Appendix B

Supplemental Surface Water and Treated Effluent Information
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## Abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>FFCA</td>
<td>Federal Facilities Compliance Agreement</td>
</tr>
<tr>
<td>FRL</td>
<td>final remediation level</td>
</tr>
<tr>
<td>GMA</td>
<td>Great Miami Aquifer</td>
</tr>
<tr>
<td>IEMP</td>
<td>Integrated Environmental Monitoring Plan</td>
</tr>
<tr>
<td>LMICP</td>
<td>Comprehensive Legacy Management and Institutional Controls Plan</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
</tr>
<tr>
<td>OU5 ROD</td>
<td>Final Record of Decision for Remedial Actions at Operable Unit 5</td>
</tr>
</tbody>
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## Measurement Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cfs</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td>mg/kg</td>
<td>milligram per kilogram</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
</tr>
<tr>
<td>pCi/L</td>
<td>picocuries per liter</td>
</tr>
<tr>
<td>µg/L</td>
<td>micrograms per liter</td>
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B.1.0 Surface Water and Treated Effluent

This appendix presents additional surface water and treated effluent data in support of Section 4 of this Fernald Preserve 2016 Site Environmental Report. This appendix provides an evaluation of the final remediation level (FRL) exceedances for surface water and treated effluent, including an assessment of potential cross-media impacts to the groundwater exposure pathway. Surface water data are available through the U.S. Department of Energy Office of Legacy Management’s Geospatial Environmental Mapping System (https://www.lm.doe.gov/Fernald/Sites.aspx).

Surface water and treated effluent samples are collected as required by the “Integrated Environmental Monitoring Plan” (IEMP), which is Attachment D of the Comprehensive Legacy Management and Institutional Controls Plan (LMICP) (DOE 2017). Figures B-1 and B-2 show all surface water monitoring locations. The following information is discussed in this appendix:

- Surveillance monitoring (see Section B.1.1).
- Federal Facilities Compliance Agreement (FFCA)/Final Record of Decision for Remedial Actions at Operable Unit 5 (OU5 ROD) (DOE 1996) compliance (see Section B.1.2).
- Controlled and uncontrolled areas (see Section B.1.3).

The National Pollutant Discharge Elimination System (NPDES) permit sampling is not discussed in this appendix because it is discussed in detail in Section 4, “Surface Water and Treated Effluent Pathway,” of the 2016 Site Environmental Report.

B.1.1 Surveillance Monitoring

Surveillance monitoring is the comparison of surface water and treated effluent analytical results to the surface water FRLs to determine effects of remediation activities on the surface water exposure pathway. Surveillance monitoring also includes an assessment of the effects surface water may have on the groundwater pathway (referred to as cross-media impacts).

All 2016 data were compared to surface water FRLs. Concentration versus time plots are presented in Figures B-3 through B-41. Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point treated effluent is sampled prior to discharge to the Great Miami River.

Water discharges to the Great Miami River are required to be below the FRLs at the point where discharged water is completely mixed with water in the Great Miami River (i.e., outside the mixing zone). In cases where the Parshall Flume data are already below the FRLs, no further action is taken. When the Parshall Flume data are above the FRLs, to make a determination of each constituent’s concentration at this point in the Great Miami River, the following calculation is applied:

\[ C_{PF\ 4001} = \frac{[Q_{0}]C_{Conc} + [Q_{PF}]C_{PF}}{[Q_{0}]+[Q_{PF}]} \]
where:

\[ C_{PF4001} = \text{Flow-weighted average concentration outside the mixing zone in the Great Miami River, picocuries per liter (pCi/L), micrograms per liter (µg/L), or milligrams per liter (mg/L)} \]

\[ Q_{10} = \text{7-day, 10-year low flow, 280.58 cubic feet per second (cfs)} \]

\[ C_{GMR} = \text{Background concentration in Great Miami River from Table 11 in Attachment D of the LMICP (DOE 2017), pCi/L, µg/L, or mg/L (zero was used when no background concentration was available)} \]

\[ Q_{PF} = \text{Daily flow at PF 4001, cfs} \]

\[ C_{PF} = \text{Daily concentration at PF 4001, pCi/L, µg/L, or mg/L} \]

**Note:** Flow conditions at the Hamilton Dam gauge are periodically reviewed to determine if there is a lower flow than the 7-day, 10-year low flow of 280.58 cfs. The lowest daily flow measured at the Hamilton Dam gauge (if lower than 280.58 cfs) is used in the equation to see if an exceedance could potentially occur. The lowest daily flow recorded during 2016 was 575 cfs, which occurred on August 9. The low flow of 280.58 cfs went into effect during the NPDES permit renewal process using information provided in the NPDES permit fact sheet finalized in early 2015.

No samples collected at PF 4001 exceeded the surface water FRLs.

**B.1.1.1 Evaluation of Constituents Above FRLs for 2016**

As shown in Table B-1, there were 15 exceedances in 2016 of surface water FRLs. Below is a summary of the 2016 surface water results:

- Fourteen results from sampling location SWD-09 exceeded the surface water FRL for total uranium (530 µg/L). A new high uranium concentration of 2,087 µg/L was measured at this location in December 2016. Figure B-3 is a plot of the total uranium concentration versus time for sampling location SWD-09. Figures B-3 through B-22 are plots of the total uranium concentration versus time for all surface water sampling locations.

- The overall statistical trend (Mann-Kendall) for FRL exceedances at SWD-09 is “Down” (Table B-1).

- One sample collected from sampling location SWD-05 exceeded the surface water FRL for total uranium (530 µg/L). This is the first exceedance at this location since 2013. Figure B-7 is a plot of the total uranium concentration versus time for sampling location SWD-05.

- The overall statistical trend (Mann-Kendall) for FRL exceedances at SWD-05 is “Down” (Table B-1).

As discussed in Section 4, surface water monitoring currently conducted in a small swale area west of the former waste pits continues to show elevated but slowly diminishing uranium concentrations. After a limited maintenance activity was completed in the fall of 2007, DOE committed to continued monitoring of the swale area. Two monitoring points (SWD-05 and SWD-09) were added to the surface water program to fulfill this monitoring commitment. These
two locations are sampled weekly, when water is present. Location SWD-05 has been sampled 163 times, and SWD-09 has been sampled 284 times between January 2007 and December 2016. Fifteen of the 163 samples collected at SWD-05 and 196 of the 284 samples collected at SWD-09 have exceeded the surface water FRL. As discussed in Attachment A.2, the swale is isolated from surface drainage features, so water entering the swale either evaporates or infiltrates into the ground. If the surface water with elevated total uranium concentration infiltrates into the aquifer beneath the swale, it is quickly captured by nearby extraction well 33347 and poses no threat to human health or the environment.

B.1.1.2 Evaluation of Cross-Media Impacts for 2016

Another objective of the IEMP surveillance monitoring program is to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer (GMA). To conduct this assessment, sampling locations were selected to evaluate contaminant concentrations in surface water just upstream from those areas where site drainages have eroded through the protective glacial overburden (e.g., the Storm Sewer Outfall Ditch, Pilot Plant Drainage Ditch, and certain reaches of Paddys Run). In areas where the glacial overburden is absent, a direct pathway exists for contaminants to reach the aquifer. Key sampling locations associated with these areas of direct infiltration are SWD-02, SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, STRM 4005, and SWP-02 (Figures B-4 through B-11).

Because it is the primary contaminant at the site, total uranium is used as an indicator to evaluate the impact of surface water on the GMA. A conservative assumption is used in this assessment, which considers the total uranium concentration (and all other constituent concentrations) in the surface water to be at the same concentration when the water reaches the GMA through infiltration. However, the more likely scenario is that the total uranium concentration (and all other constituent concentrations) would decrease through dilution and adsorption to sediment particles as the water infiltrates through the ground and mixes with the groundwater in the GMA. The groundwater total uranium FRL of 30 µg/L is used in this cross-media impact assessment.

The results of the cross-media impact assessment for 2016 indicate that two of the eight surface water locations evaluated (SWD-04 [Figure B-6], and SWD-05 [Figure B-7]) had results that exceeded the total uranium groundwater FRL of 30 µg/L. These sampling locations are within capture zone of the groundwater remediation system. Sampling at these locations will continue, and results of these samples will provide an assessment of the cross-media impacts.

Locations SWD-04 and SWD-05 are in the former Waste Storage Area. SWD-04 is located in the former Waste Pit 3 excavation, and SWD-05 is the point at which drainage from the swale area adjacent to former Waste Pit 3 collects. Surface water at both locations infiltrates into the underlying aquifer. As discussed in Attachment A.2, the design of the groundwater restoration systems has accounted for this potential contaminant pathway. The area of infiltration is within the capture zone of the groundwater remediation system.

B.1.2 FFCA/OU5 ROD Compliance

The OU5 ROD and subsequent Explanation of Significant Differences for Operable Unit 5 (DOE 2001) stipulate compliance with a monthly flow-weighted average total uranium concentration discharge limit of 30 µg/L at the Great Miami River via PF 4001. In addition to the
concentration limitation, the OU5 ROD stipulated that the total mass discharged during a year not exceed 600 pounds.

During 2016, the total uranium concentrations were monitored daily at PF 4001 to demonstrate compliance with these limitations. The Fernald Preserve was in compliance with the total mass limitation, as uranium discharges totaled 436 pounds, which is below the 600-pound limit. The Fernald Preserve was in compliance with the monthly flow-weighted concentration limit every month in 2016, as identified on Figure B-42.

**B.1.3 Controlled and Uncontrolled Storm Water Runoff Areas**

In 2016, there were no previously uncontrolled areas that were added to the Fernald Preserve controlled storm water system (refer to Figure B-43). At the conclusion of remediation in October 2006, control of storm water runoff was no longer required. The only storm water collected for treatment is that which falls on the controlled pad of the Converted Advanced Wastewater Treatment Facility.

**B.2.0 References**


Table B-1. Summary Statistics and Trend Analysis for Constituents with 2016 Results Above Surface Water Final Remediation Levels

<table>
<thead>
<tr>
<th>Location</th>
<th>Constituent</th>
<th>No. of Samples&lt;sup&gt;b,c,d&lt;/sup&gt;</th>
<th>No. of Samples Above FRL&lt;sup&gt;b,c,d&lt;/sup&gt;</th>
<th>No. of Samples Above FRL for 2016&lt;sup&gt;c,d&lt;/sup&gt;</th>
<th>FRL&lt;sup&gt;e&lt;/sup&gt; (µg/L)</th>
<th>Min.&lt;sup&gt;b,c,d,f,g&lt;/sup&gt; (µg/L)</th>
<th>Max.&lt;sup&gt;b,c,d,f,g&lt;/sup&gt; (µg/L)</th>
<th>Avg.&lt;sup&gt;b,c,d,f,g&lt;/sup&gt; (µg/L)</th>
<th>SD&lt;sup&gt;b,c,d,f,g&lt;/sup&gt; (µg/L)</th>
<th>Trend&lt;sup&gt;b,c,d,f,g&lt;/sup&gt; (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWD-05</td>
<td>Uranium</td>
<td>163</td>
<td>15</td>
<td>1</td>
<td>530</td>
<td>4.4</td>
<td>988</td>
<td>254</td>
<td>199</td>
<td>Down</td>
</tr>
<tr>
<td>SWD-09</td>
<td>Uranium</td>
<td>284</td>
<td>196</td>
<td>14</td>
<td>530</td>
<td>18</td>
<td>2087</td>
<td>739</td>
<td>371</td>
<td>Down</td>
</tr>
</tbody>
</table>

<sup>a</sup> Refer to Figure B-1.<br><sup>b</sup> Based on samples collected from January 3, 2007, through December 31, 2016.<br><sup>c</sup> If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation), Mann-Kendall test for trend, and in determining FRL exceedances.<br><sup>d</sup> Rejected data qualified with either an R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.<br><sup>e</sup> From OU5 ROD, Table 9−5.<br><sup>f</sup> 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 method detection limit.<br><sup>g</sup> 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.
Figure B-2. IEMP Background Surface Water Sample Locations
Figure B-3. Total Uranium Concentration Versus Time Plot for Location SWD-09 (Former Waste Storage Area)

Figure B-4. Total Uranium Concentration Versus Time Plot for Location SWD-02 (Storm Sewer Outfall Ditch) for Cross-Media Impact Evaluation
Figure B-5. Total Uranium Concentration Versus Time Plot for Location SWD-03 (Former Waste Storage Area) for Cross-Media Impact Evaluation

Figure B-6. Total Uranium Concentration Versus Time Plot for Location SWD-04 (Former Waste Pit 3) for Cross-Media Impact Evaluation
Figure B-7. Total Uranium Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area) for Cross-Media Impact Evaluation

Figure B-8. Total Uranium Concentration Versus Time Plot for Location SWD-07 (Former Production Area Drainage) for Cross-Media Impact Evaluation
Figure B-9. Total Uranium Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units) for Cross-Media Impact Evaluation

Figure B-10. Total Uranium Concentration Versus Time Plot for Location STRM 4005 (Drainage to Paddys Run) for Cross-Media Impact Evaluation
Figure B-11. Total Uranium Concentration Versus Time Plot for Location SWP-02 (Paddys Run) for Cross-Media Impact Evaluation

Figure B-12. Total Uranium Concentration Versus Time Plot for Location SWD-06 (Former Pilot Plant)
Figure B-13. Total Uranium Concentration Versus Time Plot for Location SWD-10 (Lodge Pond)

Figure B-14. Total Uranium Concentration Versus Time Plot for Location SWD-11 (Former Lime Sludge Pond)
Figure B-15. Total Uranium Concentration Versus Time Plot for Location SWD-12 (Former Area 4B)

Figure B-16. Total Uranium Concentration Versus Time Plot for Location STRM 4003 (Drainage to Paddys Run)
Figure B-17. Total Uranium Concentration Versus Time Plot for Location STRM 4004/4004A (Drainage to Paddys Run)

Figure B-18. Total Uranium Concentration Versus Time Plot for Location STRM 4006 (Drainage to Paddys Run)
Figure B-19. Total Uranium Concentration Versus Time Plot for Location SWD-13 (Former Silos Area)

Figure B-20. Total Uranium Concentration Versus Time Plot for Location SWR-01 (Great Miami River Background)
Figure B-21. Total Uranium Concentration Versus Time Plot for Location SWP-01 (Paddys Run Background)

Figure B-22. Total Uranium Concentration Versus Time Plot for Location SWP-03 (Paddys Run at Downstream Property Boundary)
Figure B-23. Radium-226 Concentration Versus Time Plot for Location SWP-03 (Paddys Run)

The groundwater FRL for radium-226 is 20 pCi/L.

Note: The surface water FRL for radium-226 is 35 pCi/L.

Figure B-24. Radium-228 Concentration Versus Time Plot for Location SWP-03 (Paddys Run)

The groundwater FRL for radium-228 is 20 pCi/L.

Note: The surface water FRL for radium-228 is 47 pCi/L.
Figure B-25. Thorium-228 Concentration Versus Time Plot for Location SWP-03 (Paddys Run)

Figure B-26. Thorium-230 Concentration Versus Time Plot for Location SWP-03 (Paddys Run)
Figure B-27. Thorium-232 Concentration Versus Time Plot for Location SWP-03 (Paddys Run)

Figure B-28. Radium-226 Concentration Versus Time Plot for Location SWD-04 (Former Waste Pit 3)
Figure B-29. Radium-226 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area)

Figure B-30. Radium-228 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area)
Figure B-31. Thorium-228 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area)

Figure B-32. Thorium-230 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area)
Figure B-33. Thorium-232 Concentration Versus Time Plot for Location SWD-05 (Former Waste Storage Area)

Figure B-34. Radium-226 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units)
Figure B-35. Radium-228 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units)

Figure B-36. Thorium-228 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units)
Figure B-37. Thorium-230 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units)

Figure B-38. Thorium-232 Concentration Versus Time Plot for Location SWD-08 (Former Southern Waste Units)
Figure B-39. Technetium-99 Concentration Versus Time Plot for Location PF 4001 (Parshall Flume)

Figure B-40. Radium-226 Concentration Versus Time Plot for Location PF 4001 (Parshall Flume)
Figure B-41. Radium-228 Concentration Versus Time Plot for Location PF 4001 (Parshall Flume)

Note: The surface water FRL for radium 228 is 47 pCi/L.
On November 30, 2001, the monthly average discharge limit became 30 µg/L.

Figure B-42. 2016 Monthly Average Total Uranium Concentration in Water Discharged from PF 4001 to the Great Miami River
Figure B-43. Uncontrolled Surface Water Areas and Runoff Flow Directions