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SGW-57790
Revision 2

Characterization data for New Waste Streams (200-UP-1, ERDF Leachate, 200-BP-5 and Perched Water) for the 200 West Pump-and-Treat Facility

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

ch2m

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Richland, Washington 99352

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Assistant Secretary for Environmental Management

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Terms

200 West P&T	200 West Pump and Treat
BP-5	200-BP-5 Operable Unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
Cr(VI)	hexavalent chromium
EQ	equalization
ERDF	Environmental Restoration Disposal Facility
GEA	gamma energy analysis
HEIS	Hanford Environmental Information System
IX	ion exchange
MBR	membrane bioreactor
NA	not applicable
OU	operable unit
Perched Water	200-DV-1 Perched Water horizon within the B Complex
Tc-99	technetium-99
TOC	total organic carbon
TSS	total suspended solids
U	uranium
UP-1	200-UP-1 Operable Unit
ZP-1	200-ZP-1 Operable Unit

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1 Purpose

The purpose of this document is to provide a technical basis for evaluations of hazard classification and treatment assessments for the following sources planned for treatment at the 200 West Pump and Treat (200 West P&T):

- 200-BP-5 Operable Unit (OU), hereinafter called BP-5
- 200-DV-1 Perched Water horizon within the B Complex, hereinafter called Perched Water
- 200-UP-1 OU, hereinafter called UP-1
- Leachate from the Environmental Restoration Disposal Facility (ERDF), hereinafter called ERDF leachate
- 200-ZP-1 OU, hereinafter called ZP-1

Concentrations of contaminants assumed for the initial design of 200 West P&T are updated in this document using recent data from the well monitoring program. This report is intended to assist technical staff by accomplishing the following objectives:

- Identifying the methods employed to determine the key contaminant concentration levels from BP-5 groundwater and the Perched Water horizon
- Documenting concentrations of key contaminants used to determine planning treatment operations at 200 West P&T
- Creating a reference for staff preparing engineering evaluations (e.g., hazard categorization, ion exchange (IX) resin selection and replacement frequency, and radiological evaluations) in preparation of transporting and treating water from BP-5, Perched Water, UP-1, and ERDF leachate

This report provides the technical justification to allow for the abovementioned waste streams to be processed at 200 West P&T. This information will help provide the basis for future *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) response action documentation to allow these streams to be sent to 200 West P&T. This report is not intended to have a direct bearing on the CERCLA 200-ZP-1 OU record of decision for the site and does not include an explanation of significant differences that may result from the treatment of these new streams. Its sole purpose is to serve as a resource for engineering evaluations related to the treatment of new streams.

2 Background

As part of the strategy to maximize the use of 200 West P&T (CHPRC-02129, *Strategy for Maximizing the Use of the 200 West Pump and Treat for Remediating Groundwater and Leachate in the Central Plateau*), additional groundwater plumes are being considered for treatment, including Perched Water and groundwater from BP-5 and UP-1. In addition, plans are underway to pump ERDF leachate to 200 West P&T.

BP-5 groundwater contamination is beneath the northern half of the 200 East Area and adjacent portions of the surrounding 600 Area. The nature of this source and the resulting groundwater plumes have caused groundwater concentrations to be highly variable. Contaminant concentrations have varied by up to 2.5 orders of magnitude within recent history. Seven persistent contaminant plumes are identified in this area. The contaminants are spatially variable within both the vadose zone perched water horizon and the unconfined aquifer. The changing flow patterns make future treatment planning at 200 West P&T

difficult. However, engineering calculations, such as initial determination of hazard categorization, require the use of concentrations that are representative of expected conditions. This report documents the concentrations used for engineering evaluations and hazard classification.

Concentrations of uranium and other compounds from UP-1 and ERDF leachate have been more consistent than those from the BP-5 OU, and concentrations of the contaminants have not been as great. The identification of the 95th percentile concentrations needed for the hazard analysis calculations is more straightforward.

3 Methodology and Approach

The following conventions were used in evaluating the data and calculating averages and 95th percentile concentrations:

- Negative values of some of the radioactive compounds were set to zero.
- Concentrations that were below the detection limit were assumed to be present at half the detection limit.
- The time periods were carefully considered to include data representative of the high concentrations initially expected (more information is provided in Section 3.3).
- Extreme values that only occurred once were not screened out.

Calculations of the 95th percentile concentrations are presented in Chapter 6. In the ERDF leachate, some contaminants of radiological concern were never detected. For the purposes of providing 95th percentile concentrations for calculation of the hazard categorization, these contaminants were considered to be present at the detection limit. For the purposes of treatment evaluations (in contrast to calculations of hazard classification), these nondetect compounds were assumed to be present at half the detection limit.

3.1 Data Sources

With the exception of ERDF leachate, contaminant concentrations defined in this document were taken from the Hanford Environmental Information System (HEIS) database. The following subsections provide the data sources used for this evaluation.

3.1.1 Perched Water Data Sources

Data inclusive from the years 2000 to 2014 were reviewed from HEIS. Most of the data are from the Perched Water perched horizon well 299-E33-344, with some additional data from new Perched Water wells 299-E33-350 and 299-E33-351. Because of the larger analytical data set associated with well 299-E33-344, this well is being used to represent the future water for treatment from this perching horizon.

3.1.2 BP-5 Data Sources

Data inclusive from years 2000 to 2014 were reviewed from HEIS. BP-5 groundwater was represented primarily by Well 299-E33-31 sample results. This well was chosen because it has a long history of data and is adjacent to the planned extraction well. Some radiological compounds were not analyzed in the water from Well 299-E33-31. In these cases, concentrations for Wells 299-E33-341 and 299-E33-342 were used. All data for BP-5 were extracted from the HEIS database.

3.1.3 ERDF Leachate Data Sources

Data from the 2014 ERDF annual report (WCH-590, *Groundwater, Leachate, and Lysimeter Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year 2013*) included samples collected between March 2011 and March 2014. Earlier samples from previous annual reports were not included because the nature of the waste received and operational practices in use have changed, and data from March 2011 are not representative of the long-term ERDF leachate. For select contaminants that are critical to treatment at 200 West P&T (nitrate, uranium, technetium-99, and chromium), the data set included sampling as recent as November 2014. Data from March through November 2014 were provided by ERDF staff. In cases where the concentrations were below detection in the preferred time frame (March 2011 to March 2013), the entire data range from 1999 to 2013 was used to determine the 95th percentile. These exceptions are noted Table 7 in Chapter 7.

3.1.4 UP-1 Data Sources

For UP-1 characterization, wells within the uranium plume were identified to be 299-W19-34A, 299-W19-34B, 299-W19-35, 299-W19-36, 299-W19-43, 299-W19-48, and 299-W19-101. Concentrations of contaminants were obtained from HEIS between April 2009 and October 2013.

3.2 Calculation of the Planning Concentration

Data from BP-1 and Perched Water are characterized by a few very great concentration spikes that cause the 95th percentile values to be extreme. For example, the 95th percentile nitrate concentration in Perched Water is 740 mg/L as N, 18 times the treatment capacity of 200 West P&T. In contrast, the average nitrate is 264 mg/L N, almost a third of the 95th percentile value. The only existing precedent for considering the worst-case water conditions is the use of the 95th percentile for calculating the hazard category. For some constituents, such as nitrate in Perched Water, the 95th percentile value was so great that it does not represent true conditions. A new approach was needed to represent worst-case conditions in Perched Water and BP-5. In response to this need, a new approach was developed to calculate worst-case but representative concentrations. This new calculation is termed the planning level concentration, and it provides a means to determine worst-case conditions in the wells from BP-5 and DV-1 perched water, while avoiding the extremely high 95th percentiles. The planning concentrations were calculated as two-thirds of the difference between the average and 95th percentile. A hand calculation is provided in Chapter 6. This method was not needed for ERDF leachate or UP-1 wells because the data sets were less variable and did not include periodic spikes of very high concentrations. This method is not suitable to the calculation of the hazard classification.

The following formula is used to calculate the planning level concentration:

$$\textit{Planning Level Concentration} = \textit{Average} + 2/3 \times (95^{th}\ \textit{Percentile} - \textit{Average})$$

3.3 Uranium Units

Uranium is expressed in units of both pCi/L and µg/L. The conversion factor used to convert between picocurie and microgram is 0.67 pCi/µg (40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity"). See Chapter 7 for validation of this factor in Perched Water.

3.4 BP-5 Groundwater Dynamics

The data used to represent groundwater within the B Complex were based on the understanding of groundwater flow at the time of this report (2014), and the contaminant plume is expected to move. Past site operations, including recent cooling water disposal associated with tank retrievals, have impacted

groundwater flow velocity and direction in the B Complex groundwater. These changes have had profound effects on the groundwater concentrations of cobalt-60, cyanide, hexavalent chromium (Cr(VI)), nitrate, technetium-99, tritium, and uranium.

For example, uranium trends at well 299-E33-31 are highly variable. Prior to 2008, uranium concentrations were generally less than 400 µg/L. At that time, the well was directly downgradient of the uranium source (241-BX-102 unplanned release). As the groundwater flow slowed to near stagnant conditions, uranium concentrations increased to values in excess of 700 µg/L. Since the flow reversal in July 2011, concentrations have decreased significantly. To be conservative, concentrations used for planning focused on the time period when the concentrations were high (the plume was not moving away from the extraction well).

Precise prediction of groundwater contaminant concentration is made difficult by unpredictable movements of the groundwater plumes, which will become more pronounced under the influence of extraction and injection wells.

3.4.1 BP-5 Water Date Ranges Included in Analysis

The entire data set was used for many of the constituents. Exceptions include the following compounds that peaked between November 19, 2007, and February 12, 2014:

- Uranium
- Tritium
- Technetium-99
- Nitrate
- Cyanide
- Cobalt-60

It is notable that BP-5 has not yet been pumped on a continuous basis, and pumping may impact the concentrations.

3.5 Perched Water Dynamics

A different dynamic was operating in Perched Water. In most cases, Perched Water concentrations increased when the pilot test started. In August 2011, the pilot test activity began to pump Perched Water continuously and, shortly after that, concentrations of uranium and technetium-99 increased 20-fold.

It is notable that total chromium and Cr(VI) concentrations did not follow the same pattern as other contaminants and peaked around 2010 in Perched Water. It is believed that much of the chromium originated from a source other than the one responsible for the release of uranium. Much of the chromium is believed to have come from the B-7 A&B Cribs, but the uranium is mostly from the 241-BX-102 release (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*). These two sources entered Perched Water at different times, resulting in different time frames for peak concentrations.

The data set for each constituent was carefully evaluated to determine the time period that would represent concentrations that may be present during periods of extraction. The evaluation focused on these periods of high concentrations to provide a conservative estimate of the concentrations.

3.5.1 Perched Water Date Ranges Included in Analysis

As a general rule, the entire data set was considered in the calculations of the average, 95th percentile, and planning concentrations, with the following exceptions:

- Tritium data between October 4, 2011, and April 22, 2014, were included in the calculation of the planning level.
- Total chromium and Cr(VI) concentrations between May 22, 2009, and October 4, 2011, were included in the calculation of the planning level. During this time, chromium concentrations were at their peak and occurred before the treatability testing and associated pumping of Perched Water. Planning level concentrations of chromium (total and hexavalent), developed using data before August 2011, will result in greater concentrations than would be calculated using data from after 2011. The planning level concentrations for chromium in Perched Water are likely conservative.

4 Assumptions and Inputs

The following key assumptions were used to evaluate the data:

- All negative values for radionuclides were assumed to be zero. A negative number results when background radiation is greater than that from the sample.
- Contaminants that were occasionally below detection were assumed to be present at a value half of the stated detection limits.
- Contaminants that were below detection in all samples were assumed to be present at their detection limit for hazard classification and at half the detection limits for treatment considerations. The data tables, in Chapter 7, are clearly titled to indicate whether the data are suitable for hazard classification, treatment evaluation, or both.
- Sample data available at the time of this report (2014) provide reasonable definition of the groundwater plume size and contaminant concentrations that will occur in the extraction well.
- Changing groundwater flows will change the plume movement and concentrations in the extraction wells. The planning concentrations are not intended to be precise measures of the expected concentrations but to provide a reasonable approximation for planning purposes.
- Selenium-79 and nickel-63 were not tested in BP-5 wells. Historical inventory records indicate that concentrations of selenium-79 and nickel-63 were five orders of magnitude less than cesium-137 concentrations (WMP-28945, *Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*). The cesium-137 concentrations measured as of 2014 in BP-5 were low, and selenium-79 and nickel-63 were assumed to be below detection. For the purposes of calculations related to hazard classification, concentrations were assumed to be at typical detection limits (Holm et al., 1990, "Nickel-63: Radiochemical Separation and Measurement with an Ion Implanted Silicon Detector").

5 Software Applications

Microsoft Excel® was used to perform the calculations. Three random calculations were hand checked.

® Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

6 Calculations

Average Value of Uranium in Perched Water:

$$\text{Average} = \sum_{i=1}^{17} C_i / 17$$

where: C_i = i[th] sample concentration

$$\text{Average} = \frac{(4{,}500+63{,}600+71{,}500+51{,}500+26{,}600+37{,}300+60{,}800+102{,}000+106{,}000+30{,}700+24{,}700+49{,}800+16{,}400+107{,}000+106{,}000+76{,}100+38{,}800\ \mu g/L)}{17}$$

$$\text{Average} = \frac{973{,}300 \frac{\mu g}{L}}{17}$$

$$\text{Average} = 57{,}252.94\ {}^{\mu g}/_{L} \text{ rounded to } 57{,}253\ {}^{\mu g}/_{L}$$

95th Percentile of Uranium Concentrations in Perched Water:

Note:

- Calculation from Excel checked by hand
- Data from uranium in perched water used as an example
- 95th percentile of uranium concentrations in perched water
- Number of values (n) = 17
- Percentile (p) = 0.95

$$(n-1)p = k + d$$

where: k= integer portion
d = decimal portion

$$(17-1)0.95 = 15.2$$

by definition: k= 15
d= 0.2

$$\text{95th percentile } (P_{(95)} = V_{(k+1)} + d(V_{(k+2)} - V_{(k+1)})$$

where: $P_{(95)}$ = 95th percentile value for data set

V_k= uranium concentration for value in rank order at position k in Table 1

k= order in set of sorted values in Table 1

$$P_{(95)} = V_{(16)} + d(V_{(17)} - V_{(16)})$$

$$P_{95} = 106{,}200\ {}^{mg}/_{L}$$

Table 1. Rank Order of Uranium Concentrations from Low to High (µg/L)

Index (k)	Uranium Concentration (V_k)
1	4,500
2	16,400
3	24,700
4	26,600
5	30,700
6	37,300
7	38,800
8	49,800
9	51,500
10	60,800
11	63,600
12	71,500
13	76,100
14	102,000
15	106,000
16	106,000
17	107,000

Planning Concentration:

$$C_{plan} = Avg + {}^{2}/_{3}\ (P_{95} - Avg)$$

$$C_{plan} = 57{,}252.94\,{}^{\mu g}/_{L} + {}^{2}/_{3}\,(106{,}200\,{}^{\mu g}/_{L} - 57{,}252.94\,{}^{\mu g}/_{L})$$

$$C_{plan} = 57{,}252.94\,{}^{\mu g}/_{L} + {}^{2}/_{3}\,(48{,}947.06\,{}^{\mu g}/_{L})$$

$$C_{plan} = 89{,}884.31\,{}^{\mu g}/_{L};\ \ rounded\ to\ 89{,}884\,{}^{\mu g}/_{L}$$

7 Results/Conclusions

Concentration results are presented in a series of tables organized by source.

7.1 Perched Water and Groundwater from BP-5

Table 2 summarizes average values for BP-5 and Perched Water. Trends for most of the constituents are in Appendix A figures. Constituents that were never detected were not trended and are not included in Appendix A.

Table 2. Average Concentrations in Perched Water and BP-5

Constituent	Units	Perched Water	BP-5	Cleanup Level (for Reference)	Detection Limit Range (for Reference)
Carbon Tetrachloride	µg/L	1.1	1.1	3.4	0.07 to 1.0
Chromium	µg/L	229	28	100	0.4 to 5
Cr(VI)	µg/L	230	23	37	2 to 8
Iodine-129	pCi/L	2.3	3.5	1	0 to 24
Nitrogen in Nitrate	mg/L	264	156	10	All samples above detection limit
Technetium-99	pCi/L	24,263	8,036	900	All samples above detection limit
Trichloroethylene	µg/L	0.45	0.5	1	0.1 to 1.0
Tritium	pCi/L	23,664	6,828	20,000	All samples above detection limit
Uranium	µg/L	57,253	469	30	All samples above detection limit
Uranium	pCi/L	38,359	314	Note 1	All samples above detection limit
Plutonium-239/240	pCi/L	0.02	Note 3	None	0.009 to 0.45
Cesium-137	pCi/L	0.6	0.3	None	0 to 5.9
Cobalt-60	pCi/L	1.2	9.5	None	0 to 16
Neptunium	pCi/L	0.27	Note 3	None	0.0431 to 0.2
Nickel-63	pCi/L	Note 3	Note 3	None	Not applicable
Selenium-79	pCi/L	0.81 (Note 2)	Note 3	None	1.83
Strontium-90	pCi/L	2.8 (Note 2)	0.24 (Note 2)		0.4 to 2.8
Carbon-14	pCi/L	639	Note 3	None	All samples above detection limit
Americium-241	pCi/L	0.09	Note 3	None	0.0001
Cyanide	µg/L	2.4	92.7	None	2 to 4.7

Note 1: The cleanup level is 30 µg/L, which corresponds to a concentration of 20.1 pCi/L based on a conversion factor of 0.67 pCi/µg for uranium (40 CFR 141, "National Primary Drinking Water Regulations").

Note 2: All sample values are below the detection limit.

Note 3: Not measured; not expected to be present.

BP-5 = 200-BP-5 Operable Unit

Cr(VI) = hexavalent chromium

Perched Water = 200-DV-1 Perched Water horizon within the B Complex

Table 3 summarizes the values to be used for treatment planning purposes for BP-5 and Perched Water.

Table 3. Planning Level Concentrations in Perched Water and BP-5

Constituent	Units	Perched Water	BP-5	Cleanup Level (for Reference)	Detection Limit Range (for Reference)
Carbon Tetrachloride	µg/L	2.2	0.69 (Note 3)	3.4	0.07 to 1.0
Chromium	µg/L	270	37	100	0.4 to 5
Cr(VI)	µg/L	308	26	37	2 to 8
Iodine-129	pCi/L	4.1	4.2	1	0 to 24
Nitrogen in Nitrate	mg/L	581	221	10	All samples above detection limit
Technetium-99	pCi/L	42,088	9,419	900	All samples above detection limit
Trichloroethylene	µg/L	0.5 (Note 3)	0.5 (Note 3)	1	0.1 to 1.0
Tritium	pCi/L	35,935	9,609	20,000	All samples above detection limit
Uranium	µg/L	89,884	640	30	All samples above detection limit
Uranium	pCi/L	60,222	429	See Note 2	All samples above detection limit
Plutonium-239/240	pCi/L	0.05	Not measured	None	0.009 to 0.45
Cesium-137	pCi/L	2.1	0.82	None	0 to 5.9
Cobalt-60	pCi/L	3.0 (Note 3)	14	None	0 to 16
Neptunium	pCi/L	0.62	Not measured	None	0.0431 to 0.2
Nickel-63	pCi/L	Not measured	Not measured	None	Not applicable
Selenium-79	pCi/L	1.83 (Note 3)	Not measured	None	1.83
Strontium-90	pCi/L	2.8 (Note 3)	0.41 (Note 3)		0.4 to 2.8
Carbon-14	pCi/L	1,282	Not measured	None	All samples above detection limit
Americium-241	pCi/L	0.13 pCi/L	Not measured	None	0.0001
Cyanide	µg/L	4.1	214	None	2 to 4.7

Note 1: See Section 3.2; planning level concentration = average + 2/3 × (95th percentile – average).

Note 2: The cleanup level is 30 µg/L, which corresponds to a concentration of 20.1 pCi/L based on a conversion factor of 0.67 pCi/µg for uranium (40 CFR 141, "National Primary Drinking Water Regulations").

Note 3: All sample values are below the detection limit.

BP-5 = 200-BP-5 Operable Unit

Cr(VI) = hexavalent chromium

Perched Water = 200-DV-1 Perched Water horizon within the B Complex

The 95th percentile values for BP-5 groundwater and Perched Water, suitable for calculations of hazard categorization, are summarized in Table 4.

Table 4. 95th Percentile Concentrations of Radioactive Constituents in BP-5 and Perched Water for Hazard Categorization

Constituent	Units	BP-5 Analyses (95th Percentile Concentration)	Perched Water Sample Analyses (95th Percentile Concentration)
Americium-241	pCi/L	0.18	0.157
Carbon-14	pCi/L	177	1,603
Cesium-137	pCi/L	1.08	2.83
Cobalt-60	pCi/L	16.2	3.84
Gross alpha	pCi/L	282	50,280
Gross beta	pCi/L	6,160	43,600
Iodine-129	pCi/L	4.55	4.94
Neptunium-237	pCi/L	0.18	0.801
Plutonium-239/240	pCi/L	0.07	0.06
Plutonium-238	pCi/L	0.085 (Note 2)	0.085 (Note 1)
Selenium-79	pCi/L	4.7 (Note 1)	4.7 (Note 2)
Nickel-63	pCi/L	0.03 (Note 1)	0.03 (Note 1)
Strontium-90	pCi/L	1.0 (Note 2)	5.6 (Notes 2 and 3)
Technetium-99	pCi/L	10,110	51,000
Total Beta Radiostrontium	pCi/L	1.1 (Notes 2 and 3)	3.36
Tritium	pCi/L	11,000	42,070
Uranium	pCi/L	486	71,154

Note 1: No measurements were taken. Value shown is a typical detection limit.

Note 2: All values are below detection. Value shown is the detection limit.

Note 3: Only one sample was taken. Value shown is value of the one sample.

BP-5 = 200-BP-5 Operable Unit

Cr(VI) = hexavalent chromium

Perched Water = 200-DV-1 Perched Water horizon within the B Complex

Samples from Perched Water were analyzed for various isotopes. Table B-1 in Appendix B summarizes the activity of the various species. Only Perched Water samples were analyzed for the various isotopes, not samples from BP-5. The laboratories typically report combined uranium-233/uranium-234 values because they have no means of distinguishing between the two isotopes. It was assumed that the uranium-233/uranium-234 value from the lab is attributed to uranium-234 because uranium-233 is not

known to be present in the source. As a result, Table B-1 in Appendix B labels uranium-233/uranium-234 solely as uranium-234 for clarity.

The calculations summarized in Table B-1 (Appendix B) treat each sample individually to determine a pCi to µg ratio for that sample. The average of all the ratios is 0.69, which is close to the 0.67 factor used to convert µg/L to pCi/L in the samples. This is considered to be within the margin of error for the laboratory analysis.

Table 5 summarizes the average mass and average activities of the isotopic species present. Uranium-234 and uranium-238 contribute about 97 percent of the uranium by activity (pCi) but, by mass, uranium-238 significantly dominates. This distribution is typical of that observed on the Hanford Site.

Table 5. Average Percentages of Mass and Activity of Isotopes from Perched Water

Isotope	Percent of Mass	Percent of Activity
Uranium-234	0.01%	48%
Uranium-235	1%	4%
Uranium-238	99%	49%
Total	100%	100%

Perched Water = 200-DV-1 Perched Water horizon within the B Complex

7.2 Groundwater from UP-1

Table 6 summarizes the average and 95th percentile concentrations for UP-1. The 95th percentile concentrations are suitable for calculations associated with hazard determination.

Table 6. UP-1 95th Percentile and Average Concentrations of Constituents

Constituent	Units	95th Percentile Concentration	Average	Source
Technetium-99	pCi/L	6,935	1,807	Note 1
Iodine-129	pCi/L	1.4	0.89	Note 1
Tritium	pCi/L	954	313	Note 1
Uranium	pCi/L	172	92	Note 1
Uranium	µg/L	256	138	Note 1
Americium-241	pCi/L	0.500	0.5 (Note 2)	Note 2
Carbon-14	pCi/L	22.5	22.5 (Note 2)	Note 2
Cesium-137	pCi/L	3.93	3.93 (Note 2)	Note 2
Cobalt-60	pCi/L	15.8	15.8 (Note 2)	Note 2
Neptunium-237	pCi/L	0.140	0.140 (Note 2)	Note 2
Nickel-63	pCi/L	7.50	7.50 (Note 2)	Note 2

Table 6. UP-1 95th Percentile and Average Concentrations of Constituents

Constituent	Units	95th Percentile Concentration	Average	Source
Selenium-79	pCi/L	60.9	60.9 (Note 2)	Note 2
Strontium-90	pCi/L	3.50	3.50 (Note 2)	Note 2
Plutonium-239/240	pCi/L	0.500	0.500 (Note 2)	Note 2
Plutonium-238	pCi/L	0.000	0.000 (Note 2)	Note 2
Carbon Tetrachloride	µg/L	260	144	Note 1
Chromium	µg/L	26	9.8	Note 1
Cr(VI)	µg/L	4.3	2.6	Note 1
Nitrate as N	mg/L	233	65	Note 1
Trichloroethene	µg/L	3.35	1.56	Note 1
Alkalinity (as Calcium Carbonate)	mg/L	130	125	Note 1
Calcium	mg/L	72	50	Note 1
Chloride	mg/L	21.2	12.4	Note 1
Chloroform	µg/L	8.58	3.82	Note 1
Fluoride (mg/L)	mg/L	0.417	0.302	Note 1
Iron (Dissolved)	mg/L	0.410	0.143	Note 1
Magnesium	mg/L	16.1	16.1	Note 1
Manganese (Dissolved)	µg/L	9.1	5.1	Note 1
Potassium	mg/L	6.06	4.98	Note 1
Sodium	mg/L	28.6	20.8	Note 1
Sulfate	mg/L	58.6	35.2	Note 1
Total Dissolved Solids	mg/L	674	400	Note 1
TOC	µg/L	2,128	840	Note 1

Note 1: HEIS January 1, 2009, to March 3, 2014, from 299-W19-34A, 299-W19-34B, 299-W19-35, 299-W19-36, 299-W19-43, 299-W19-48, and 299-W19-101.

Note 2: No average values were provided in SGW-45097, *Integrated Mass Balance for the 200 West Pump and Treat Facility*, (Calc 50), so the 95th percentile concentrations were used.

Cr(VI) = hexavalent chromium
TOC = total organic carbon
TSS = total suspended solids
UP-1 = 200-UP-1 OU

The quantity of water from UP-1 is nominally 568 lpm (150 gpm), which is based on two extraction wells at 284 lpm (75 gpm) each. The well pumps are designed for a maximum output of 852 lpm (225 gpm) (total for two wells), and the hazard classification should be based on 852 lpm (225 gpm).

7.3 ERDF Leachate

Table 7 summarizes the average and 95th percentile concentrations for ERDF leachate. The 95th percentile concentrations are suitable for calculations associated with hazard determination.

ERDF leachate contains significant concentrations of nitrate, uranium, strontium, technetium-99, and chromium (Table 7). The high hardness also indicates a strong potential for precipitation of calcium carbonate in the pipes. Most contaminant concentrations were obtained from the most the ERDF annual report available (WCH-590); however, a few key contaminants were updated with the most recent data from ERDF, as noted in Table 7.

Table 7. Concentrations of Constituents in ERDF Leachate for Planning Purposes and Hazard Categorization

Contaminant	Units	95th Percentile Concentration	Average Concentration	Source
Technetium-99	pCi/L	413	356	ERDF 2013 Annual Report updated through February 2015 with ERDF Records
Iodine-129	pCi/L	1.8 (Note 1)	0.2 (Note 1)	ERDF Annual Report March 2011 to March 2013
Tritium	pCi/L	96,075	68,891	ERDF Annual Report March 2011 to March 2013
Total Uranium	pCi/L	775	1,018	ERDF 2013 Annual Report updated through February 2015 with ERDF Records
Uranium-233/ uranium-234	pCi/L	275	262	ERDF Records March 2011 to March 2013; only two samples collected
Uranium-235	pCi/L	27.1	26.8	ERDF Records March 2011 to March 2013; only 2 samples collected
Uranium-238	pCi/L	228	216	ERDF Records March 2011 to March 2013; only two samples collected
Americium-241 (a)	pCi/L	106.4 (Note 1)	24.9 (Note 1)	ERDF Records March 2011 to March 2013
Carbon-14 (a)	pCi/L	246	87	ERDF Annual Report March 2011 to February 2014
Cesium-137 (a)	pCi/L	7.3	4.3	ERDF Records March 2011 to March 2013
Cobalt-60 (a)	pCi/L	13.8 (Note 1))	4.4 (Note 1)	ERDF Records March 2011 to March 2013
Neptunium-237 (a)	pCi/L	0.36 (Note 2)	0.18 (Note 2)	No Measurements Taken – not expected to be present

Table 7. Concentrations of Constituents in ERDF Leachate for Planning Purposes and Hazard Categorization

Contaminant	Units	95th Percentile Concentration	Average Concentration	Source
Nickel-63 (a)	pCi/L	0.06 (Note 2)	0.03 (Note 2)	No Measurements Taken – not expected to be present
Selenium-79 (a)	pCi/L	4.7 (Note 2)	2.4 (Note 2)	No Measurements Taken – not expected to be present
Plutonium-239/240	pCi/L	Below Detection Limit (half of detection limit = 0.15)	Below Detection Limit (half of detection limit = 0.12)	ERDF Records 1999 to 2013
Plutonium-238	pCi/L	Below Detection Limit (half of detection limit = 0.36)	Below Detection Limit (half of detection limit = 0.22)	ERDF Records 1999 to 2013
Gross Alpha	pCi/L	854	547	ERDF Annual Report March 2011 to February 2014
Gross Beta	pCi/L	486	407	ERDF Annual Report March 2011 to February 2014
Total Chromium	µg/L	82	47	ERDF Records March 2011 to March 2015
Cr(VI)	µg/L	71	49	ERDF Records March 2011 to March 2015
Strontium	µg/L	1485	1214	ERDF Records March 2011 to November 2014
Carbon Tetrachloride	µg/L	2.5 (Note 1)	1.7 (Note 1)	ERDF Records March 2011 to March 2013
Trichloroethylene	µg/L	2.5 (Note 1)	1.7 (Note 1)	ERDF Annual Report March 2011 to February 2014
Nitrate (as N)	mg/L	96	59	ERDF 2013 Annual Report updated through February 2015 with ERDF Records
Cyanide	µg/L	2.5	1.3	ERDF Records March 2011 to March 2015
Sulfate (as SO_4)	mg/L	612	546	ERDF Annual Report March 2011 to March 2015

Reference: WCH-590, *Groundwater, Leachate, and Lysimeter Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year 2013.*

Note 1: Values are below detection. Value shown is either the 95th percentile of the detection limit (in 95th percentile column) or half the average of the detection limits (average concentration).

Note 2: No measurements were taken. Value shown is the typical detection limit in the 95th percentile column and at half the detection limit in the average column.

Table 7. Concentrations of Constituents in ERDF Leachate for Planning Purposes and Hazard Categorization

Contaminant	Units	95th Percentile Concentration	Average Concentration	Source

Cr(VI) = hexavalent chromium
ERDF = Environmental Restoration Disposal Facility

Most radioactive compounds tested in ERDF leachate were consistently below detection. These test results are summarized in Table 8.

Table 8. Radionuclides Tested but Not Detected in ERDF Leachate

Constituent	Number of Samples	Time Frame of Sampling	Results
Americium-241	42	April 1999 to March 2013	All Below Detection
Cesium-137	44	April 1999 to March 2013	All Below Detection
Europium-152	44	April 1999 to March 2013	All Below Detection
Europium-154	44	April 1999 to March 2013	All Below Detection
Europium-155	44	April 1999 to March 2013	All Below Detection
Plutonium-238	6	December 2008 to March 2013	All Below Detection
Plutonium-239/240	6	December 2008 to March 2013	All Below Detection
Radium-226	44	April 1999 to March 2013	All Below Detection
Radium-228	44	April 1999 to March 2013	All Below Detection
Thorium-228	6	December 2008 to March 2013	All Below Detection
Thorium-230	6	December 2008 to March 2013	All Below Detection
Thorium-232	6	December 2008 to March 2013	All Below Detection
Thorium-228 GEA	40	April 1999 to March 2013	All Below Detection
Thorium-232 GEA	40	April 1999 to March 2013	All Below Detection
Alpha Radioactivity	50	June 2004 to March 2013	All Below Detection

ERDF = Environmental Restoration Disposal Facility
GEA = gamma energy analysis

ERDF leachate contains some contaminants not typically present in groundwater that can impact treatment. Table 9 summarizes the concentrations of these contaminants with a summary of the associated impact on treatment.

Table 9. Constituents in ERDF Leachate Impacting Treatment

Constituent	Units	95th Percentile Concentration	Average Concentration	Comments and Impact Summary
Ammonia as N	mg/L	0.05	0.02	Key nutrient in biological process
TOC	mg/L	8.3	7.3	Source of carbon substrate
Oil and Grease	mg/L	<5.1	<2.8	Measurements are below quantification limit. If present oil and grease can plug processes or result in undesirable accumulation in excess amounts.
TSS	mg/L	145	29	Can plug processes (most samples were below detection [<3 mg/L] with exception of one sample on March 8, 2011, at 112 mg/L).
Hardness	mg/L as calcium carbonate	1,351	959	Hardness >200 mg/L, as calcium carbonate will precipitate and plug transfer lines.
Calcium Carbonate Precipitation Potential	mg/L as calcium carbonate	Not calculated	>18,000	This water has a very high scaling potential, and value of zero means water is at equilibrium and will neither dissolve nor precipitate calcium carbonate; the recommended range is from 0 to 10 mg/L.

Note: Data are from records provided by ERDF staff.

ERDF = Environmental Restoration Disposal Facility

TOC = total organic carbon

TSS = total suspended solids

The quantity of water treated is based on current volumes of leachate production (7.9 million liters per year or 2.1 million gallons a year). This averages to a nominal flow of 15 lpm (4 gpm). The pumps are sized at 76 lpm (20 gpm) minimum flow and will be operated periodically (e.g., weekly).

7.4 Water from ZP-1

Extraction wells from ZP-1 have been operating since 2012, and concentrations of contaminants have been tracked quarterly. This section provides updated concentrations of contaminants that are treated at 200 West P&T. During the design phase of this facility, groundwater modeling was performed to estimate contaminant of concern (COC) concentrations in each of the proposed extraction wells that were used to estimate the blended influent water quality for the treatment facility, including the uranium and technetium-99 IX systems and centralized biological system. These estimates of water quality were used in the original mass and flow balance for the design (SGW-45097, *Integrated Mass Balance for the 200 West Pump and Treat Facility*) (Calc 50). The concentrations and well flows are now much better defined.

Well data from ZP-1 are divided into two categories:

- Non-radiologically active wells, which are fed directly to the biological process.

- Radiologically active wells, which contain technetium-99 and are passed through IX resin (Purolite® A530E) for the removal of technetium-99 before being blended with the non-radiologically active wells.

Section 7.4.1 summarizes non-radiologically active water, and Section 7.4.2 summarizes radiologically active water. Well concentrations are monitored quarterly and show general trends of increasing concentrations in wells positioned to pull plumes towards them and decreasing concentrations in wells positioned toward the fringe of the plume. It is recommended that these concentrations be updated.

7.4.1 ZP-1 Non-Radiologically Active Well Water

Table 10 summarizes concentrations from wells fed directly to the biological process at 200 West P&T as of November 2014.

Table 10. Concentrations in Water from Wells That Feed Directly into the Biological Treatment Plant

Constituent	95th Percentile Concentration of Wells as of November 18, 2014	Typical Flow-Weighted Concentration as of November 18, 2014	Units
Technetium-99 (a)	273	93	pCi/L
Iodine-129 (a)	0.17	0.15	pCi/L
Tritium (a)	6,605	1,448	pCi/L
Uranium	1.8	0.9	µg/L
Americium-241 (a)	No measurement	No measurement	NA
Carbon-14 (a)	No measurement	No measurement	NA
Cesium-137 (a)	No measurement	No measurement	NA
Cobalt-60 (a)	No measurement	No measurement	NA
Neptunium-237 (a)	No measurement	No measurement	NA
Nickel-63 (a)	No measurement	No measurement	NA
Selenium-79 (a)	No measurement	No measurement	NA
Strontium-90 (a)	No measurement	No measurement	NA
Plutonium (a)	No measurement	No measurement	NA
Carbon Tetrachloride	1,200	778	µg/L
Total Chromium	53	17	µg/L
Cr(VI)	47	16	µg/L
Cyanide	No measurement	No measurement	NA
Nitrate	62	19	mg/L
Trichloroethylene	6.1	3.4	µg/L

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Table 10. Concentrations in Water from Wells That Feed Directly into the Biological Treatment Plant

Constituent	95th Percentile Concentration of Wells as of November 18, 2014	Typical Flow-Weighted Concentration as of November 18, 2014	Units

(a) = activity NA = not applicable
Cr(VI) = hexavalent chromium

From early 2013, ZP-1 non-radiologically active wells have typically operated between 4,164 to 5,678 L/min (1,100 to 1,500 gpm). The individual wells are monitored quarterly, and the well flows are adjusted to provide a consistent nitrate concentration to 200 West P&T.

7.4.2 ZP-1 Radiologically Active Well Water

Table 11 summarizes concentrations from wells fed to the technetium-99 IX system for technetium-99 removal at 200 West P&T as of November 2014.

Table 11. Concentrations in Water from Wells That Feed Technetium-99 Ion Exchange (Radiologically active Wells)

Constituent	95th Percentile Concentration of Wells as of November 18, 2014	Typical Flow-Weighted Concentration as of November 18, 2014	Units
Technetium-99 (a)	4,444	1406	pCi/L
Iodine-129 (a)	0.82	0.22	pCi/L
Tritium (a)	11,180	5,707	pCi/L
Uranium	4.3	1.9	µg/L
Americium-241 (a)	No measurement	No measurement	NA
Carbon-14 (a)	No measurement	No measurement	NA
Cesium-137 (a)	No measurement	No measurement	NA
Cobalt-60 (a)	No measurement	No measurement	NA
Neptunium-237 (a)	No measurement	No measurement	NA
Nickel-63 (a)	No measurement	No measurement	NA
Selenium-79 (a)	No measurement	No measurement	NA
Strontium-90 (a)	No measurement	No measurement	NA
Plutonium (a)	No measurement	No measurement	NA
Carbon Tetrachloride	1,470	916	µg/L
Total Chromium	79	51	µg/L
Cr(VI)	70	46	µg/L
Cyanide	No measurement	No measurement	NA

Table 11. Concentrations in Water from Wells That Feed Technetium-99 Ion Exchange (Radiologically active Wells)

Constituent	95th Percentile Concentration of Wells as of November 18, 2014	Typical Flow-Weighted Concentration as of November 18, 2014	Units
Nitrate	50	35	µg/L
Trichloroethylene	9.2	4.7	µg/L

(a) = activity
Cr(VI) = hexavalent chromium
NA = not applicable

From early 2013, the ZP-1 radiologically active wells have averaged about 1,703 lpm (450 gpm) and are typically operated near peak capacity to maximize technetium-99 removal.

7.5 Well Flows

For planning purposes, the flows of the various waste streams need to be considered to determine the mass loading of key contaminants. Table 12 summarizes flow information from each source to provide a basis for evaluating various scenarios.

Table 12. Water Flow Ranges from Wells That Flow to 200 West P&T

Water Source	Nominal Flow (lpm/gpm)	Flow Range (lpm/gpm)	Basis	Reference
UP-1	568/150	379 to 856/ 100 to 226	2 wells at 189 to 428 lpm per well (50 to 113 gpm)	SGW-57830
BP-5	379/100	189 to 568/ 50 to 150	1 well at 189 to 568 lpm per well (50 to 150 gpm)	SGW-58337
ZP-1 Radiologically Active Wells	1,325/350	1,230 to 1,703/325 to 450	All wells in service. Minimum is based on minimum pump operation and maximum is based on either the maximum pump capacity or the maximum flow that can be achieved without clogging the filters.	Based on operating experience
ZP-1 Non-Radiologically Active Wells	6,435/1,700	4,410 to 7,382/1,165 to 1,950	Minimum is based on minimum pump operation with all wells in service. Flow can be reduced by turning wells off. Potential for freezing during winter months makes this undesirable. Maximum is based on either the maximum pump capacity or the maximum flow that can be achieved without clogging the filters with well sand.	Based on operating experience

Table 12. Water Flow Ranges from Wells That Flow to 200 West P&T

Water Source	Nominal Flow (lpm/gpm)	Flow Range (lpm/gpm)	Basis	Reference
ERDF Leachate	76/20	76 to 303/ 20 to 80	ERDF generates 454,249 liters (120,000 gal) every 3 weeks. Leachate transfer pumps have an operating range of 76 to 303 lpm (20 to 80 gpm). Leachate will be pumped periodically (e.g., weekly).	ERDF Flow: CHPRC-02129 Transfer Pump: SGW-58344
Perched Water	19/5	19 to 76/ 5 to 20	18,927 liters (5,000 gal) per week, delivered in trucks to the transfer tank. Pumps from the transfer tank have a range of 19 to 76 lpm (5 to 20 gpm). The transfer tank will be pumped periodically (daily).	Based on results from Perched Water pilot test (SGW-58494)

Note: Complete reference citations are provided in Chapter 9.

BP-5 = 200-BP-5 Operable Unit
ERDF = Environmental Restoration Disposal Facility
Perched Water = 200-DV-1 Perched Water horizon within the B Complex
UP-1 = 200-UP-1 Operable Unit
ZP-1 = 200-ZP-1 Operable Unit

Figure 1 shows the general process flow through the three main treatment trains: uranium IX, technetium-99 IX, and the biological process. Only a small portion of water is treated by all three trains.

7.6 Treatment Constraints

The capacity of the treatment plant is an important limitation. Flow limitations of the 200 West P&T are shown in Table 13. A number of flow combinations are possible; for the sake of example, the following flows and concentrations were assumed:

- The planning level concentrations in streams from BP-5 and Perched Water, and average concentrations of contaminants in the remaining streams, were used. Concentrations from Perched Water and BP-5 are quite variable, and expected concentrations are highly dependent on the movement of the plume, which is subject to site activities that can easily change. Calculation of the planning level was defined in the methodology (Chapter 3).
- The nominal flows from each source are from Table 12. For this example, all sources are assumed to be active. In reality, ERDF leachate will not be pumped continuously.

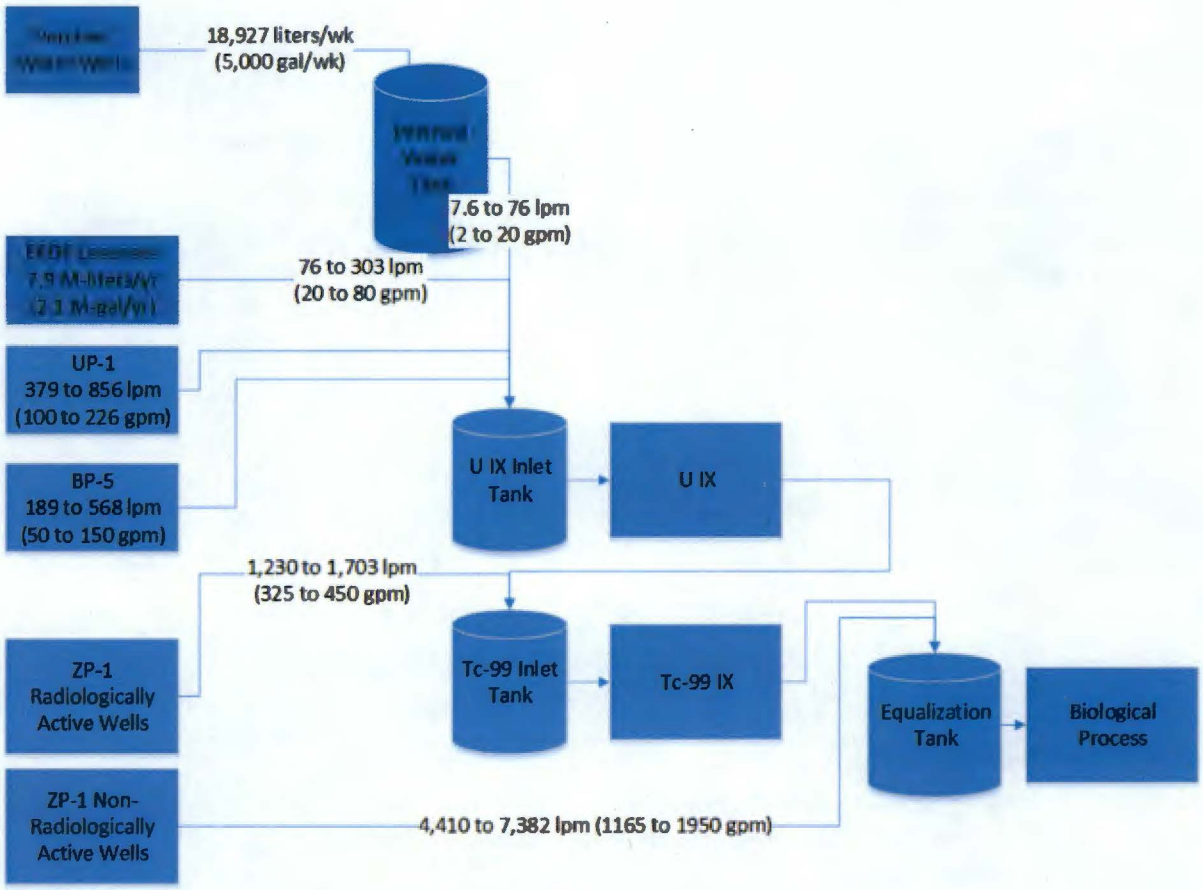

Figure 1. Generalized Process Flow for 200 West P&T

Table 13. Flow Limitations of 200 West P&T for the Three Treatment Trains in Series

System	Minimum Capacity (lpm/gpm)	Maximum Capacity (lpm/gpm)	Maximum Sustained Treatment Capacity[a] (lpm/gpm)
Uranium IX	568/150[b]	1,514/400	1,363/360
Technetium-99 IX	1,136/300 [two trains at 568 lpm per train (150 gpm)][b]	3,028/800 [two trains at 1,514 lpm per train (400 gpm)]	2,725/720
Biological Treatment	3,407/900[c]	9,464/2,500	7,571/2,000

a. Maximum sustained capacity takes into consideration internal recycles, introduction of utility water, and downtime for resin change, membrane cleaning, and equipment maintenance. A downtime factor of 0.9 was applied to account for downtime associated with maintenance and repair.

b. From supplier (AVANTech, Inc.) submittal A-6004-757.

c. Minimum based on the minimum flow to maintain operation of two MBRs. The system will not run properly on one MBR because of the potential for shutdown on high water level during relax or backpulse.

IX = ion exchange MBR = membrane bioreactor

Table 14 shows the nitrate mass loading for this scenario and compares it to the mass loading derived from the basis of design (9,464 lpm [2,500 gpm] and a maximum nitrate concentration of 40 mg/L as N).

Table 14. Mass Flux of Nitrate Assuming Nominal Flows from All Waste Streams and Average Concentrations

Water Source	Nominal Flow (lpm/gpm)	Average Nitrate Concentration (mg/L as N)	Mass Flux (kg per week)
UP-1	568/150	65	372
BP-5	379/100	221	844
ZP-1 Radiologically active Wells	1,325/350	35	467
ZP-1 Non-Radiologically active Wells	6,435/1,700	19	1,232
ERDF Leachate	76/20	59	45
Perched Water	19/5	581	111
Summation	8,801/2,325	35 (flow weighted average)	3,105
Design Basis	9,464/2,500	40	3,816

BP-5 = 200-BP-5 Operable Unit
ERDF = Environmental Restoration Disposal Facility
Perched Water = 200-DV-1 Perched Water horizon within the B Complex
UP-1 = 200-UP-1 Operable Unit
ZP-1 = 200-ZP-1 Operable Unit

In this example, the mass flux of nitrate (3,105 kg/week) is less than the design value of 3,816 kg/week. The sum of the nominal flows exceeds the sustained treatment capacity of the biological treatment system, so this example shows the necessity of balancing the flow from the six waste streams to stay within the treatment plant's constraints.

In addition to the hydraulic limits listed in Table 13, the plant has the following limitations:

- Nitrate concentrations to the plant should be consistent.
  - Avoid concentration changes greater than 10 percent in any one 24-hour period.
  - Likewise, avoid mass nitrate loading (e.g., kg nitrate/day) change greater than 10 percent in any one 24-hour period.
- Avoid large sulfate changes in uranium or technetium-99 IX systems, especially once the bed has become loaded with anions.
  - IX reactions are reversible, and sudden increases in competing ions (e.g., sulfate) will displace previously adsorbed uranium or technetium-99.
  - Although firm guidelines are highly site specific, avoid concentration changes greater than 30 percent in any one 24-hour period until the system has shown an ability to handle more.

- Avoid large changes in uranium or technetium-99 concentrations and mass loading, particularly after the bed has been loaded.
  - Large swings in uranium or technetium-99 mass loading can lead to premature breakthrough of the IX bed.
  - Technetium-99 will initially accumulate on the uranium IX resin, and then be released at concentrations in excess of those coming in. This release could compromise the efficiency of the downstream technetium-99 IX resin (Purolite A530E) to remove technetium-99.
- Avoid introducing cyanide concentrations greater than 25 µg/L without further evaluation of the capacity of the biological system to acclimate to cyanide.

8 Recommendations

The following recommendations are provided, based on careful consideration of the information contained in this report:

- Update SGW-45097 (Calc 50) to include the new flows and concentrations and provide a user interface to help identify changes to treatment streams that result from changes in waste stream concentrations and flows.
- Develop an approach to balance the flows, concentrations of key contaminants, and mass loadings under expected operating scenarios (e.g., with and without ERDF).
- Develop and maintain a set of recipes of flows from the various waste streams that maintain steady nitrate concentrations to 200 West P&T.
- Develop and maintain a database of concentrations for the new cells and ERDF leachate. Periodically evaluate the data to determine the impact of the observed trends on treatment or on hazard classification.
- Update this document, in 3 to 5 years after date of issue, with new well concentrations and changes to plant capacity.
- Develop a sampling program for the IX systems. The program should include target anions (uranium and technetium-99), as well as chromate, to provide an early warning of breakthrough, track the contaminants through the bed, and provide improved guidance for allowable swings in anion concentration.
- Determine the maximum cyanide concentration that can be processed by the biological treatment system at 200 West P&T, including the daily increases that can be accommodated without compromising the removal of COCs. A literature review will be sufficient, as the impact of cyanide on biological treatment has been studied. Results of these studies need to be applied to the fluidized bed reactors at 200 West P&T.

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Appendix A

Trending of Constituents in BP-5 and Perched Water

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Figure A-29. Neptunium-237 in Perched Water Effluent A-29
Figure A-30. Plutonium-239/Plutonium-240 in Perched Water Effluent A-30

(Note: Complete citations for references in figures are provided in the main text of this report.)

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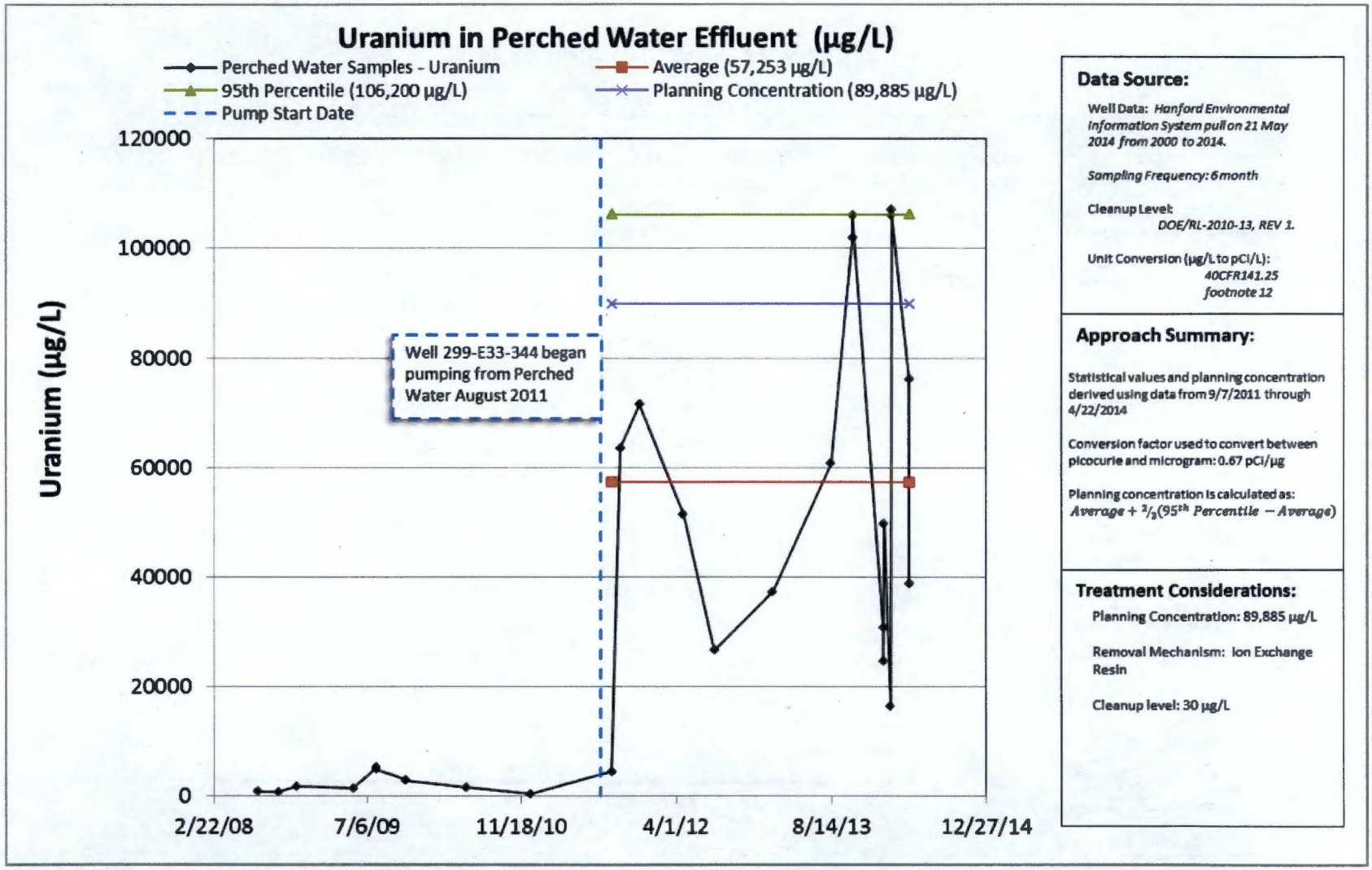
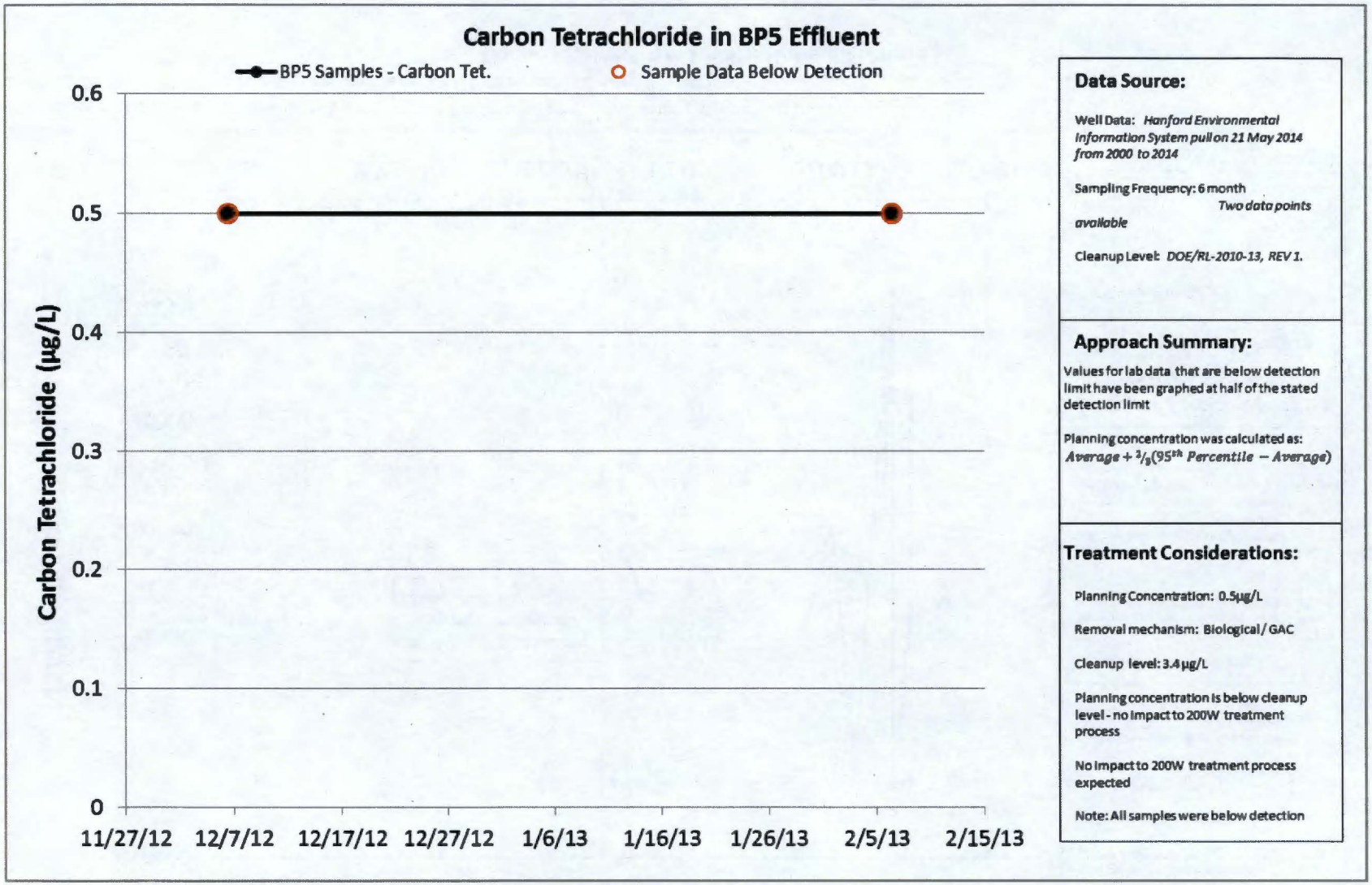


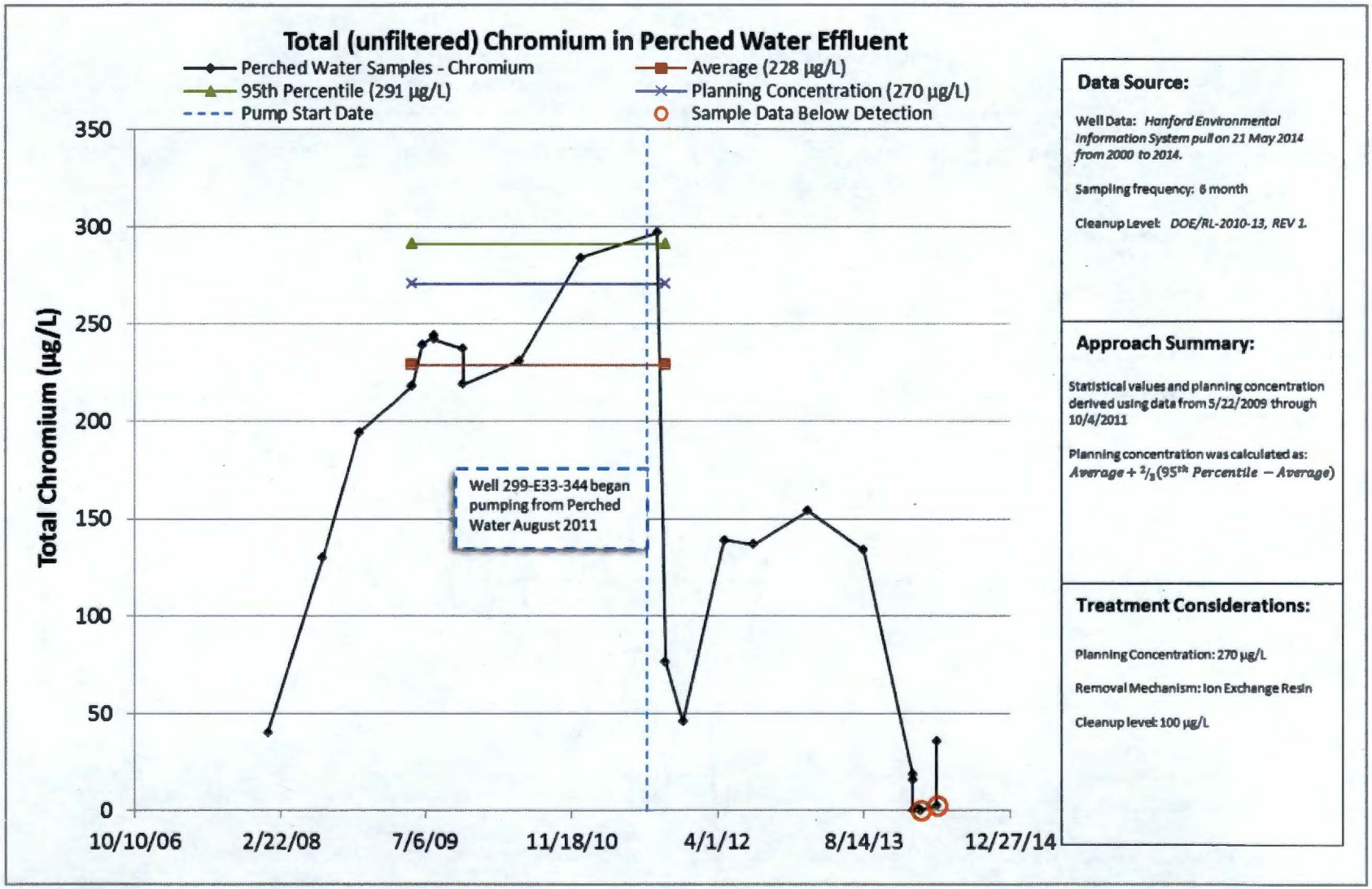
References: 40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity."
DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-1. Uranium in Perched Water Effluent



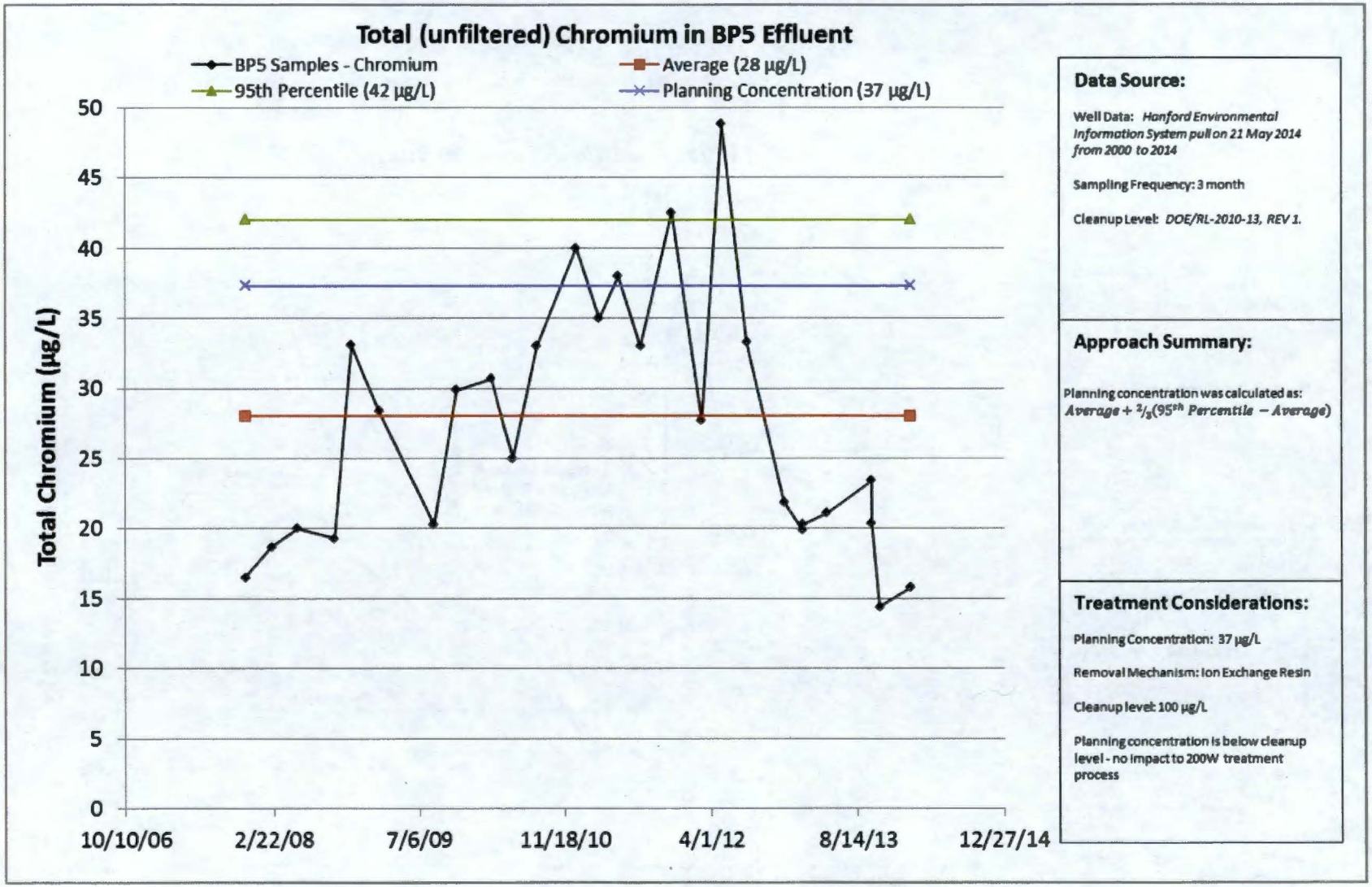
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-2. Carbon Tetrachloride in 200-BP-5 Effluent



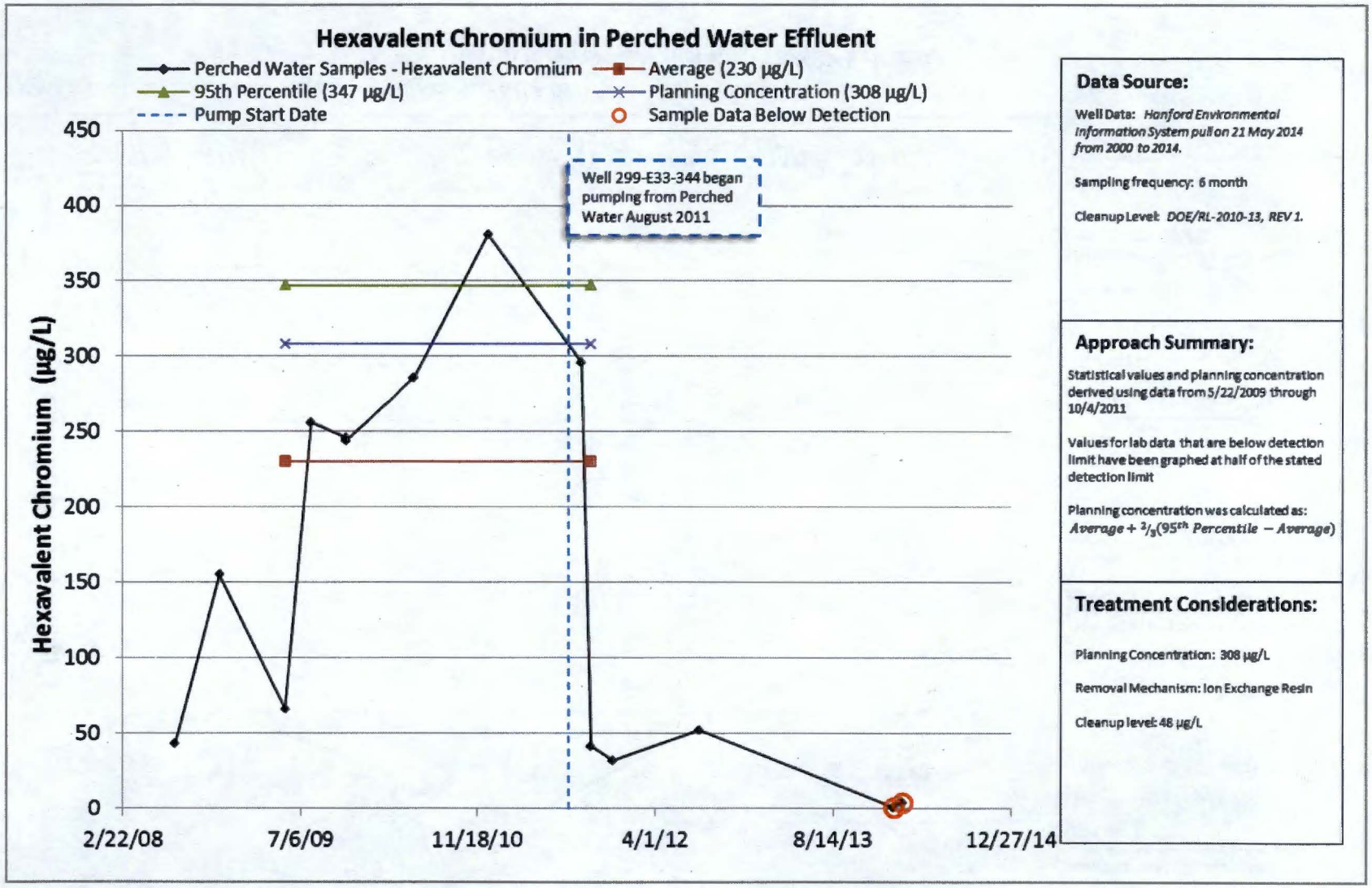
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-3. Total (Unfiltered) Chromium in Perched Water Effluent



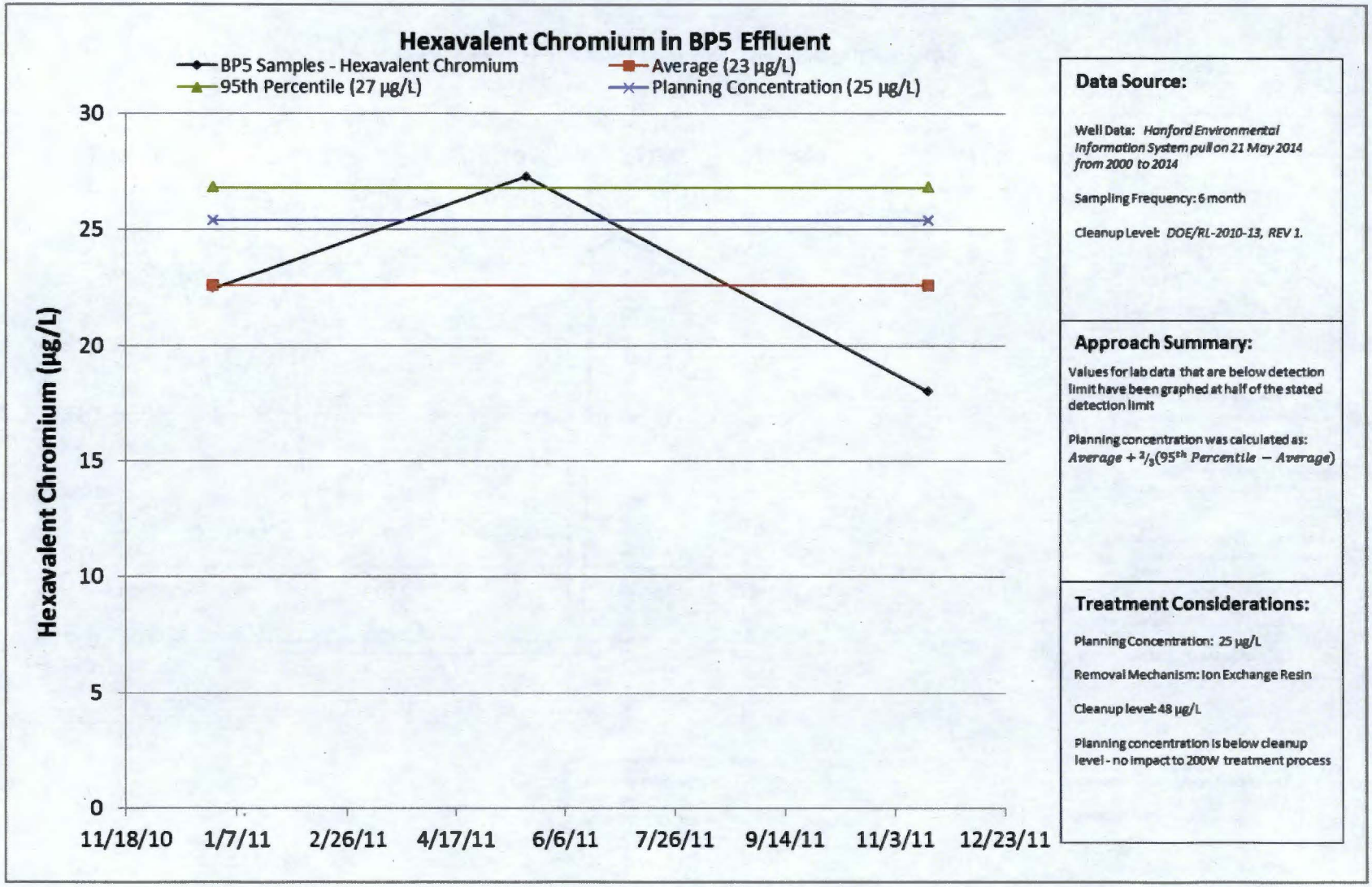
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-4. Total (Unfiltered) Chromium in 200-BP-5 Effluent



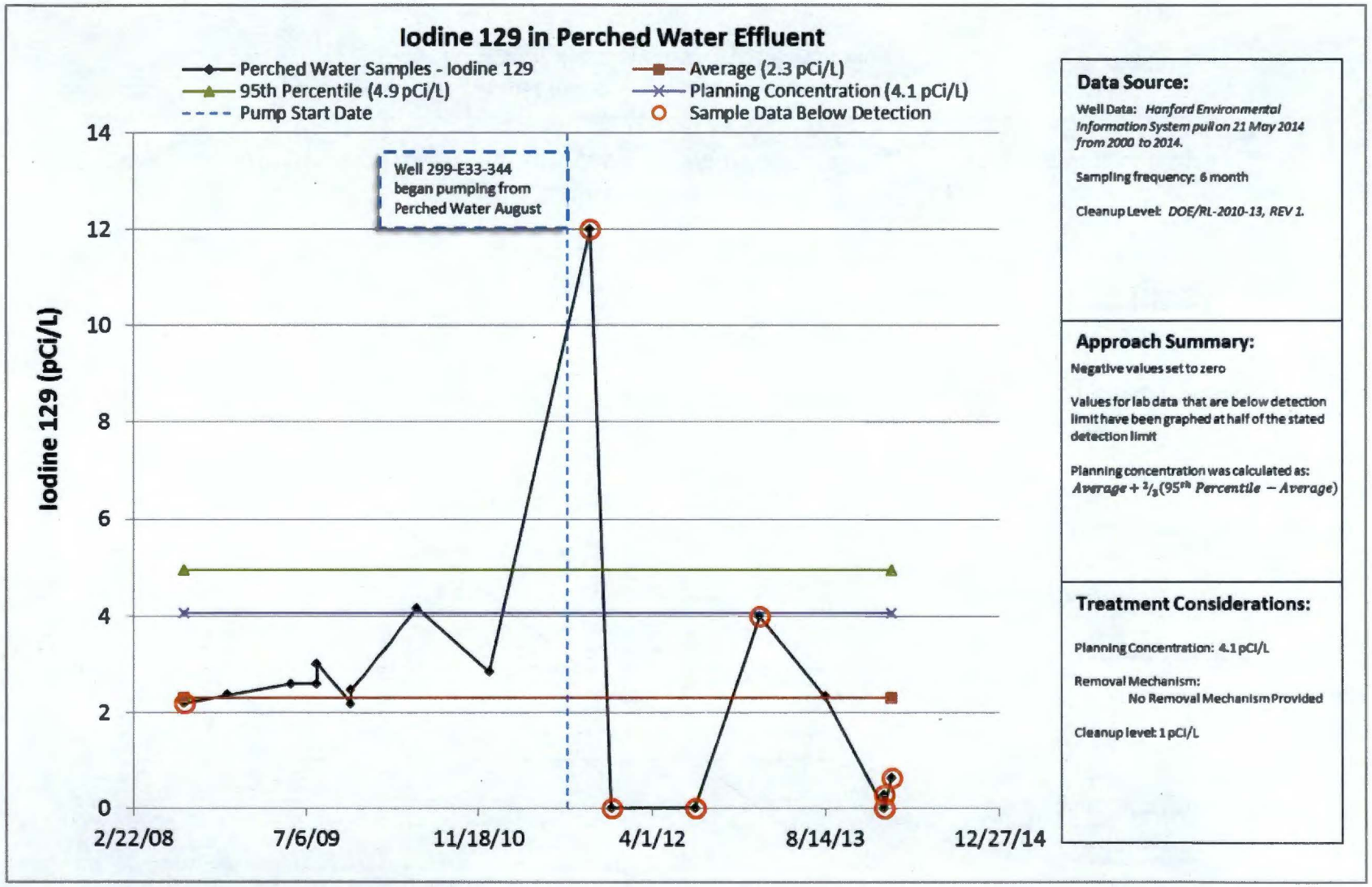
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-5. Hexavalent Chromium in Perched Water Effluent



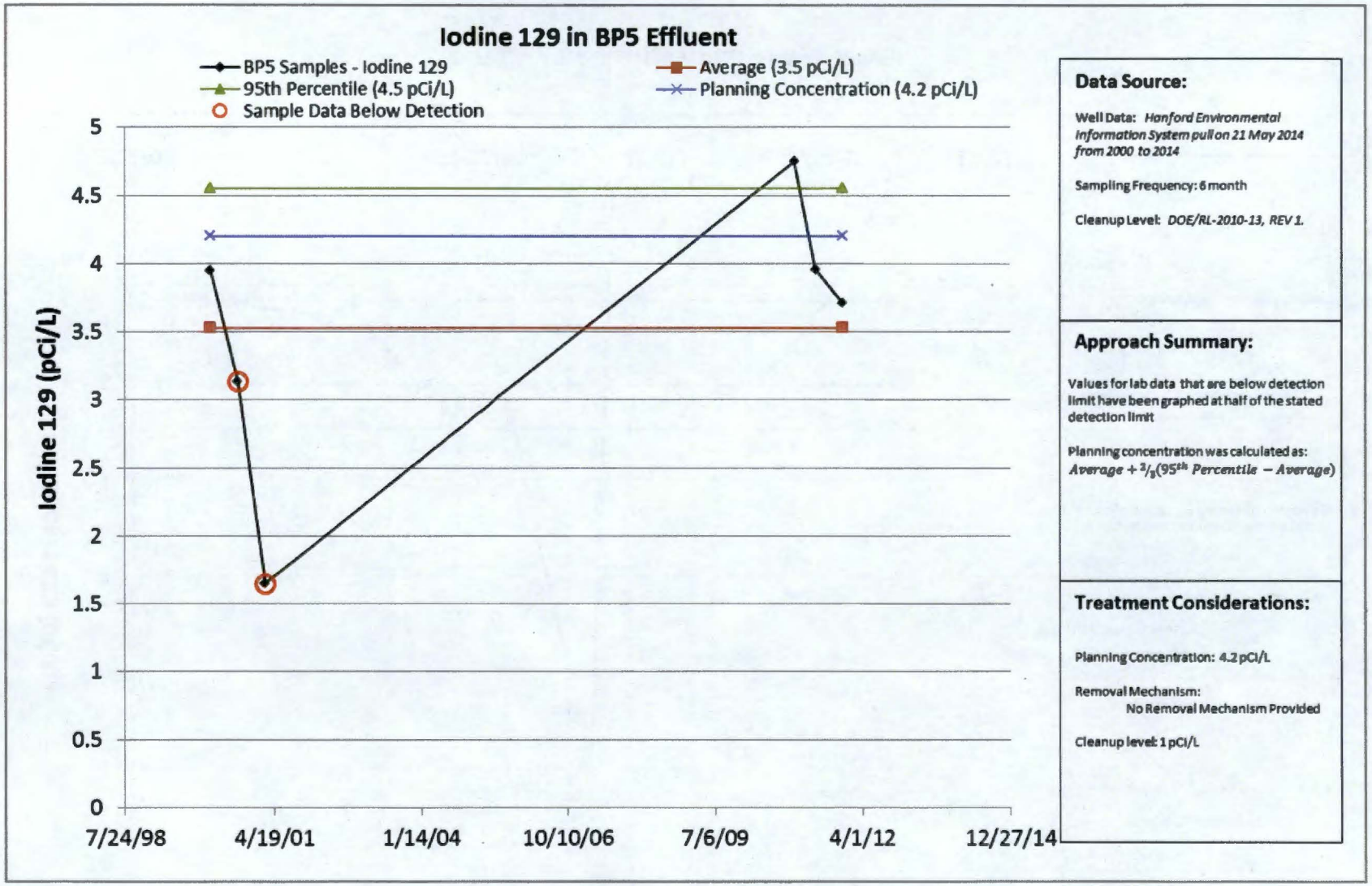
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-6. Hexavalent Chromium in 200-BP-5 Effluent



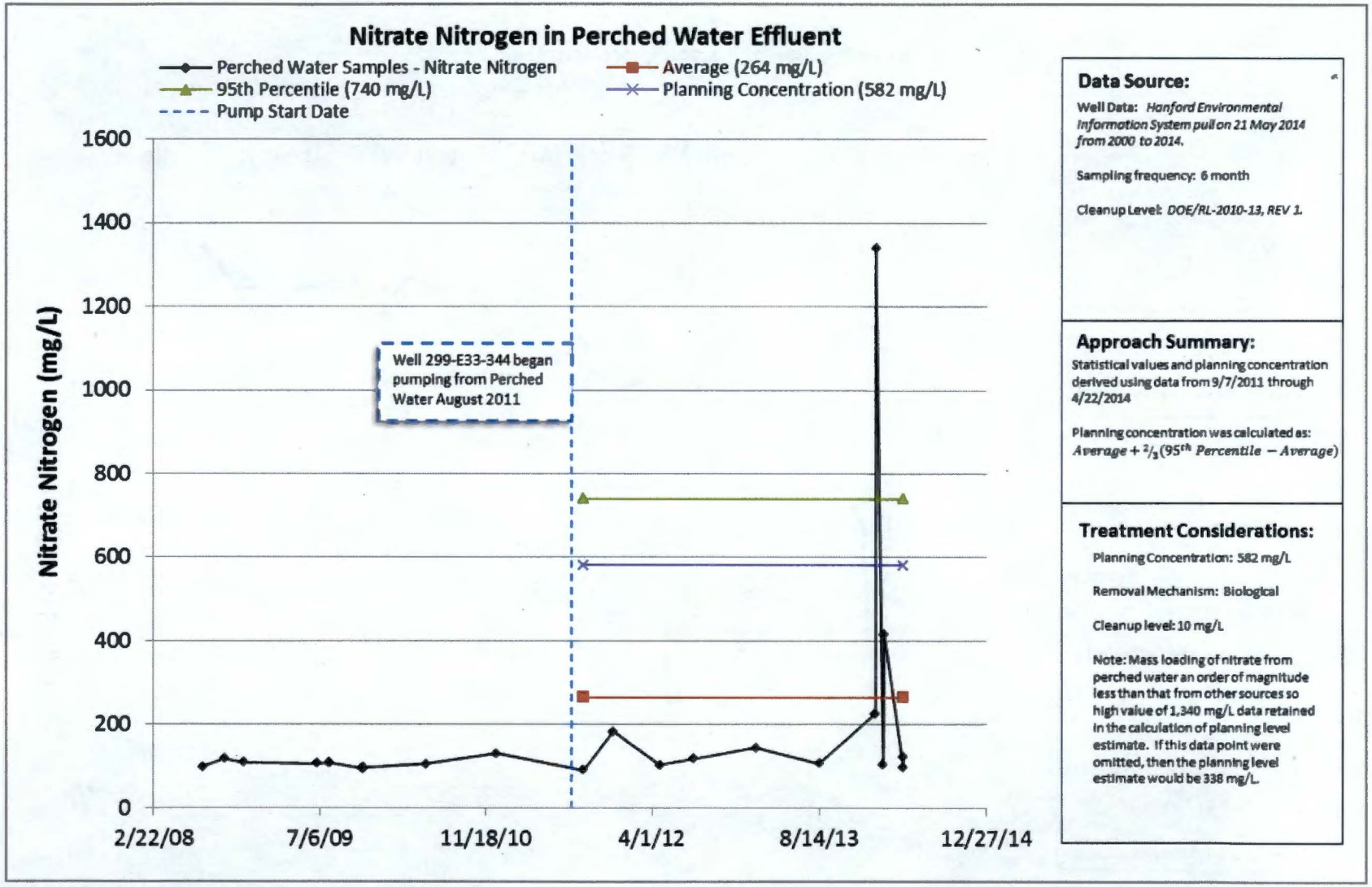
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-7. Iodine-129 in Perched Water Effuent



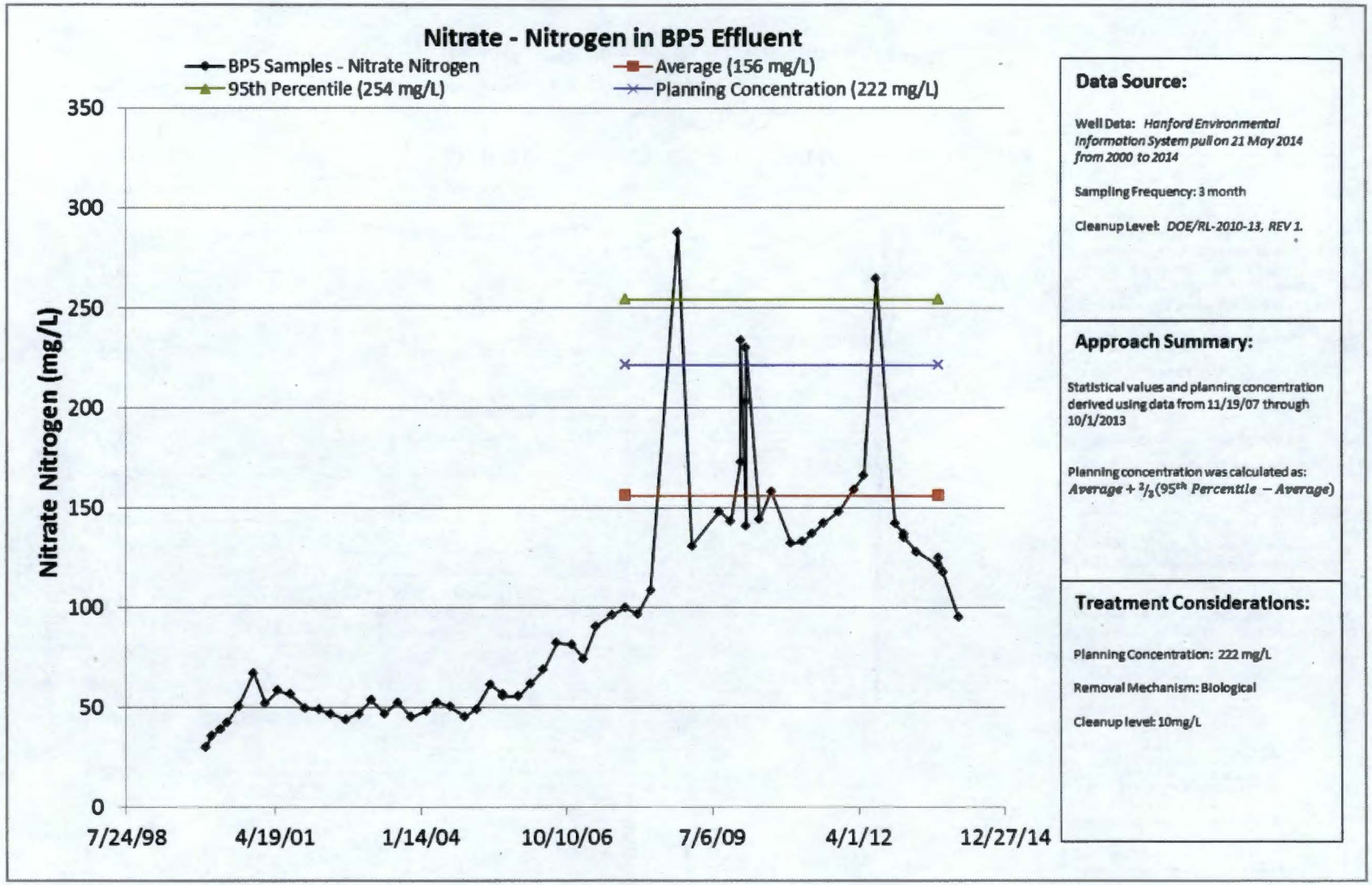
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-8. Iodine-129 in 200-BP-5 Effluent



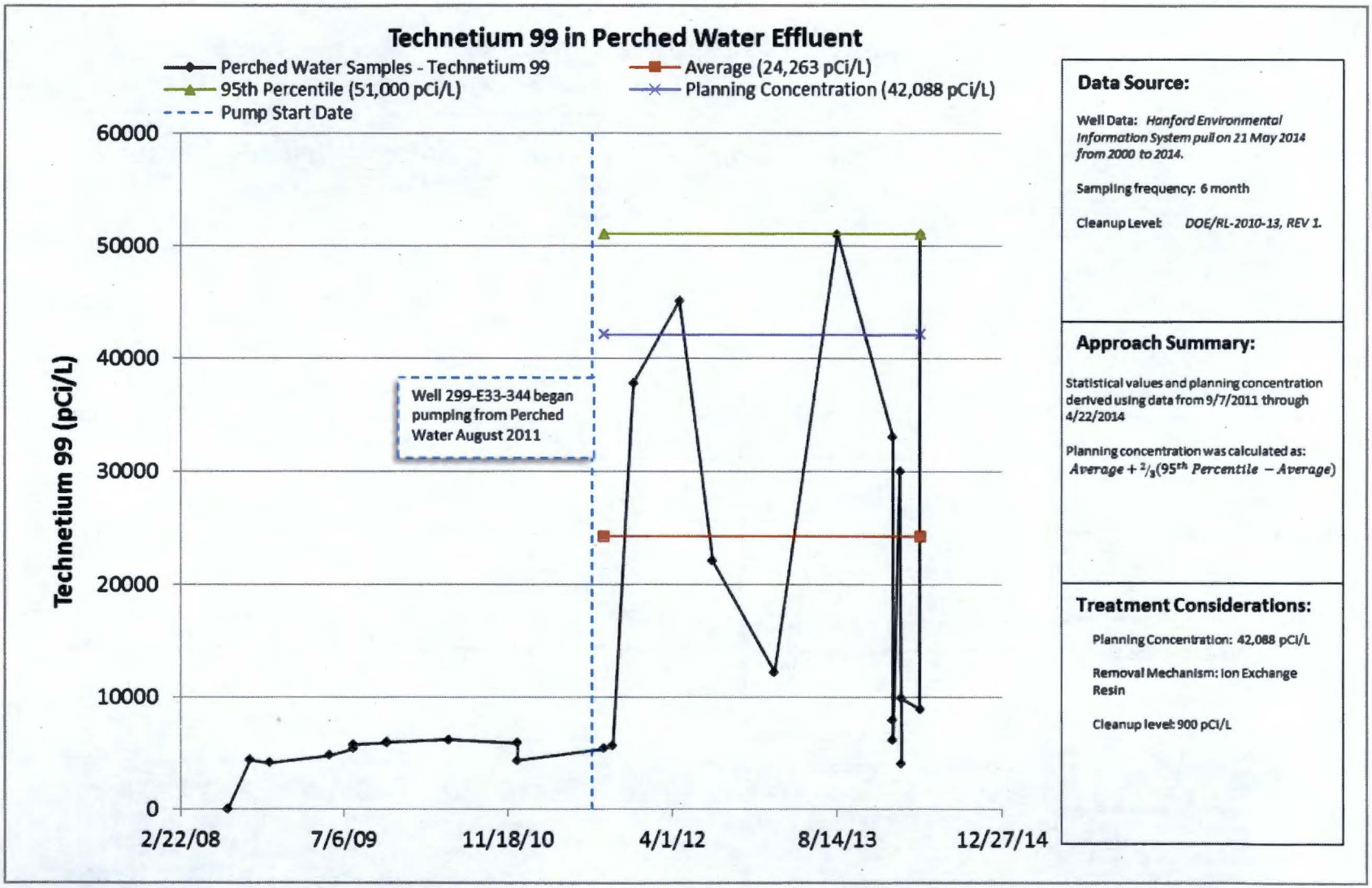
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-9. Nitrate-Nitrogen in Perched Water Effluent



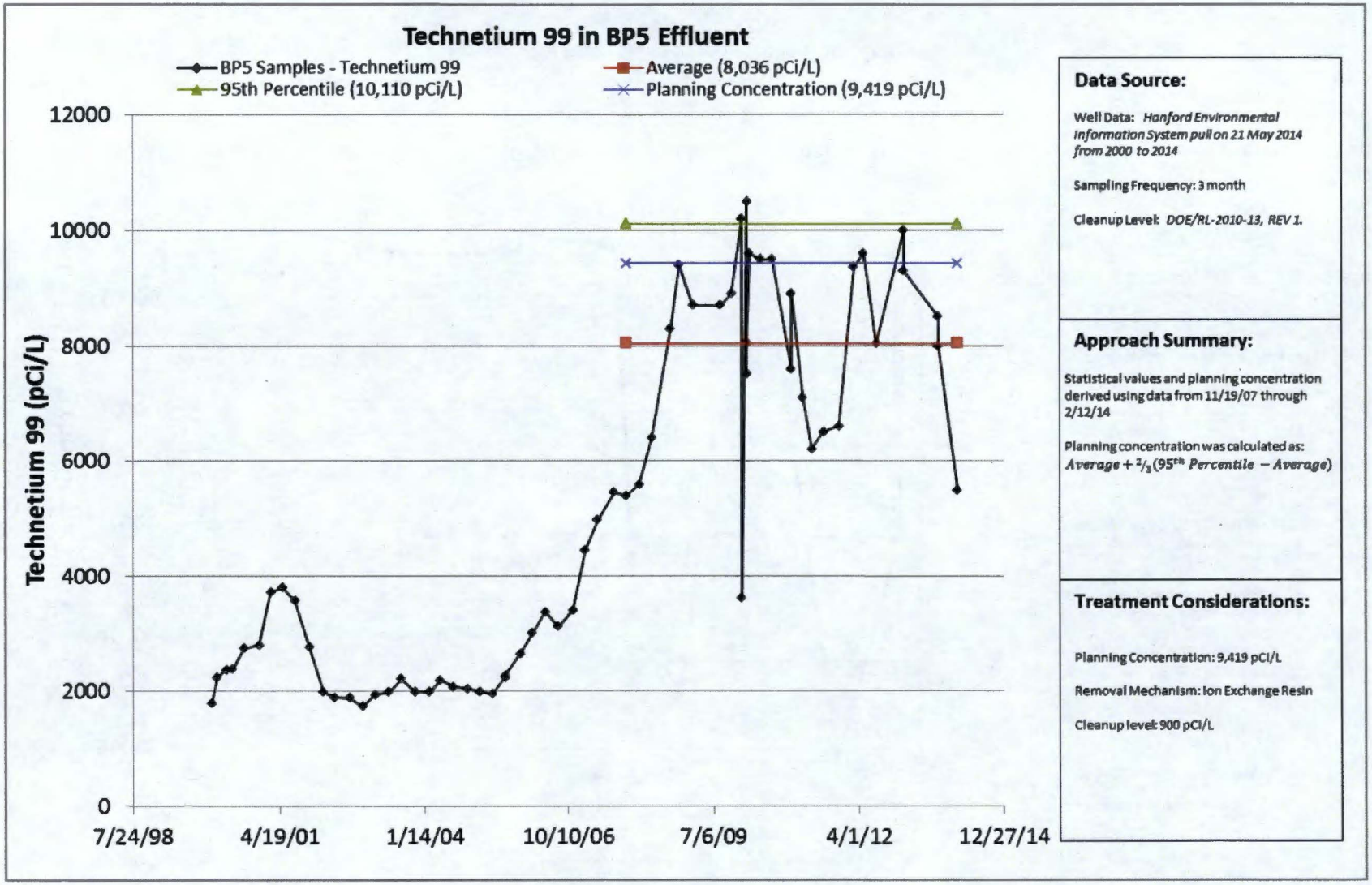
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-10. Nitrate-Nitrogen in 200-BP-5 Effluent



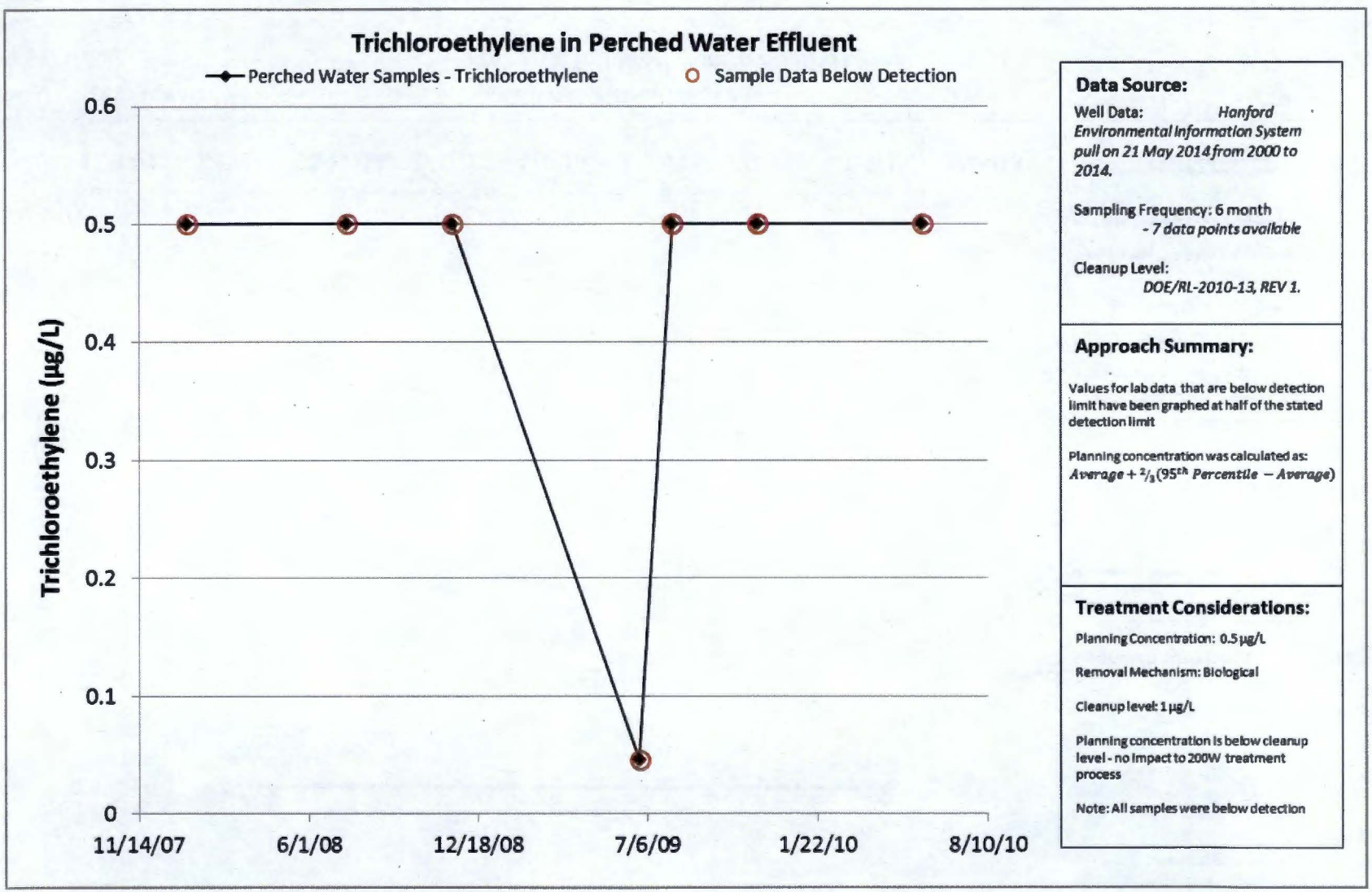
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-11. Technetium-99 in Perched Water Effluent



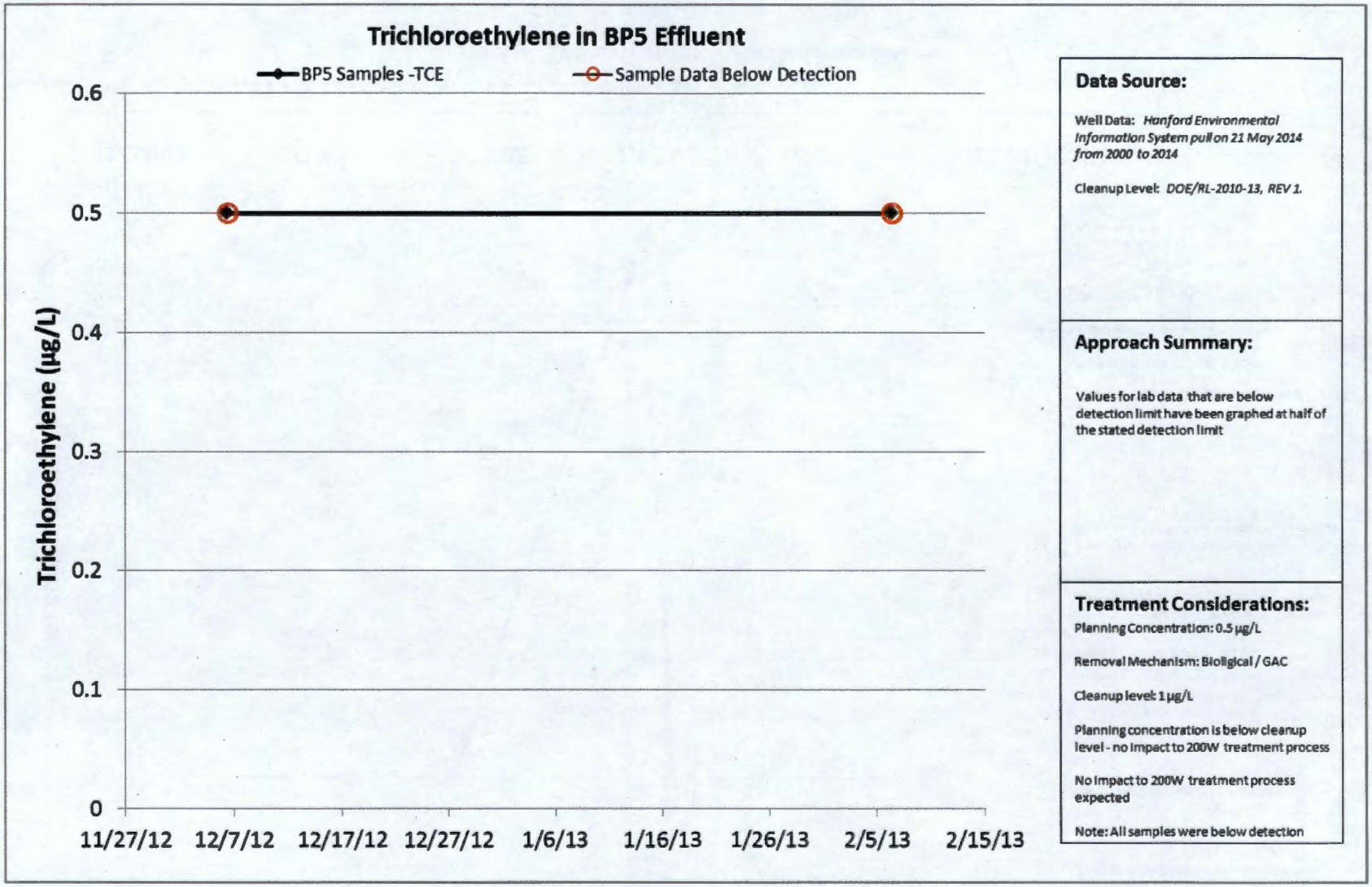
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-12. Technetium-99 in 200-BP-5 Effluent



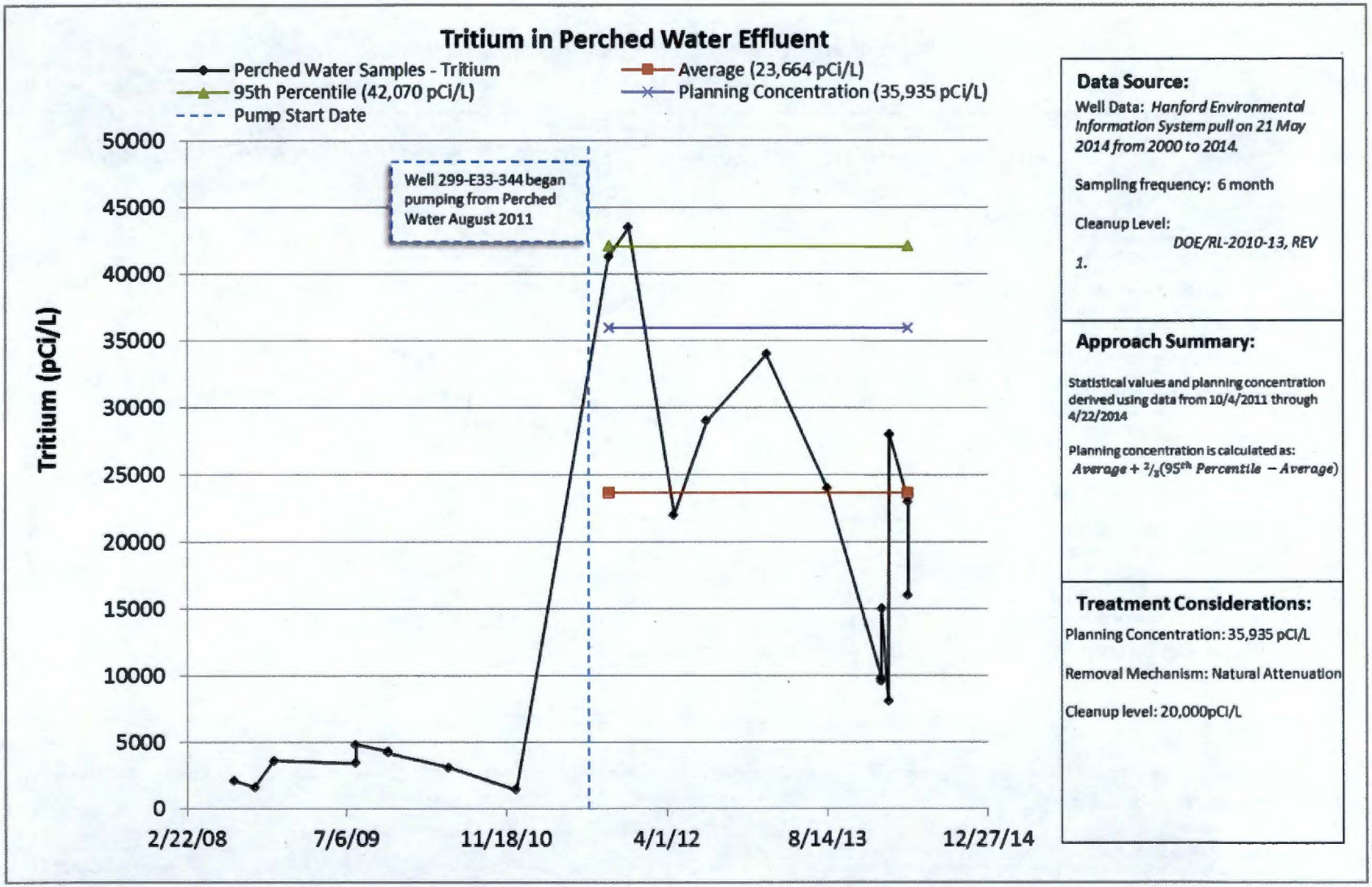
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-13. Trichloroethylene in Perched Water Effluent



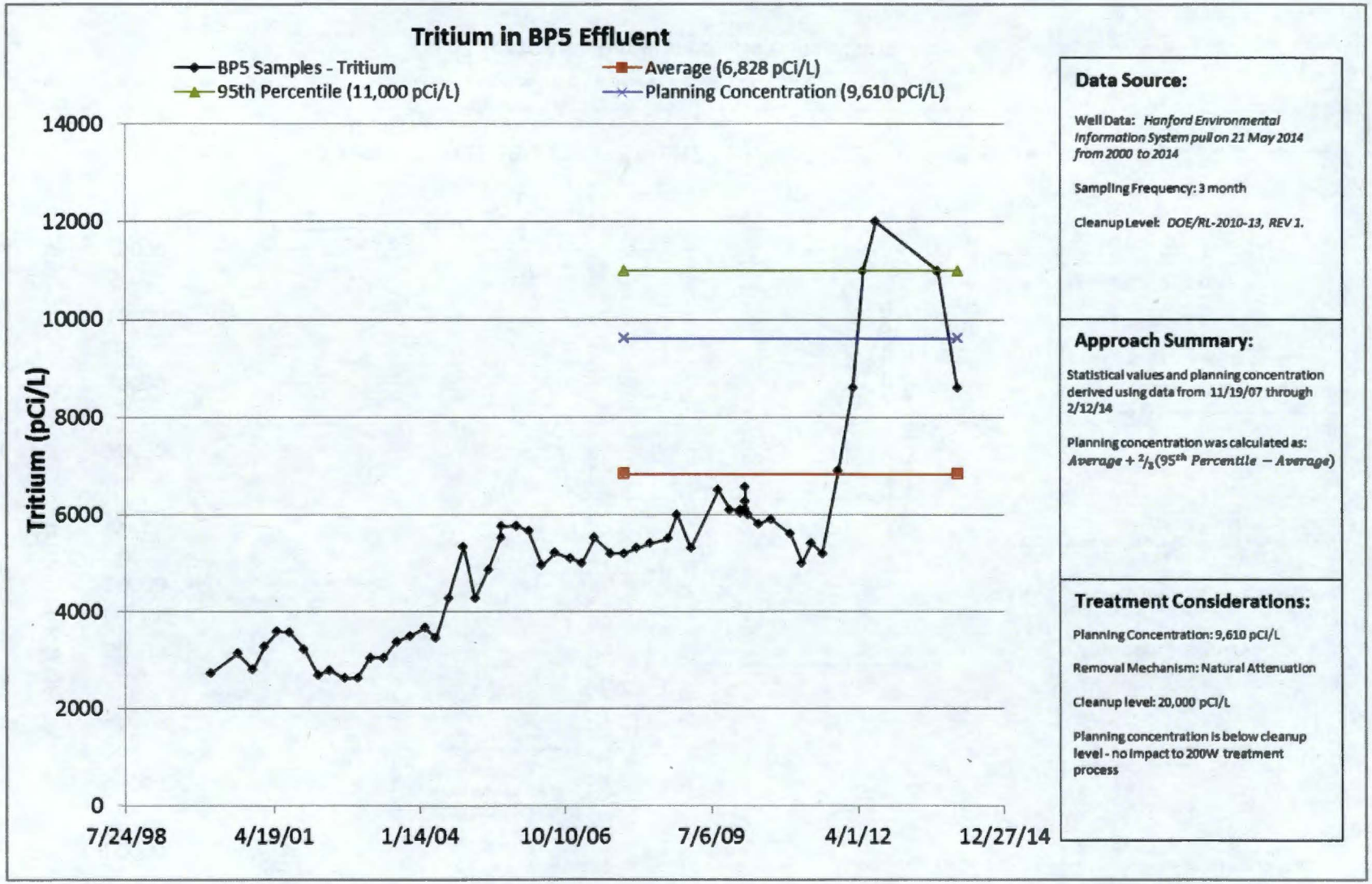
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-14. Trichloroethylene in 200-BP-5 Effluent



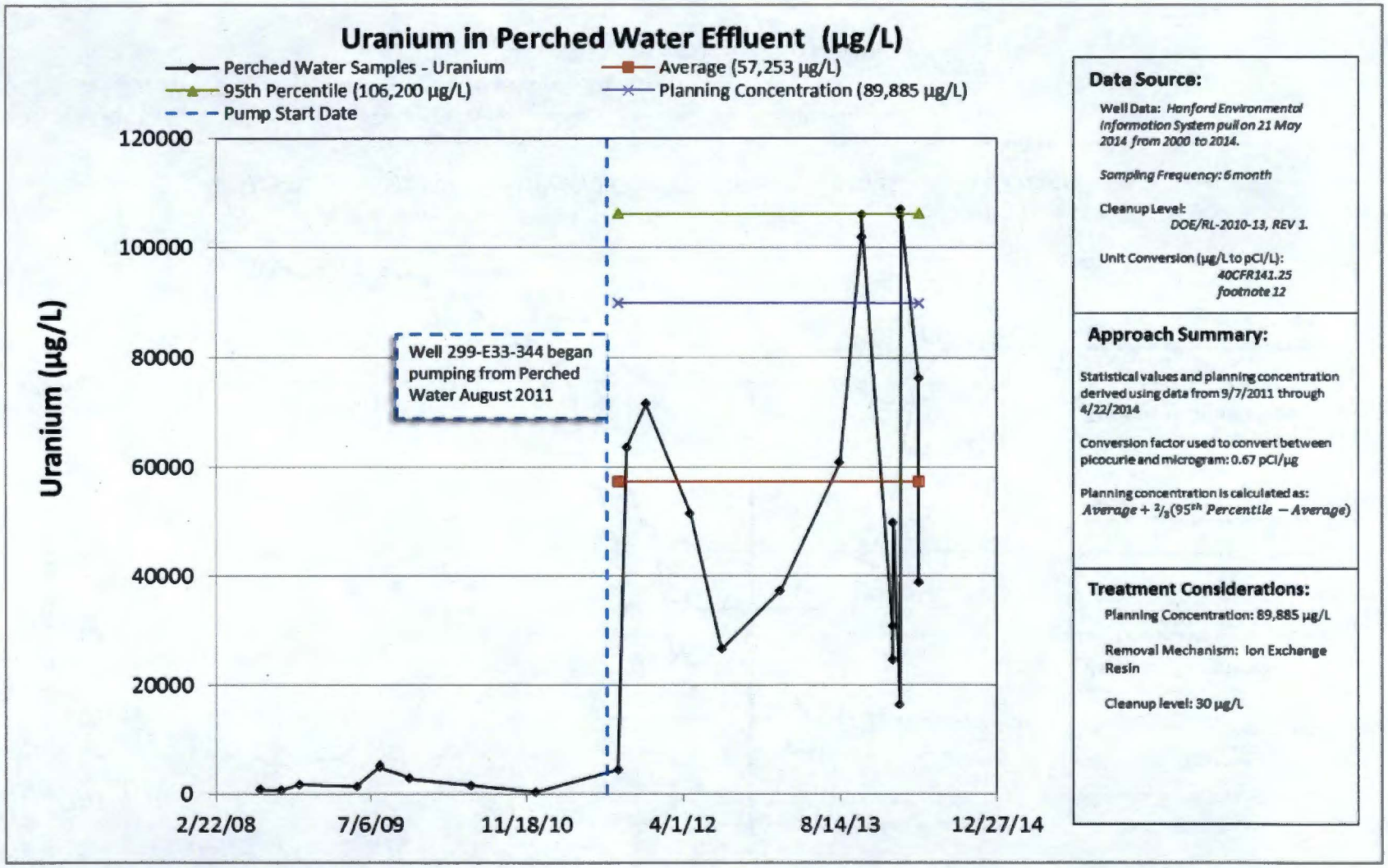
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-15. Tritium in Perched Water Effluent



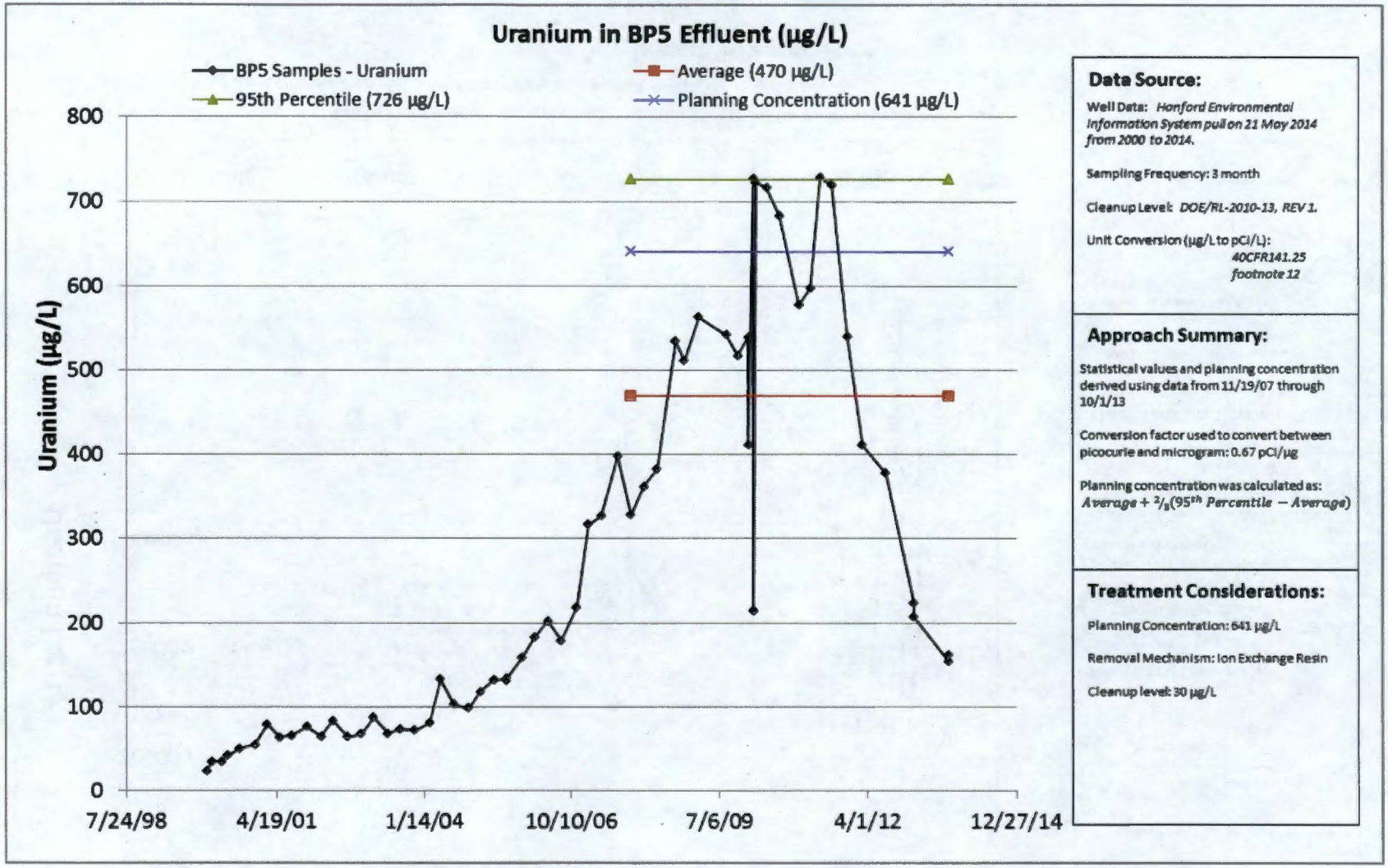
Reference: DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-16. Tritium in 200-BP-5 Effluent



References: 40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity."
DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

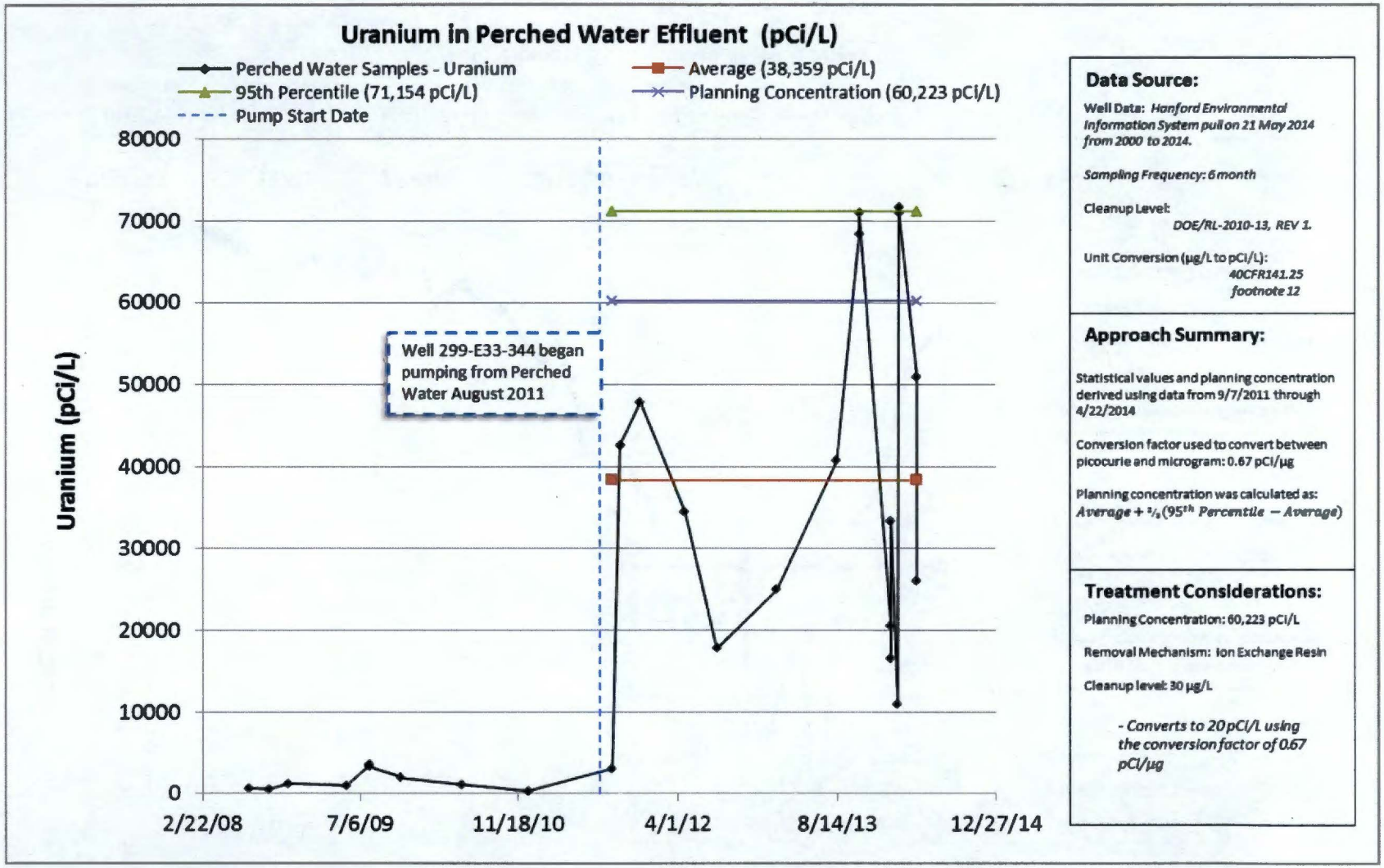
Figure A-17. Uranium in Perched Water



References: 40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity."

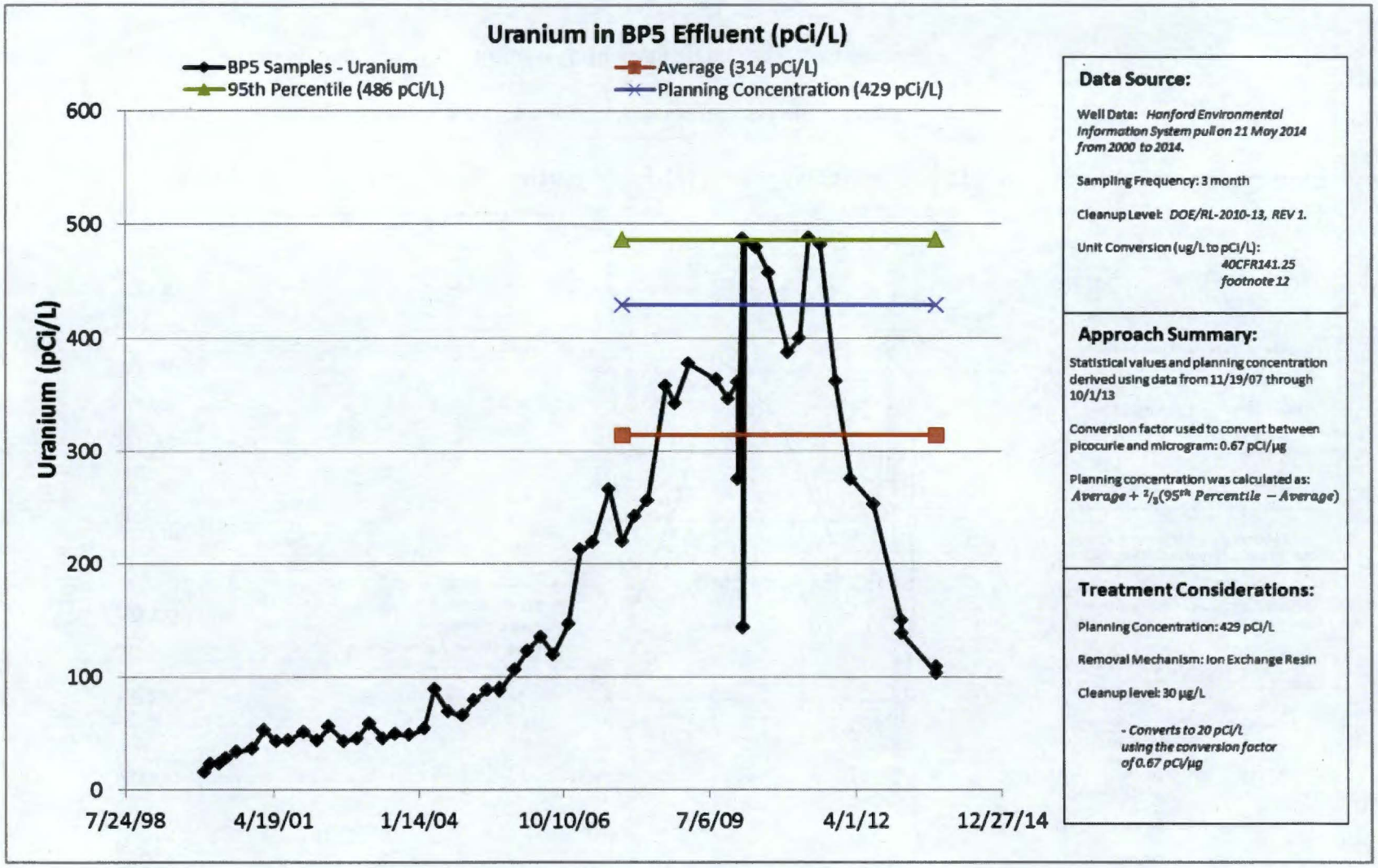
DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-18. Uranium in 200-BP-5 Effluent



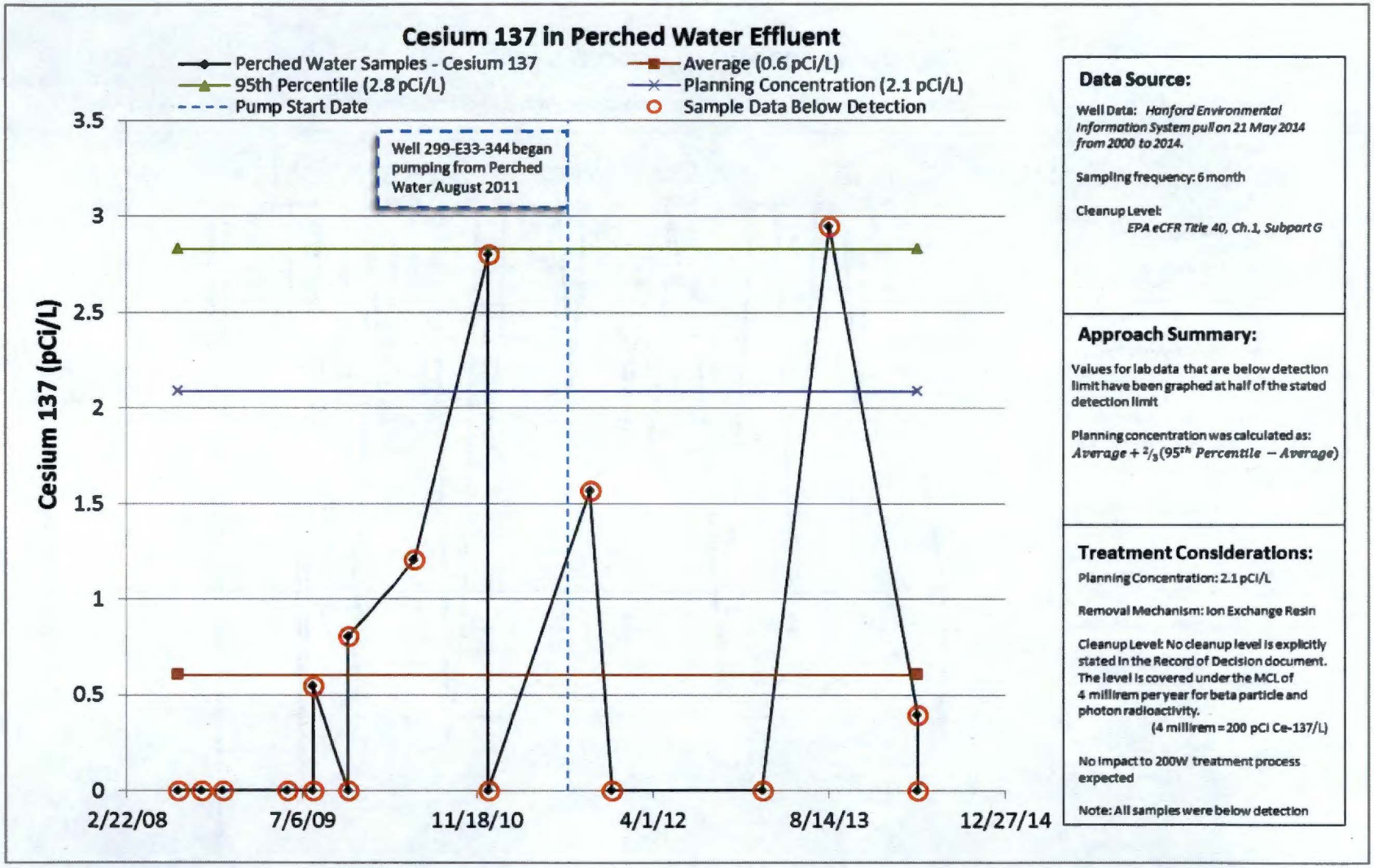
References: 40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity."
DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-19. Uranium in Perched Water Effluent



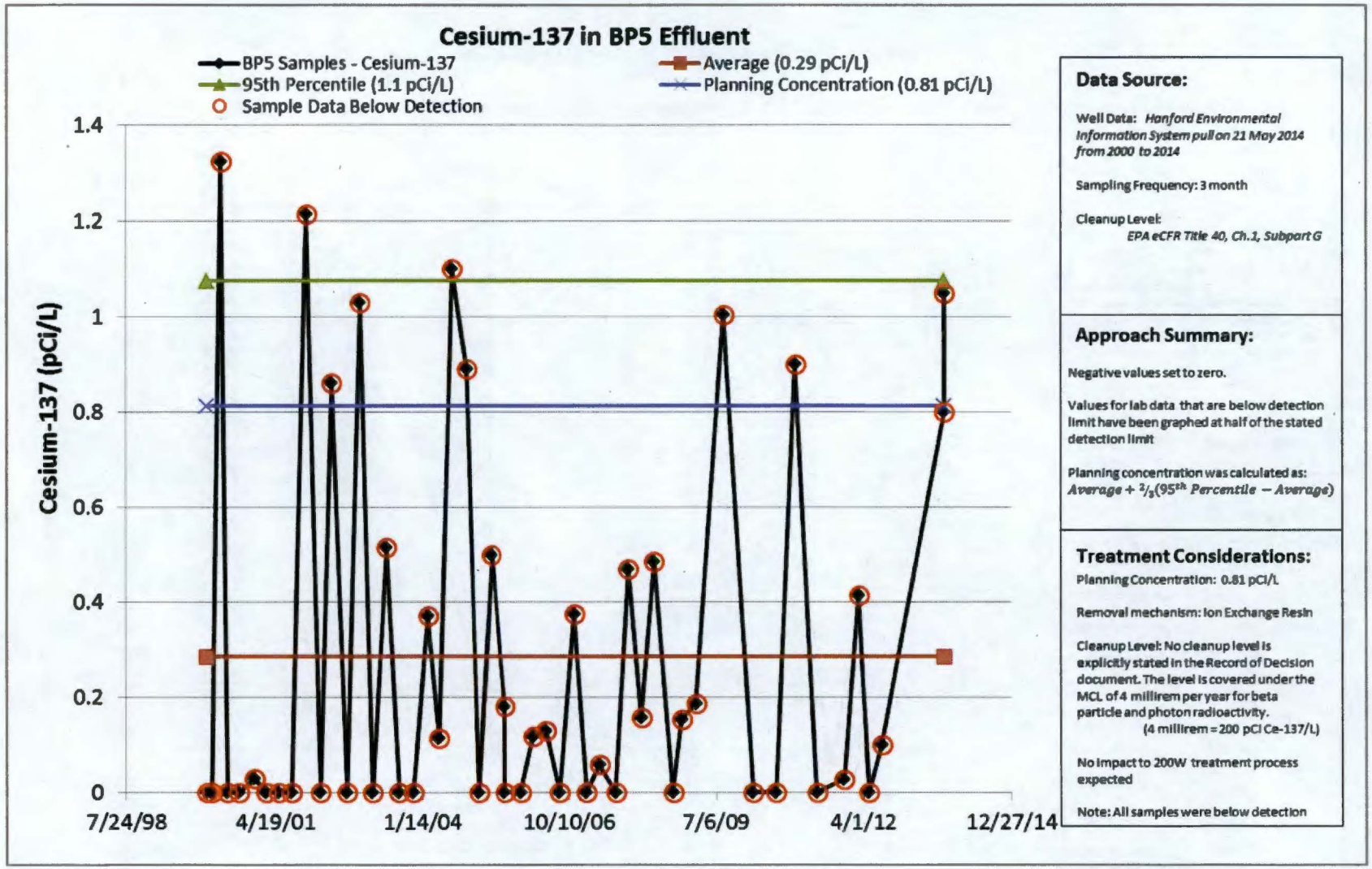
References: 40 CFR 141.25, "National Primary Drinking Water Regulations," "Analytical Methods for Radioactivity."
DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report.*

Figure A-20. Uranium in 200-BP-5 Effluent



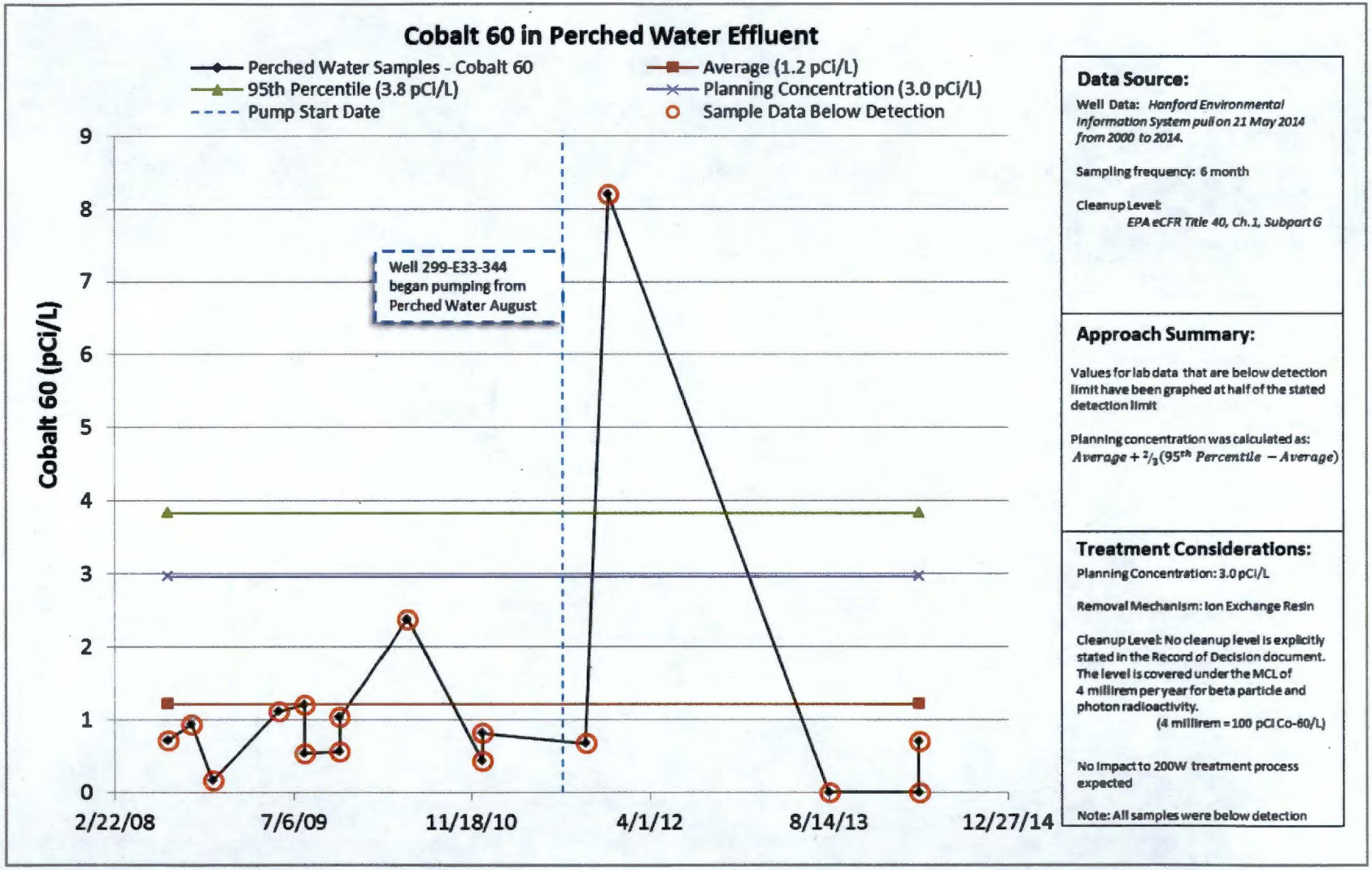
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-21. Cesium-137 in Perched Water Effluent



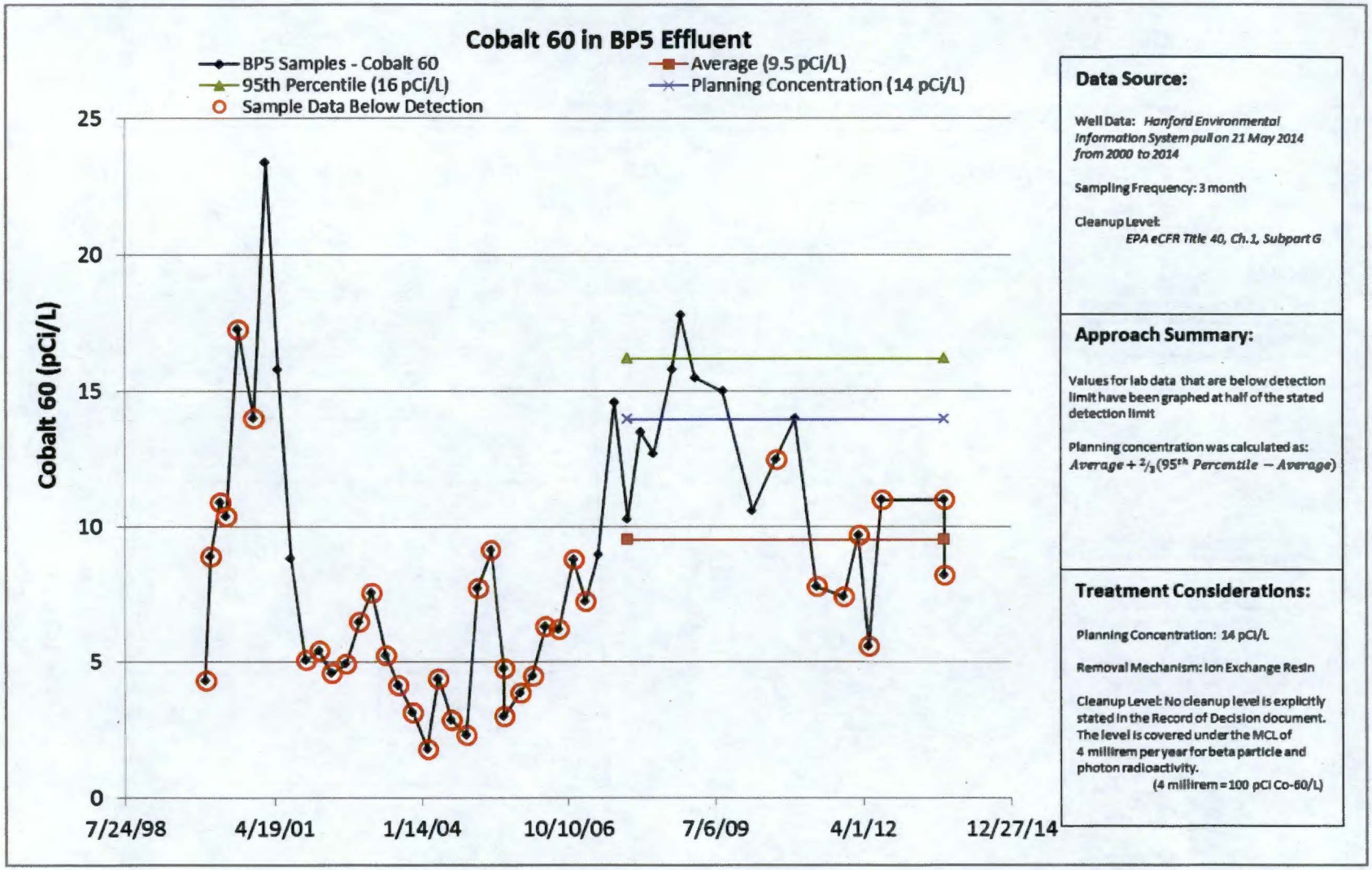
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-22. Cesium-137 in 200-BP-5 Effluent



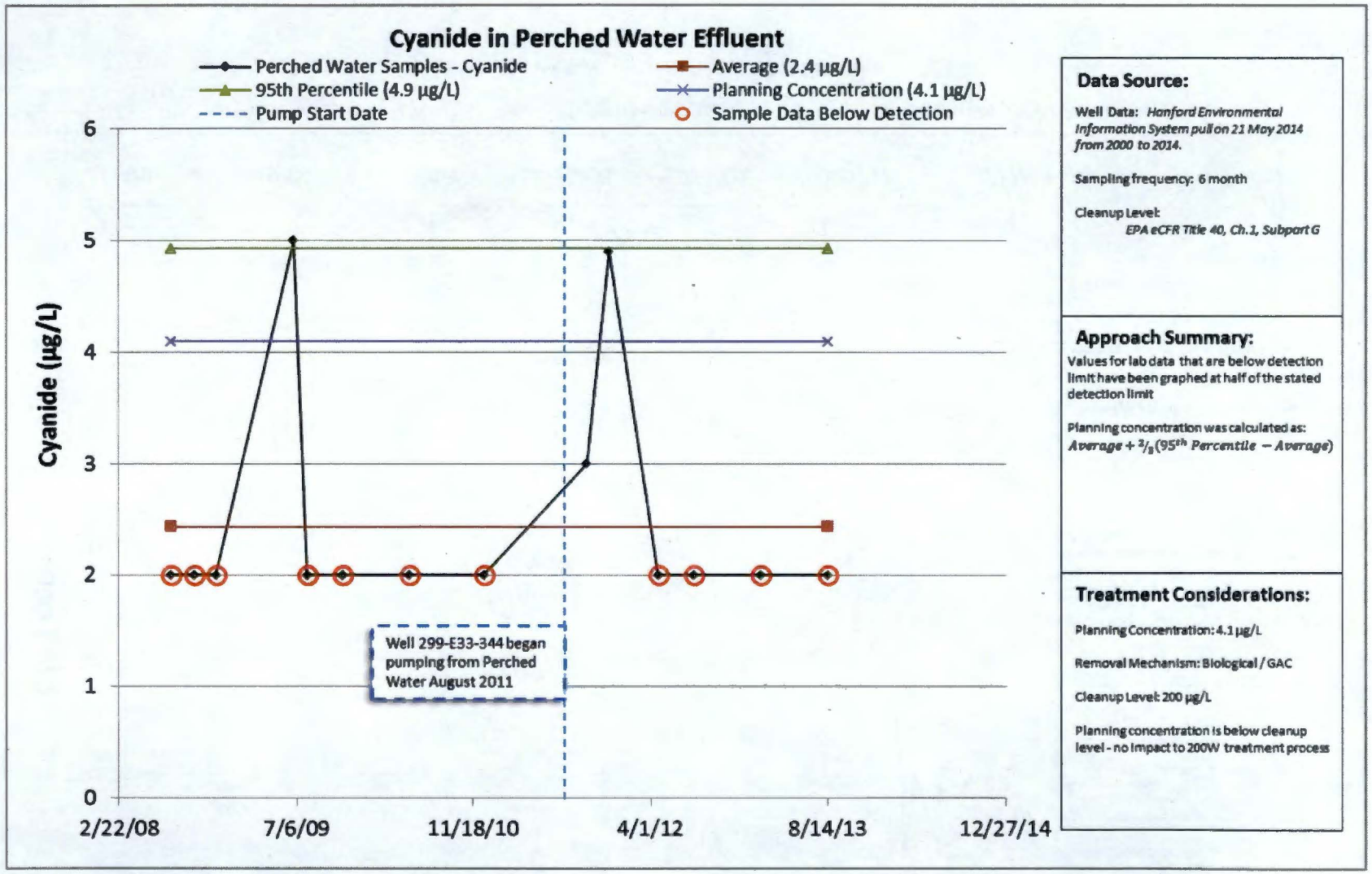
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-23. Cobalt-60 in Perched Water Effluent



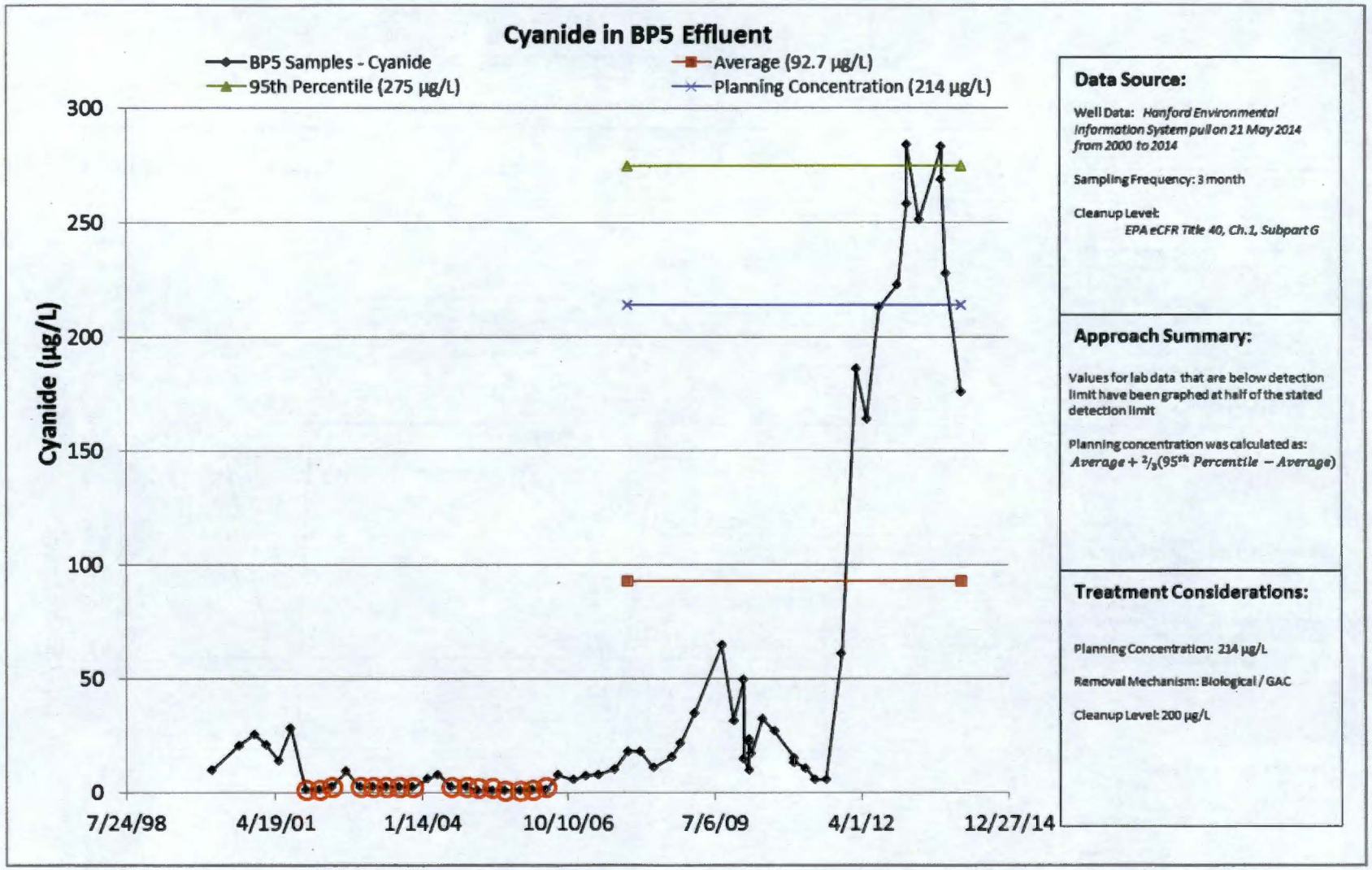
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-24. Cobalt-60 in 200-BP-5 Effluent



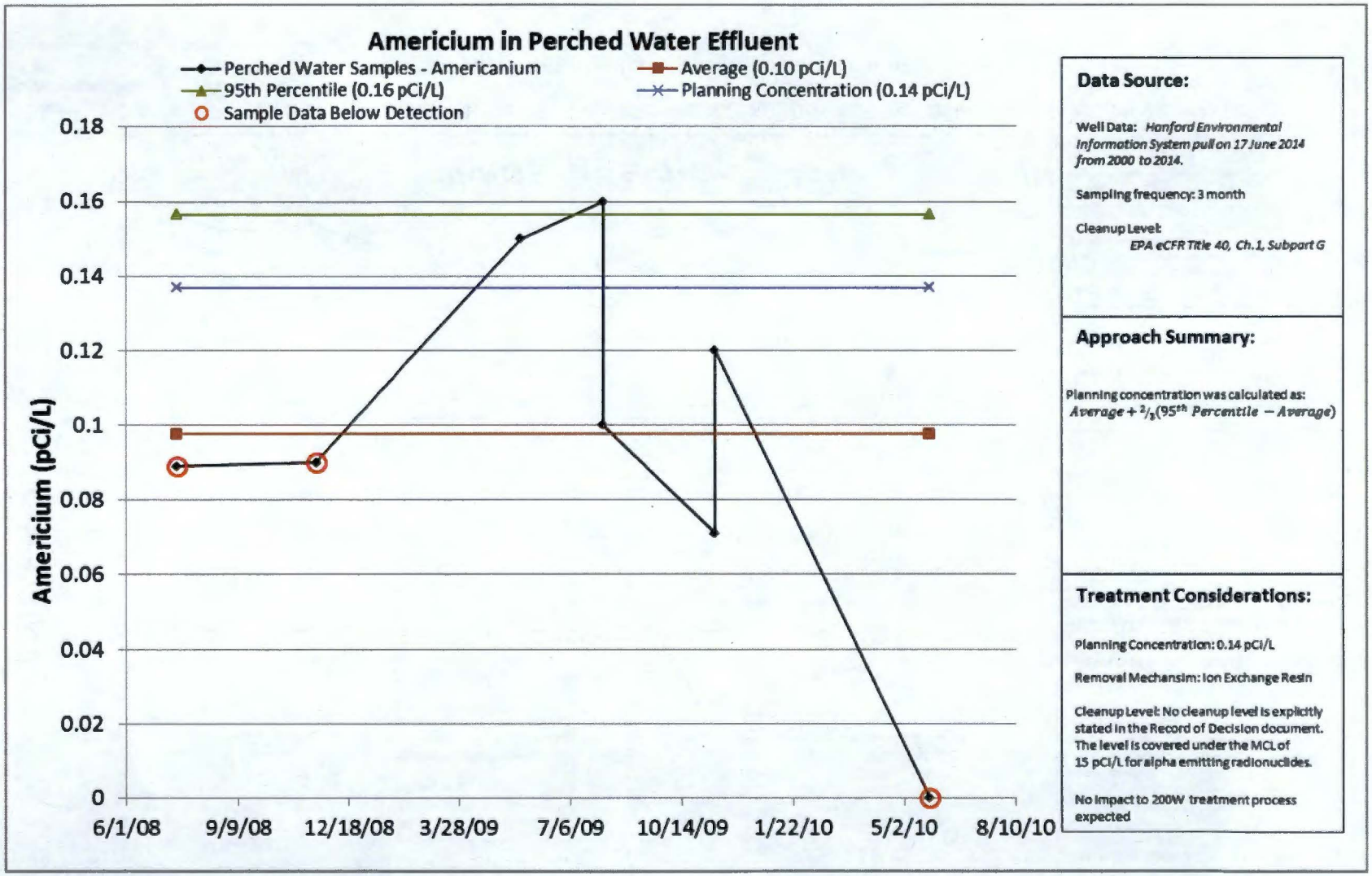
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-25. Cyanide in Perched Water Effluent



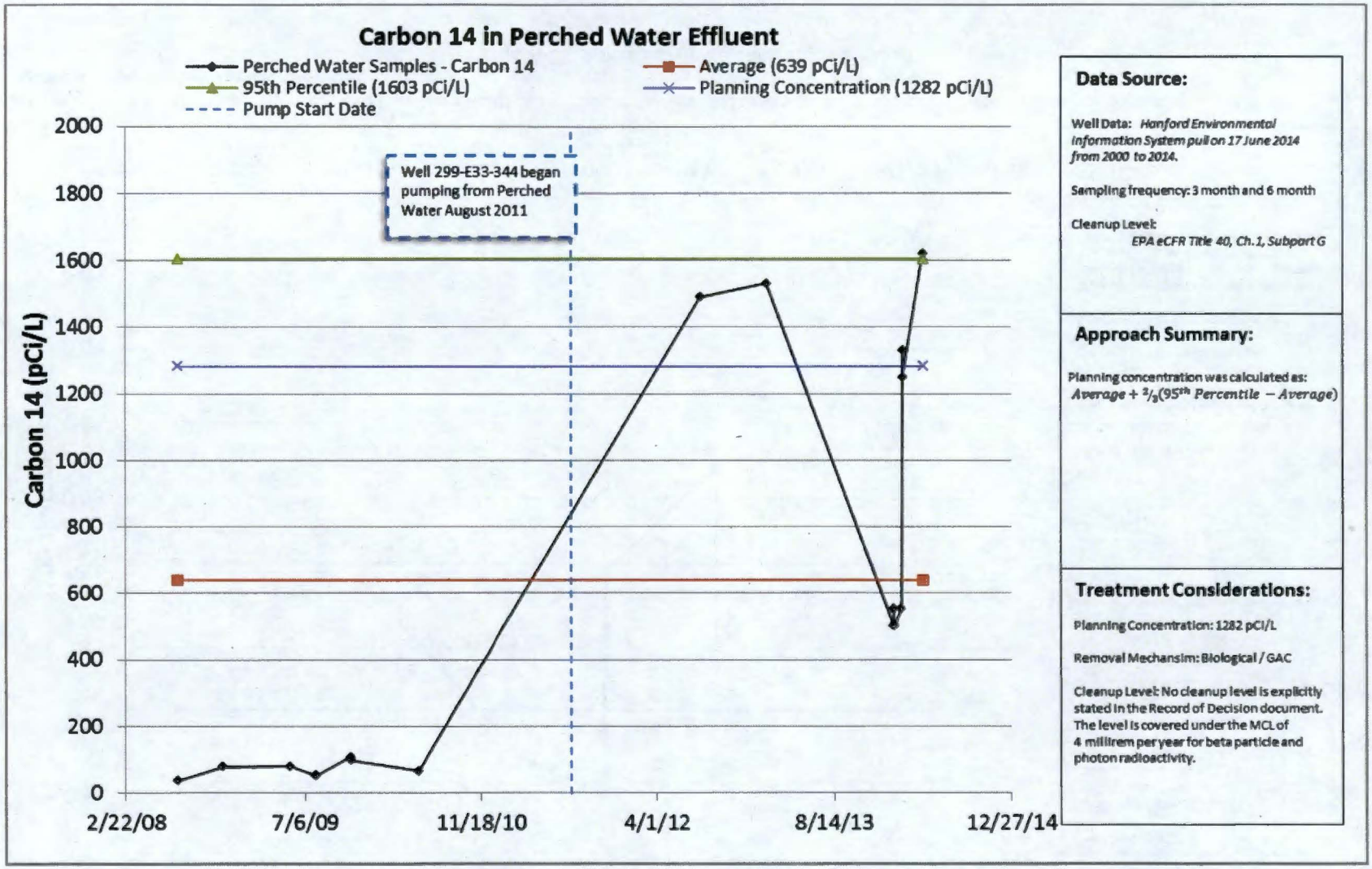
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-26. Cyanide in 200-BP-5 Effluent



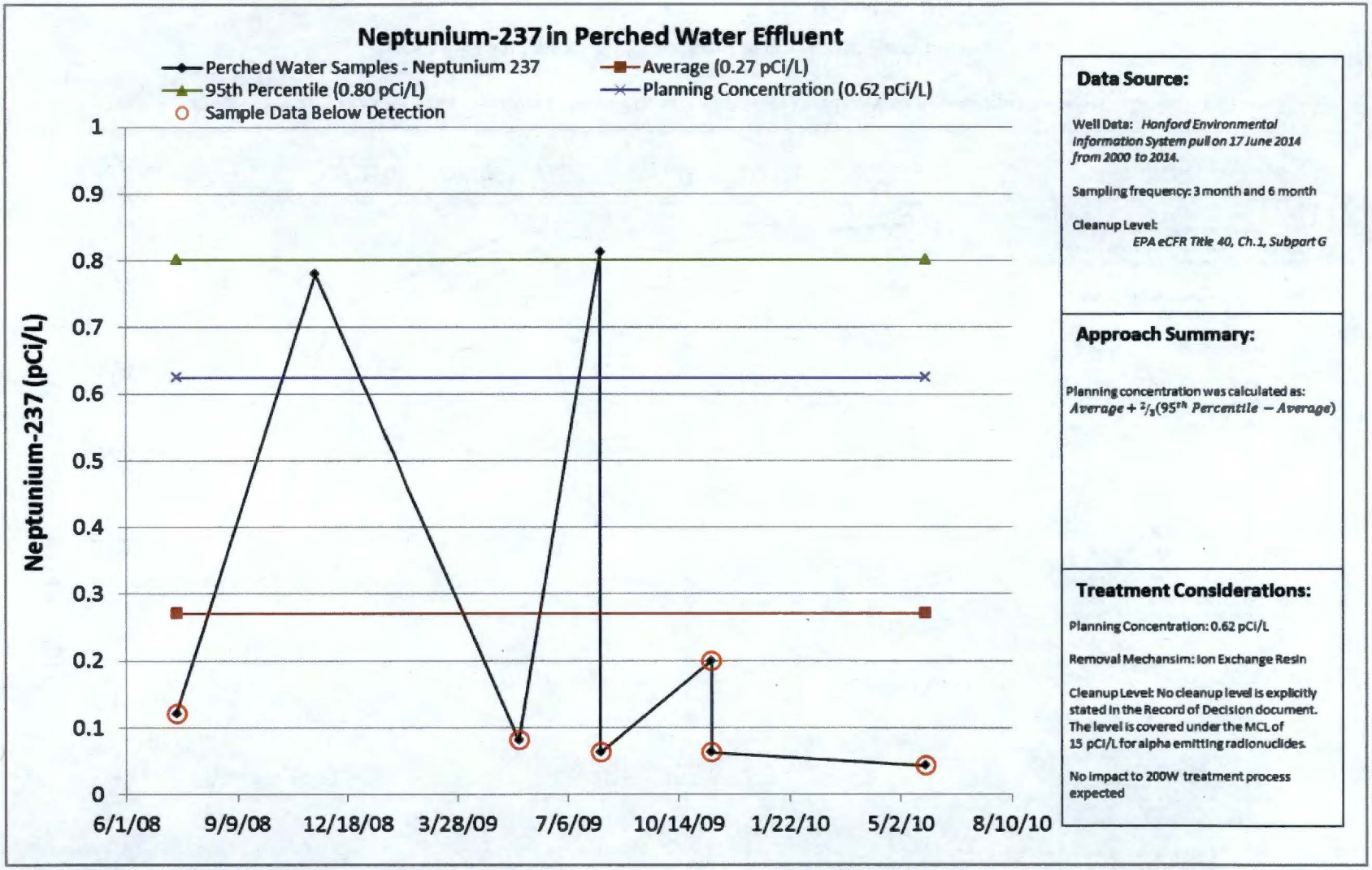
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-27. Americium in Perched Water Effluent



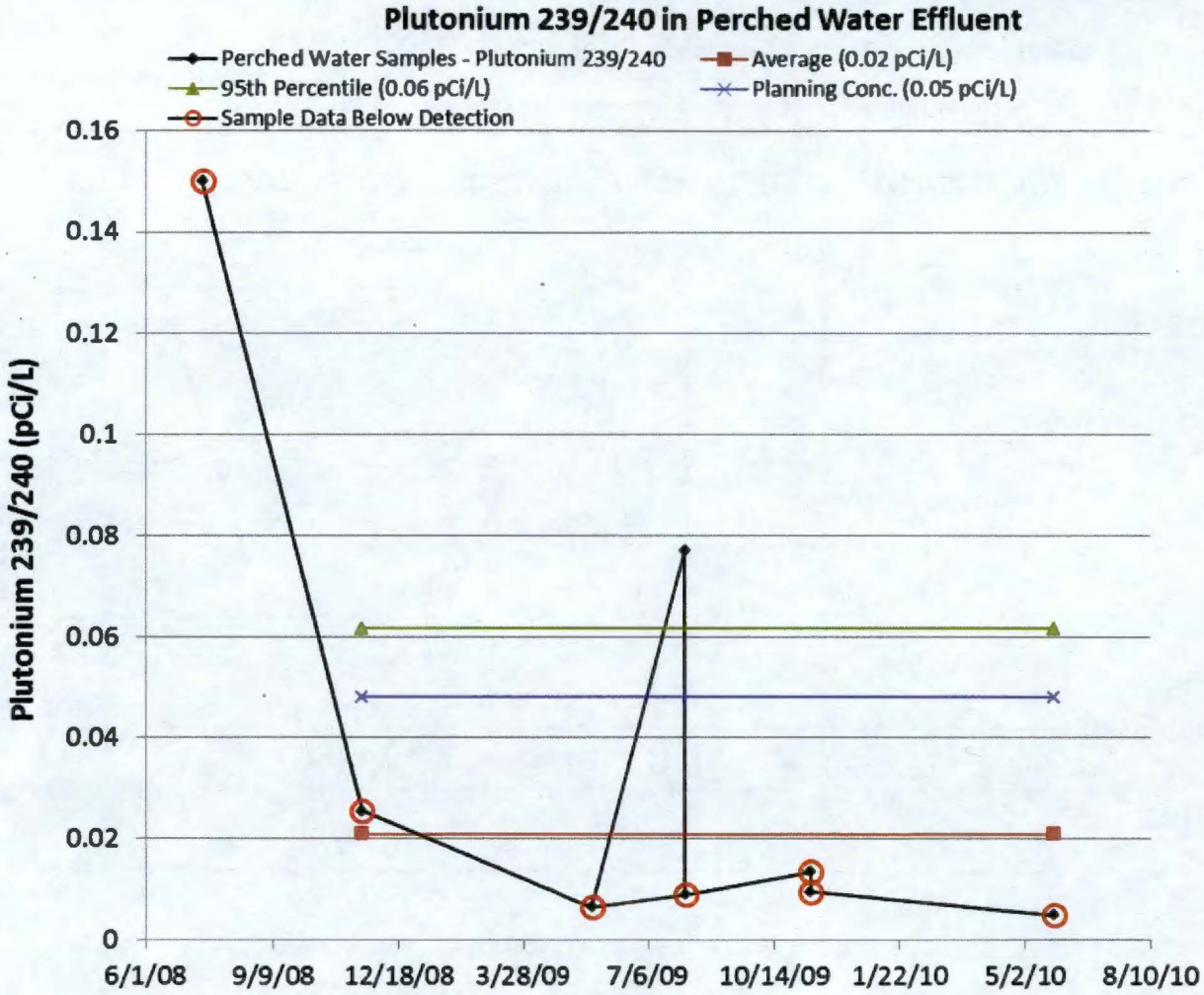
Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-28. Carbon-14 in Perched Water Effluent



Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-29. Neptunium-237 in Perched Water Effluent



Data Source:

Well Data: *Hanford Environmental Information System pull on 21 May 2014 from 2000 to 2014.*

Sampling frequency: 6 month

Cleanup Level:
EPA eCFR Title 40, Ch.1, Subpart G

Approach Summary:

Statistical values and planning concentration derived using data from 11/18/2008 through 5/24/2010

Planning concentration was calculated as:
$Average + {}^{2}/_{3}(95^{th}\ Percentile - Average)$

Treatment Considerations:

Planning Concentration: 0.05 pCi/L

Removal Mechanism: Ion Exchange Resin

Cleanup Level: No cleanup level is explicitly stated in the record of decision document.

Drinking Water maximum contaminant limit (MCL): Covered under the MCL of 15 pCi/L for alpha particle activity

No impact to 200W treatment process expected

Reference: 40 CFR 141, "National Primary Drinking Water Regulations," Subpart G, National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels."

Figure A-30. Plutonium-239/Plutonium-240 in Perched Water Effluent

Appendix B

Specific Activity for Uranium Isotopes from Perched Water

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Table

Table B-1. Specific Activity for Uranium Isotopes in Perched Water B-1

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Table B-1. Specific Activity for Uranium Isotopes in Perched Water

Date	Well	U-234 (pCi/L)	U-234 Specific Activity (pCi/µg)	U-234 (µg/L)	U-235 (pCi/L)	U-235 Specific Activity (pCi/µg)	U-235 (µg/L)	U-238 (pCi/L)	U-238 Specific Activity (pCi/µg)	U-238 (µg/L)	Uranium Total (pCi/L)	Uranium Total (µg/L)	Ratio
11/29/2011	299-E33-343	598	6,250	0.10	16	2.16	8	574	0.336	1,708	1,188	1,716	0.692
11/29/2011	299-E33-343	595	6,250	0.10	27	2.16	12	585	0.336	1,741	1,207	1,754	0.688
8/2/2012	299-E33-344	8,600	6,250	1.38	610	2.16	282	8,600	0.336	25,595	17,810	25,879	0.688
2/5/2013	299-E33-344	29,000	6,250	4.64	1,900	2.16	880	29,000	0.336	86,310	59,900	87,194	0.687
1/29/2014	299-E33-351	7,700	6,250	1.23	1,100	2.16	509	9,300	0.336	27,679	18,100	28,189	0.642
1/29/2014	299-E33-351	13,000	6,250	2.08	870	2.16	403	11,000	0.336	32,738	24,870	33,143	0.750
1/30/2014	299-E33-351	17,000	6,250	2.72	1,600	2.16	741	18,000	0.336	53,571	36,600	54,315	0.674
2/20/2014	299-E33-350	5,800	6,250	0.93	440	2.16	204	5,800	0.336	17,262	12,040	17,467	0.689
2/24/2014	299-E33-350	33,000	6,250	5.28	2,000	2.16	926	33,000	0.336	98,214	68,000	99,145	0.686
2/24/2014	299-E33-350	34,000	6,250	5.44	2,200	2.16	1,019	35,000	0.336	104,167	71,200	105,191	0.677
4/22/2014	299-E33-344	33,000	6,250	5.28	2,600	2.16	1,204	34,000	0.336	101,190	69,600	102,399	0.680
4/22/2014	299-E33-344	24,000	6,250	3.84	1,700	2.16	787	24,000	0.336	71,429	49,700	72,219	0.688

Perched Water = 200-DV-1 Perched Water horizon within the B Complex
U-234 = uranium-234
U-235 = uranium-235
U-238 = uranium-238

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