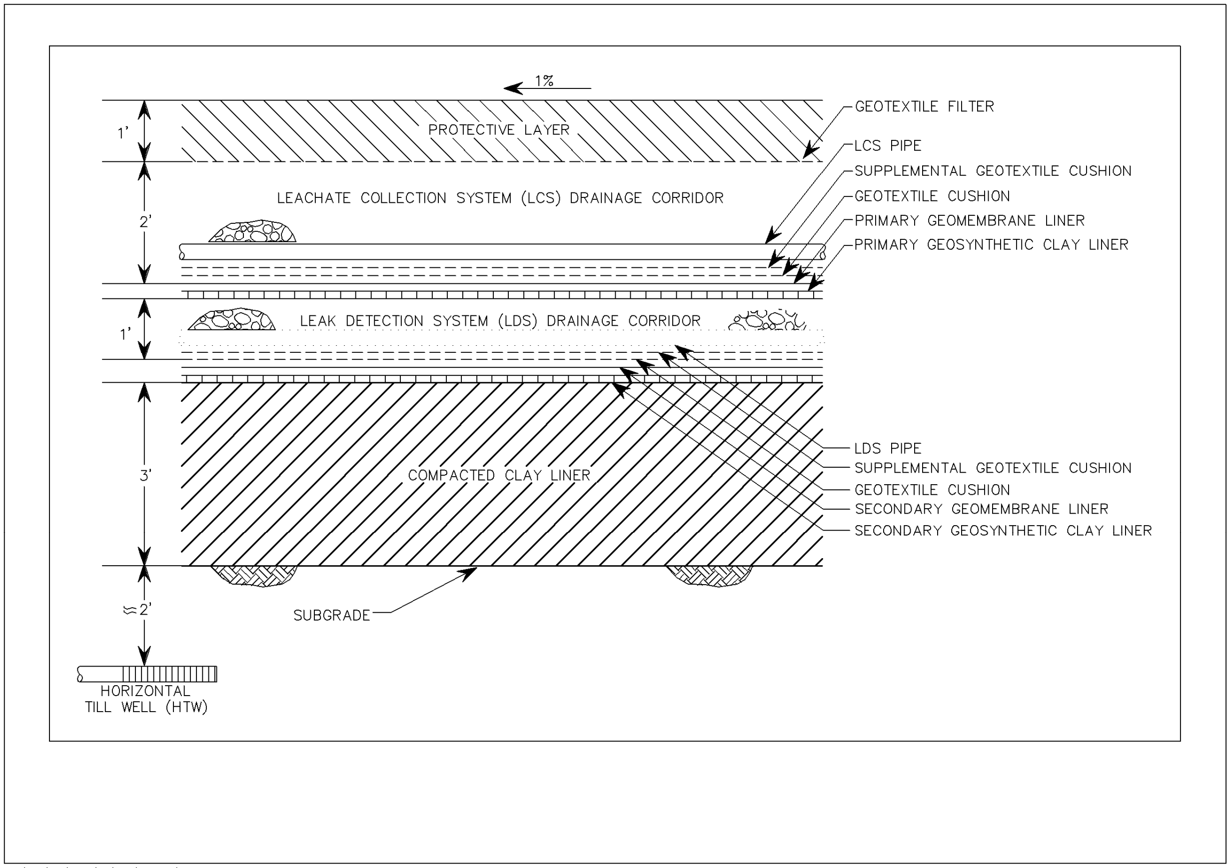
Cell	Sample Initiation per Horizon[a]	Waste Placement Initiation	LDS Volume Measurement Initiation[b]	Cap Geomembrane Layer Completion[c]	Cap Completion[d]
7	LCS: September 2, 2004 LDS: September 2, 2004 HTW: February 24, 2004 GMA-U: January 21, 2004 GMA-D: January 21, 2004	September 9, 2004	September 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.



M: /LTS/111/0051/17/008/S12493/S1249300.DWG

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

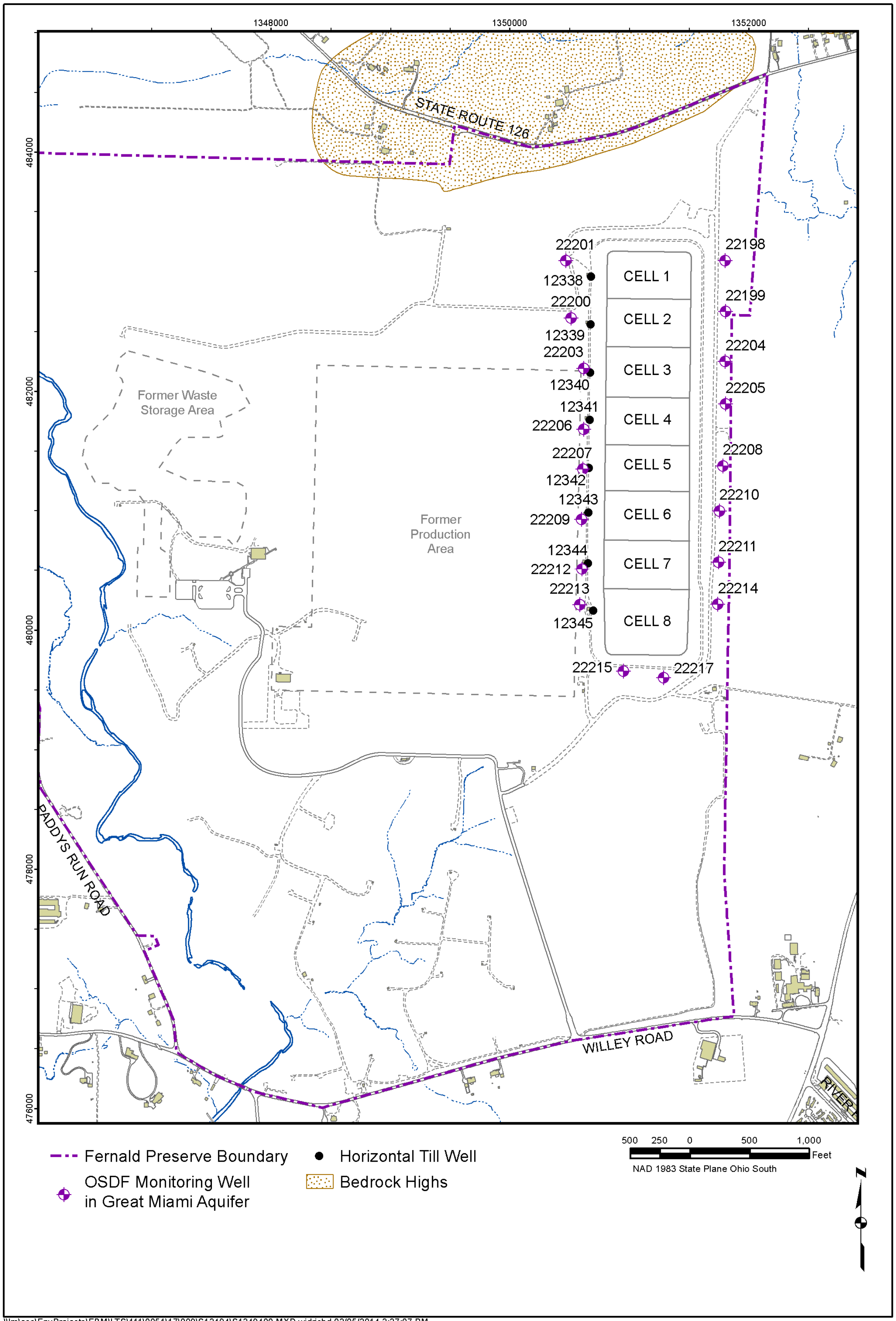


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Figure A.5-2. OSDF Footprint and Monitoring Well Locations

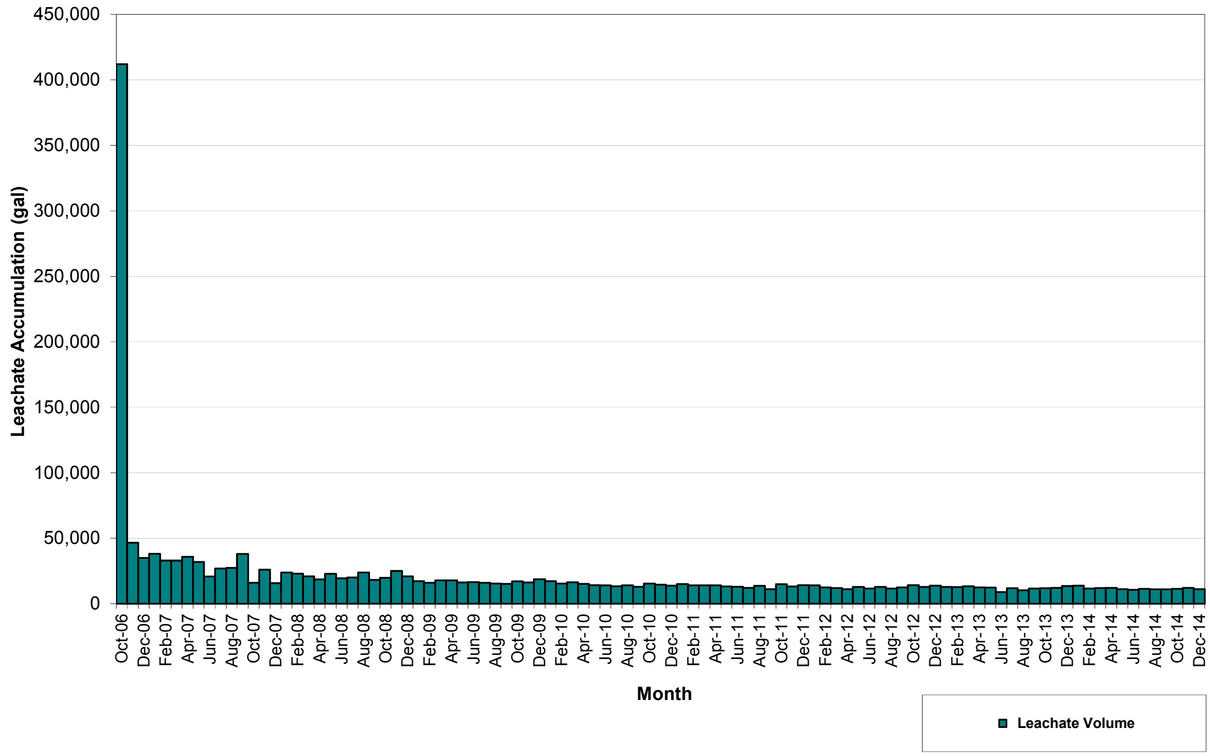

Figure A.5-3. OSDF Monthly LCS Flow (October 2006 Through December 2014)

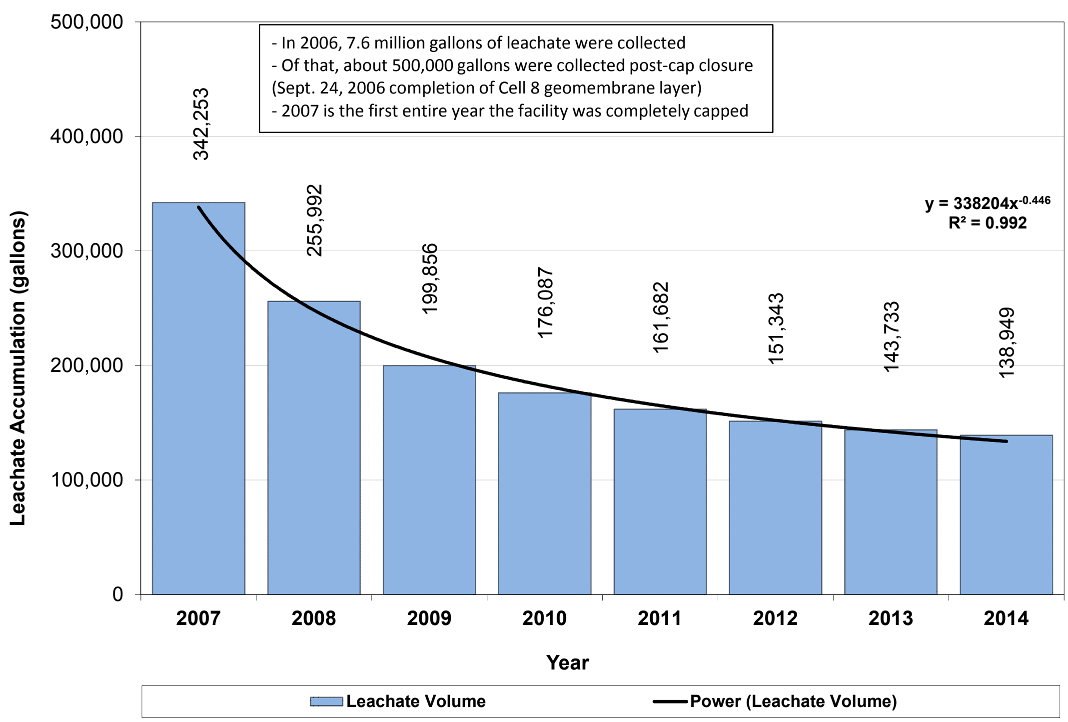

Figure A.5-4. OSDF Annual LCS Flow (2007 Through 2014)

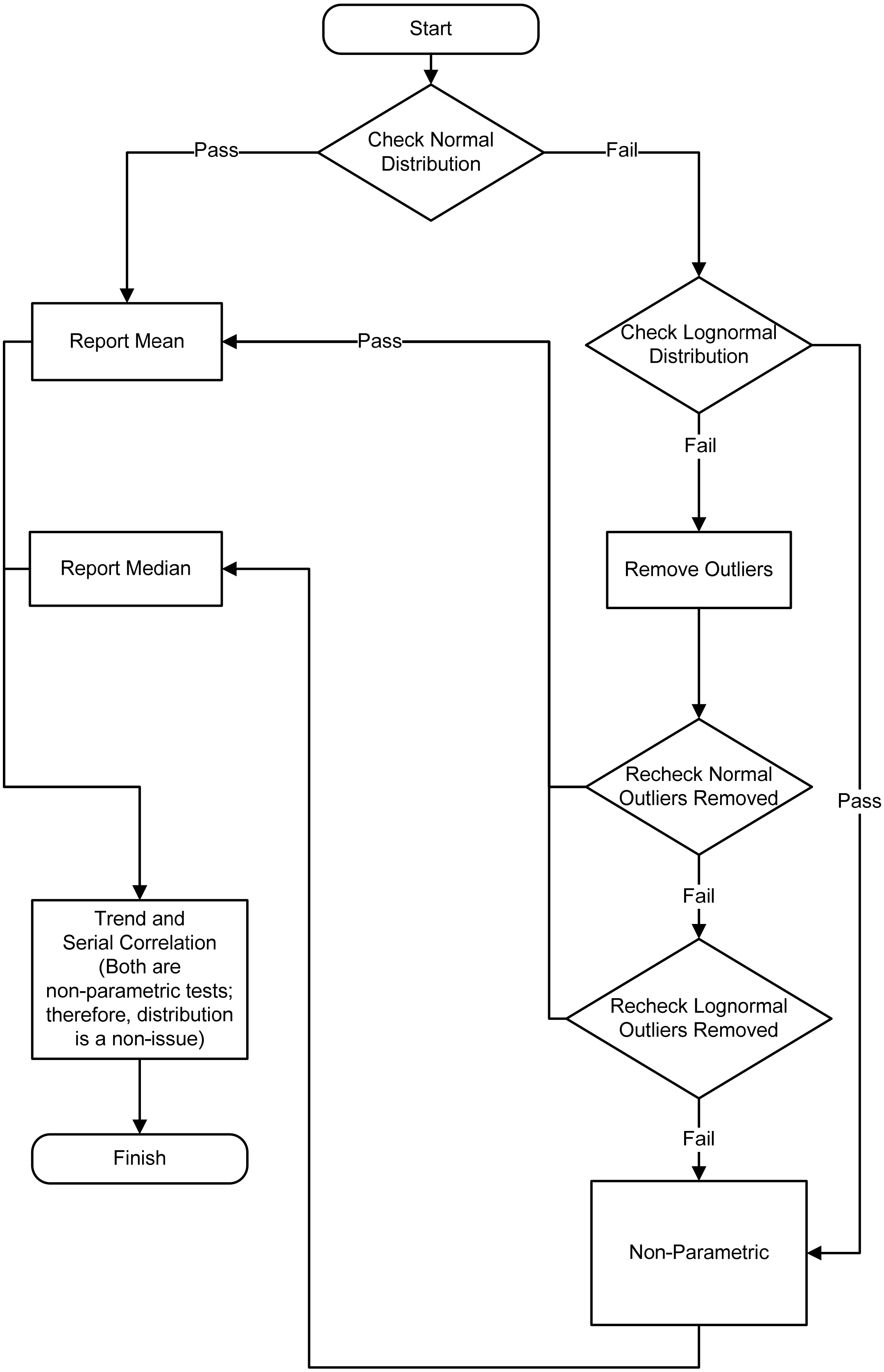

Figure A.5-5. OSDF Statistical Evaluation Process

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