SGW-57790
Revision 4

Characterization Data for Waste Streams (200-ZP-1, 200-UP-1, 200-BP-5, ERDF Leachate, 200-DV-1 Perched Water, MSU, and A-Farm/C-Farm) 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

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

APPROVED
By Sarah Harrison at 2:13 pm, Dec 03, 2020

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Terms

200 West P&T	200 West Pump and Treat
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
ERDF	Environmental Restoration Disposal Facility
HEIS	Hanford Environmental Information System
IX	ion exchange
MSU	modular storage unit
OU	operable unit

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1 Purpose

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

- 200-BP-5 Operable Unit (OU)
- 200-DV-1 perched water horizon within the B Complex
- 200-UP-1 OU
- Leachate from the Environmental Restoration Disposal Facility (ERDF), hereinafter called ERDF leachate
- 200-ZP-1 OU
- Water from the modular storage unit (MSU) facility, hereinafter called MSU water
- A-AX and C Farm (located in 200-PO-1 OU and 200-BP-5 OUs, respectively), hereinafter called A Farm and C Farm

The purpose of this revision is to update the concentrations of contaminants in legacy feed streams and add new feed streams. As directed by the U.S. Department of Energy, biological treatment was suspended in October 2019 for a period of 5 to 7 years to implement DOE/RL-2019-38, *200-ZP-1 Operable Unit Optimization Study Plan*. This revision includes 10 new extraction wells in the 200-ZP-1 aquifer to assist in remediating the carbon tetrachloride plume. A new air stripper is scheduled for installation in 2022 that will increase the total plant throughput to 14,195 L/min (3,750 gal/min). This report is intended to assist technical staff by accomplishing the following objectives:

- Documenting concentrations of key contaminants used to determine treatment operations at the 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 200-ZP-1, 200-BP-5, 200-DV-1, 200-UP-1, ERDF leachate, A Farm, C Farm, and the MSUs.

This document provides the technical justification to allow the abovementioned waste streams to be processed at the 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 the 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 Hanford 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 the 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 (including 200-DV-1), groundwater from 200-BP-5, 200-UP-1, and ERDF leachate were added as feed streams to the 200 West P&T. Based on the results of DOE/RL-2018-28, *Optimization Test Plan for Treating Water from Modular Storage Units at 200 West*

Pump & Treat Facility, MSU water is being piped to the 200 West P&T on an episodic basis. Due to suspension of biological treatment at the 200 West P&T, a new evaluation has been performed to document impacts from treating MSU water (SGW-65559, *Impacts and Recommendations Regarding Transfer of Modular Storage Unit Water Comingled with BP-5 and DV-1 Feed Streams*). A feasibility study for treatment of A Farm and C Farm groundwater has been developed to remediate technetium-99 in the groundwater at the waste sites. As of this document revision, the two extraction wells have not been drilled. Monitoring well data were used to model expected contaminant concentrations in each well. This report documents the concentrations used for engineering evaluations.

3 Methodology and Approach

The following conventions were used in evaluating the data:

- Concentrations that were below the specified detection limit were assumed to be present at the detection limit for hazard classification and at half of the detection limits for treatment considerations.
  - The same was done for samples with “undetected” or “false positive” lab qualifiers, as well as for negative values for radionuclides (indicating background radiation greater than the sample).
- For 200-ZP-1, 200-UP-1, 200-BP-5, and 200-DV-1 extraction well data, concentrations were first determined for individual wells.
  - 95th percentile concentrations are then calculated across the set of individual well concentrations within each source.
  - Flow-weighted averages for each source are calculated from individual well concentrations weighted according to flows used for plant operation at 14,195 L/min (3,750 gal/min).
- For ERDF leachate and MSU water, data from January 2019 through December 2019 were used for the calculations for 95th percentile and average calculations.
- For A Farm and C Farm water, modeling data from the monitoring well network were used for expected concentrations.

Sample calculations of 95th percentile and average concentrations are presented in Chapter 6.

3.1 Data Used in Analysis

All contaminant concentrations defined in this document were obtained from the Hanford Environmental Information System (HEIS) database. The extraction wells are sampled quarterly, and the concentrations gradually change as the remedy progresses. Recent extraction well data (January 2020) was evaluated for sources composed of extraction wells including 200-ZP-1, 200-UP-1, and 200-BP-5. Conversely, a range of dates was used for sources such as ERDF leachate that, unlike extraction wells, do not exhibit a distinct trend but can vary from one sampling event to the other. The following sections describe the data used for this evaluation.

3.1.1 200-DV-1 Data

Three extraction wells were operational in the 200-DV-1 OU: 299-E33-344, 299-E33-350, and 299-E33-351. Concentrations of contaminants in these wells from January 2019 through December 2019 were obtained from HEIS.

3.1.2 Environmental Restoration Disposal Facility Leachate Data

Concentrations of contaminants in ERDF leachate from January 2019 through December 2019 were obtained from HEIS. Certain compounds present in ERDF leachate are critical to treatment at the 200 West P&T (e.g., uranium, nitrate, technetium-99, and sulfate) and have been tested quarterly for the entire date range. Other contaminants were sampled less frequently, as noted in Chapter 7.

3.1.3 200-UP-1 Data

Three extraction wells were operational in the 200-UP-1 OU: Wells 299-W19-113, 299-W19-114, and 299-W19-125. Contaminant concentrations were obtained from HEIS using data from the most recent sampling events (typically January 2020).

3.1.4 200-ZP-1 Data

The 200-ZP-1 extraction wells are either categorized as radiological or nonradiological wells from which groundwater is fed to either the technetium-99 IX process or the central treatment, respectively. As of February 2020, 17 nonradiologically active wells and 7 radiologically active wells within 200-ZP-1 are in operation. Contaminant concentrations were obtained from HEIS using the data from the most recent sampling events (typically January 2020). For the 10 future 200-ZP-1 extraction wells, concentration data from modeling runs was used.

3.1.5 Modular Storage Unit Water Data

For characterization of MSU water, concentrations of contaminants in MSU 3 from January 2019 through December 2019 were obtained from HEIS.

3.1.6 A Farm and C Farm

For characterization of A and C Farm data, monitoring wells in the A and C Farm complexes were evaluated from 2016 through 2019. Two extraction wells, one from A Farm and one from C Farm, will be added to the 200 West P&T system.

3.2 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 the 200-DV-1 OU.

4 Assumptions and Inputs

The following key assumptions were used to evaluate the data:

- Concentrations that were below the detection limit were assumed to be present at half the detection limit.
  - This included all sample results with “undetected” or “false positive” lab qualifiers.
  - This included negative values of some of the radioactive compounds. A negative number results when more background radiation is measured than that from the sample.

- The datasets evaluated for each source are assumed to provide reasonable definition of upper bound contaminant concentrations that will occur in the feed streams.
  - Concentrations in individual 200-DV-1 extraction wells are represented by averaging recent sample data for each well.
  - Concentrations in individual 200-ZP-1, 200-UP-1, and 200-BP-5 extraction wells are represented by the most recent extraction well sampling.
  - All available samples within specified date ranges for ERDF leachate and MSU water were considered in order to provide representative datasets for 95th percentile or average concentrations in water from each source.
  - Concentrations from monitoring wells in A Farm and C Farm from 2016 through 2019 were considered to provide representative datasets for 95th percentile or average concentrations.

5 Software Applications

Microsoft® Excel® was used to perform the calculations. Three calculations were selected to be hand-checked.

6 Calculations

The calculations in this chapter provide examples of data evaluation and the conventions identified in Chapter 3, as follows

- For samples below detection, the detection limit was assumed for 95th percentile calculations, while half the detection limit was assumed for average calculations.
- Averages are either the arithmetic mean of the data within the specified date range or are flow-weighted with respect to typical flows used in the operation of extraction wells.

Flow-weighted concentrations were used for extraction well data (200-ZP-1, 200-UP-1, 200-BP-5, and 200-DV-1), while averages were used for data from A and C Farm monitoring wells, ERDF leachate, and MSU water.

The following sections provide average and 95th percentile calculations for 200-BP-5 as well as flow-weighted averages for 200-DV-1 and 200-ZP-1 radiologically active wells.

6.1 Calculation of Flow-Weighted Concentration in the 200-DV-1 Operable Unit

Table 1 lists technetium-99 concentrations in 200-DV-1 extraction wells.

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Table 1. Technetium-99 Concentration in 200-DV-1 Wells

Extraction Well	Sampling Date	Technetium-99 Concentration (pCi/L)
299-E33-344	March 2019	34,700
	May 2019	25,600
	August 2019	24,100
	September 2019	31,700
	December 2019	32,300
299-E33-350	March 2019	29,050
	May 2019	25,600
	August 2019	26,650
	September 2019	77,750
	December 2019	47,100
299-E33-351	March 2019	46,000
	May 2019	37,050
	August 2019	35,900
	September 2019	35,400
	December 2019	48,800

Reference: Hanford Environmental Information System.

Average well concentrations are first determined for each extraction well.

$$\text{j}^{\text{th}} \text{ well average concentration } C_j = \sum_i^n C_i \,/n$$

where:

C_I = i^{th} sample concentration from the well

N = total number of samples from the well.

Values from each well are then weighted using typical flows used as of October 2018 for plant operation at 8,706 L/min (2,300 gal/min).

$$\text{Flow-weighted concentration} = \frac{\sum_j^3 C_j Q_j}{\sum_j^3 Q_j}$$

where:

C_j = average concentration in j^{th} well

Q_j = flow of jth well.

Average technetium-99 concentration in well 299-E33-344:

$$\text{Average} = \frac{34{,}700+25{,}600+24{,}100+31{,}700+32{,}300\ \mu\text{g/L}}{5} = 29{,}680\ \text{pCi/L}$$

Average technetium-99 concentration in well 299-E33-350:

$$\text{Average} = \frac{29{,}050+25{,}600+26{,}650+77{,}750+47{,}100\ \mu\text{g/L}}{5} = 41{,}230\ \text{pCi/L}$$

Average technetium-99 concentration in well 299-E33-351:

$$\text{Average} = \frac{46{,}000+37{,}050+35{,}900+35{,}400+48{,}800\ \mu\text{g/L}}{5} = 40{,}630\ \text{pCi/L}$$

In this case, a representative value of 1.9 L/min (0.5 gal/min) was used as the average flow from each 200-DV-1 extraction well.

Flow-weighted average concentration in 200-DV-1:

$$\text{Flow-weighted concentration} = \frac{0.5\left(29{,}680\frac{\text{pCi}}{\text{L}}\right)+0.5\left(42{,}967\frac{\text{pCi}}{\text{L}}\right)+0.5\left(40{,}033\frac{\text{pCi}}{\text{L}}\right)}{0.5+0.5+0.5}$$

$$\text{Flow-weighted concentration} = 37{,}560\,\frac{\text{pCi}}{\text{L}}$$

6.2 Calculation of Flow-Weighted Concentration in 200-ZP-1 Radiologically Active Wells

Table 2 lists the 200-ZP-1 radiologically active wells as well as flows and technetium-99 concentrations as of March 2018 for each well.

Table 2. Technetium-99 Concentrations in 200-ZP-1 Radiologically Active Wells

Extraction Well	Typical Flow[a] (gal/min)	Technetium-99 Concentration[b] (pCi/L)
299-W11-50	60	1,460
299-W11-90	120	946
299-W14-20	60	1,290
299-W14-73	90	186
299-W22-90	25	385
299-W22-91	30	3,720
299-W22-92	25	882

a. Nominal flow for plant operation at 14,195 L/min (3,750 gal/min).

b. Source: Hanford Environmental Information System.

A single sample from each well was accepted as a representative concentration for the well.

$$\text{Flow-weighted concentration} = \frac{60\frac{\text{gal}}{\text{min}}\times\left(1{,}460\frac{\text{pCi}}{\text{L}}\right)+120\frac{\text{gal}}{\text{min}}\times\left(946\frac{\text{pCi}}{\text{L}}\right)+60\frac{\text{gal}}{\text{min}}\times\left(1{,}290\frac{\text{pCi}}{\text{L}}\right)+90\frac{\text{gal}}{\text{min}}\times\left(186\frac{\text{pCi}}{\text{L}}\right)+25\frac{\text{gal}}{\text{min}}\times\left(385\frac{\text{pCi}}{\text{L}}\right)+30\frac{\text{gal}}{\text{min}}\times\left(3{,}720\frac{\text{pCi}}{\text{L}}\right)+25\frac{\text{gal}}{\text{min}}\times\left(882\frac{\text{pCi}}{\text{L}}\right)}{60+120+60+90+25+30+25\,\frac{\text{gal}}{\text{min}}}$$

$$\text{Flow-weighted concentration} = 1{,}069.598\,\frac{\text{pCi}}{\text{L}}\text{; rounded to } 1{,}070\,\frac{\text{pCi}}{\text{L}}$$

7 Results/Conclusions

Concentration results are presented in a series of tables organized by source. Nonradioactive and radioactive constituents are listed separately while those identified as a contaminant of concern are in bold.

Generally, tables list “no measurement” for contaminants of interest that were tabulated for that source in the last document revision but have not been tested for recently. Measurements are not regularly obtained for noncritical contaminants if they are not expected to be present in considerable amounts in the aquifer.

7.1 200-DV-1 Operable Unit

Extraction of the 200-DV-1 OU from well 299-E33-344 began in 2011 and from wells 299-E33-350 and 299-E33-351 since 2016. Concentrations of contaminants have been tracked quarterly while wells were in operation.

The 200-DV-1 OU contains high amounts of uranium and technetium-99. Table 3 summarizes the average and 95th percentile concentrations for 200-DV-1 wells from January 2019 to December 2019. The 95th percentile concentrations are suitable for calculations associated with hazard determination.

Table 3. Concentrations of Constituents in Water from the 200-DV-1 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Nonradioactive Constituents				
Aluminum	µg/L	41.3	16.0	
Arsenic	µg/L	16.5	10.0	
Calcium	mg/L	313	213	
Carbon tetrachloride	**µg/L**	**0.30**	**0.15**	*
Chloride	mg/L	91.7	79.0	
Chloroform	µg/L	3.40	0.58	
Chromium	**µg/L**	**104**	**65.1**	
Cr(VI)	**µg/L**	**108**	**74.0**	
Cyanide	µg/L	2.45	1.23	

Table 3. Concentrations of Constituents in Water from the 200-DV-1 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Manganese	µg/L	7.32	4.18	
Magnesium	mg/L	100	77.8	
Nitrate (as N)	**mg/L**	**428**	**230**	
Sulfate (as SO_4)	mg/L	841	574	
Trichloroethene	**µg/L**	**0.30**	**0.15**	*
Radioactive Constituents				
Americium-241	pCi/L	No measurement	No measurement	
Carbon-14	pCi/L	1,268	981	
Cesium-137	pCi/L	No measurement	No measurement	
Cobalt-60	pCi/L	9.71	4.08	*
Gross alpha	pCi/L	No measurement	No measurement	
Gross beta	pCi/L	No measurement	No measurement	
Iodine-129	**pCi/L**	**8.18**	**3.77**	
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-238	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	No measurement	No measurement	
Technetium-99	**pCi/L**	**77,255**	**37,560**	
Tritium	**pCi/L**	**19,575**	**11,367**	
Uranium	**µg/L**	**105,150**	**45,285**	
Uranium (a)	pCi/L	70,451	30,341	

Reference: Hanford Environmental Information System January 2019 through December 2019 for wells 299-E33-344, 299-E33-350, and 299-E33-351.

Notes: Flow-weighted concentrations are calculated from individual well concentration data, which are weighted according to well flows for plant operation at 14,195 L/min (3,750 gal/min).

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

The 200-DV-1 extraction wells are pumped to a collection tank, depleting water levels in the wells during pumping. The on/off pump control for each well is regulated by a water-level transducer, providing downtime for the water levels to recover. The 200-DV-1 tank is then pumped into a transfer tank, combining with 200-BP-5 groundwater before transfer to the 200 West P&T (DOE/RL-2017-68, *Calendar Year 2017 Annual Summary Report for Pump-and-Treat Operations in the Hanford Central Plateau Operable Units*).

It should be noted that flow out of the 200-DV-1 collection tank is continuous, at around 3.8 L/min (1.0 gal/min). While extraction flow is limited by the well and aquifer dynamics, the low flow rates are also crucial when managing blend ratios for the large concentrations of uranium and technetium-99 present in the 200-DV-1 wells.

7.1.1 Uranium Isotope Analysis

Samples from the 200-DV-1 OU were analyzed for various uranium isotopes. Table A-1 in Appendix A summarizes the activity of the various species. Only 200-DV-1 OU samples were analyzed for the various isotopes. 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 laboratory is attributed to uranium-234 because uranium-233 is not known to be present in the source. As a result, Table A-1 (Appendix A) labels uranium-233/uranium-234 solely as uranium-234 for clarity.

The calculations summarized in Table A-1 (Appendix A) treat each sample individually to determine a pCi to µg ratio for that sample. The average of all the ratios is 0.669, which is close to the 0.67 factor used in this document to convert µg/L to pCi/L. This is considered to be within the margin of error for the laboratory analysis.

Table 4 summarizes the average mass and average activities of the isotopic species present. Uranium-234 and uranium-238 contribute about 97% of the uranium by activity (pCi), but uranium-238 significantly dominates by mass.

Table 4. Average Percentages of Mass and Activity of Isotopes from the 200-DV-1 OU

Isotope	Percent of Mass	Percent of Activity
Uranium-234	0.01	47
Uranium-235	1	4
Uranium-238	99	50
Total	100	100

7.2 200-BP-5 Groundwater

Extraction of groundwater from the 200-BP-5 OU began in 2015 with well 299-E33-268 (suspended in June 2017). Well 299-E33-360 began pumping in March 2017, and in May 2019, well 299-E33-361 began pumping to support the cleanup of the 200-BP-5 groundwater. Initial concentrations from the 200-BP-5 extraction wells were extremely high, but rapidly decreased when pumping began and are slowly declining with continued pumping.

The 200-BP-5 groundwater is notable for high concentrations of cyanide. Analysis of free cyanide from 200-BP-5 extraction wells has yielded results consistently below the detection limit. The high total cyanide levels in 200-BP-5 water are attributed primarily to metal complexed cyanide (SGW-61013, *Cyanide Sampling at the 200 West Pump and Treat*). The 200-BP-5 groundwater is influent to the uranium ion exchange at the 200 West P&T, where the resin DOWEX® 21K has demonstrated effective total cyanide removal.

Table 5 summarizes 95th percentile and average concentrations in 200-BP-5 extraction wells. The 95th percentile concentrations are suitable for calculations associated with hazard determination.

Table 5. Concentrations of Constituents in Water from the 200-BP-5 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Nonradioactive Constituents				
Aluminum	µg/L	19.3	9.65	*
Arsenic	µg/L	10.5	9.85	
Calcium	mg/L	60.6	60.1	
Carbon tetrachloride	**µg/L**	**0.30**	**0.15**	*
Chloride	mg/L	16.8	16.1	
Chloroform	µg/L	0.30	0.15	*
Chromium	**µg/L**	**7.25**	**6.73**	
Cr(VI)	**µg/L**	**7.65**	**7.22**	
Cyanide	µg/L	104	86	
Manganese	µg/L	1.00	0.50	*
Magnesium	µg/L	18.5	15.8	
Nitrate (as N)	**mg/L**	**41.6**	**36.1**	
Sulfate (as SO_4)	mg/L	82.6	78.4	
Trichloroethene	**µg/L**	**0.30**	**0.15**	*
Vanadium	µg/L	17.9	17.3	
Radioactive Constituents				
Americium-241	pCi/L	No measurement	No measurement	
Carbon-14	pCi/L	36.2	14.9	*
Cesium-137	pCi/L	9	3.66	*
Cobalt-60	pCi/L	12.2	4.46	*

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Table 5. Concentrations of Constituents in Water from the 200-BP-5 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Gross alpha	pCi/L	No measurement	No measurement	
Gross beta	pCi/L	No measurement	No measurement	
Iodine-129	**pCi/L**	**2.56**	**2.41**	
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-238	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	No measurement	No measurement	
Technetium-99	**pCi/L**	**3,435**	**2,802**	
Tritium	**pCi/L**	**1,989**	**1,628**	
Uranium	**µg/L**	**76.3**	**61.7**	
Uranium (a)	pCi/L	51.1	41.4	

Reference: Hanford Environmental Information System, December 2019 and January 2020 from wells 299-E33-360 and 299-E33-361.

Notes: Flow-weighted concentrations are calculated from individual well concentration data, which are weighted according to well flows for plant operation at 14,195 L/min (3,750 gal/min).

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

7.3 200-UP-1 Groundwater

Extraction of water from the 200-UP-1 OU began in September 2015. Table 6 summarizes the 95th percentile and average concentrations for 200-UP-1 groundwater as of January 2020. The 95th percentile concentrations are suitable for calculations associated with hazard determination.

Table 6. Concentrations of Constituents in Water from the 200-UP-1 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Nonradioactive Constituents				
Aluminum	µg/L	19	9.65	*
Calcium	mg/L	49	42	
Carbon tetrachloride	**µg/L**	**114**	**81**	
Chloride	mg/L	10.2	9.8	
Chloroform	µg/L	5.09	3.93	
Chromium	**µg/L**	**4.62**	**4.52**	
Cr(VI)	**µg/L**	**3.57**	**3.48**	
Cyanide	µg/L	No measurement	No measurement	
Magnesium	mg/L	16.0	13.8	
Manganese	µg/L	1.00	0.50	*
Nitrate (as N)	**mg/L**	**18.8**	**10.9**	
Sulfate (as SO_4)	mg/L	25.8	24.8	
Trichloroethene	**µg/L**	**2.79**	**2.11**	
Radioactive Constituents				
Americium-241	pCi/L	No measurement	No measurement	
Carbon-14	pCi/L	No measurement	No measurement	
Cesium-137	pCi/L	No measurement	No measurement	
Cobalt-60	pCi/L	No measurement	No measurement	
Gross alpha	pCi/L	No measurement	No measurement	
Gross beta	pCi/L	No measurement	No measurement	
Iodine-129	**pCi/L**	**1.4**	**1.04**	
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-238	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	No measurement	No measurement	
Technetium-99	**pCi/L**	**476**	**337**	

Table 6. Concentrations of Constituents in Water from the 200-UP-1 OU

Constituent	Units	95th Percentile Concentration of Wells	Flow-Weighted Concentration	Note
Tritium	**pCi/L**	**949**	**618**	
Uranium	**µg/L**	**95**	**35.5**	
Uranium (a)	pCi/L	63.9	23.8	

Reference: Hanford Environmental Information System from wells 299-W19-113, 299-W19-114, and 299-W19-125.

Notes: Flow-weighted concentrations are calculated from individual well concentration data, which are weighted according to well flows for plant operation at 14,195 L/min (3,750 gal/min).

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

The quantity of water from the 200-UP-1 OU is nominally 568 L/min (150 gal/min), which is based on three extraction wells at 284 L/min (50 gal/min) each. The well pumps are capable, as measured with installed configuration, for a maximum output of 1,230 L/min (325 gal/min) (total for three wells), and the hazard classification should be based on 1,230 L/min (325 gal/min).

7.4 Environmental Restoration Disposal Facility Leachate

Table 7 summarizes the 95th percentile and average concentrations for ERDF leachate. The 95th percentile concentrations are suitable for calculations associated with hazard determination. Due to variability in the contaminant concentrations in ERDF leachate, sampling data from all of 2019 was obtained for use in this evaluation. ERDF leachate contains significant concentrations of nitrate, uranium, technetium-99, chromium, and sulfate. The high hardness concentration also indicates a strong potential for precipitation of calcium carbonate in the pipes.

Table 7. Concentrations of Constituents in ERDF Leachate

Constituent	Units	95th Percentile Concentration	Average Concentration	Note
Nonradioactive Constituents				
Arsenic	µg/L	7.50	6.34	
Calcium	mg/L	39.6	31.2	
Carbon tetrachloride	**µg/L**	**0.19**	**0.09**	*
Chromium	**µg/L**	**182**	**145**	
Cr(VI)	**µg/L**	**186**	**154**	
Cyanide	µg/L	No measurement	No measurement	
Hardness (as $CaCO_3$)	**mg/L**	**990**	**779**	
Nitrate (as N)	**mg/L**	**71**	**57**	
Strontium	µg/L	No measurement	No measurement	

Table 7. Concentrations of Constituents in ERDF Leachate

Constituent	Units	95th Percentile Concentration	Average Concentration	Note
Sulfate (as SO_4)	mg/L	91	70	
Total dissolved solids	mg/L	2,236	1,991	
Trichloroethylene	**µg/L**	**0.31**	**0.15**	*
Radioactive Constituents				
Americium-241	pCi/L	57.8	12.7	*
Carbon-14	pCi/L	234	92.6	
Cesium-137	pCi/L	13.9	5.50	*
Cobalt-60	pCi/L	13.0	4.80	*
Gross alpha	pCi/L	758	604	
Gross beta	pCi/L	725	462	
Iodine-129	**pCi/L**	**0.91**	**0.42**	
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-238	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	18.6	11.5	
Technetium-99	**pCi/L**	**214**	**128**	
Tritium	**pCi/L**	**180,750**	**124,600**	
Uranium	**µg/L**	**1,510**	**1,155**	
Uranium	pCi/L	1,011	774	
Uranium-233/ uranium-234	pCi/L	No measurement	No measurement	
Uranium-235	pCi/L	No measurement	No measurement	
Uranium-238	pCi/L	No measurement	No measurement	

Reference: Data are from Hanford Environmental Information System records within the noted date ranges.

Notes: The datasets used in calculating the 95th percentile, and averages are comprised of quarterly duplicate samples, unless noted otherwise.

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

Some 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	8	January 2019 to December 2020	All below detection
Cesium-137	8	January 2019 to December 2020	All below detection
Cobalt-60	8	January 2019 to December 2020	All below detection
Europium-152	8	January 2019 to December 2020	All below detection
Europium-154	8	January 2019 to December 2020	All below detection
Europium-155	8	January 2019 to December 2020	All below detection
Total alpha energy emitted from radium	4	January 2019 to December 2020	All below detection

ERDF leachate is pumped periodically. While typical nominal flows when pumping have been 10 to 20 gal/min, the average flow rate based on cumulative volume pumped since start is about 21.39 L/min (5.65 gal/min). Appendix B provides the basis for this average flow rate estimate.

7.5 200-ZP-1 Water

Extraction wells from the 200-ZP-1 OU have been operating since 2012, and concentrations of contaminants have been tracked quarterly. This section provides updated concentrations of contaminants that are treated at the 200 West P&T. During the design phase of this facility, groundwater modeling was performed to estimate contaminant of concern 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*). The concentrations and well flows are now much better defined.

Well data from the 200-ZP-1 OU are divided into two categories:

- Nonradiologically 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 and A532E) for the removal of technetium-99 before being blended with the nonradiologically active wells.

Section 7.5.1 summarizes nonradiologically active water, and Section 7.5.2 summarizes radiologically active water. Well concentrations are monitored quarterly and show general trends of increasing concentrations in wells positioned to pull plumes toward them and decreasing concentrations in wells positioned toward the fringe of the plume.

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7.5.1 200-ZP-1 Nonradiologically Active Well Water

Table 9 summarizes 95th percentile and average concentrations from wells fed directly to the central treatment system for air stripping at the 200 West P&T as of January 2020.

Table 9. Concentrations in Water from Wells that Feed Directly into the Central Treatment Plant

Constituent	Units	95th Percentile Concentration of Wells	Typical Flow-Weighted Concentration	Note
Nonradioactive Constituents				
Aluminum	µg/L	28	13	
Arsenic	µg/L	4.2	3.7	
Calcium	mg/L	93	62	
Carbon tetrachloride	**µg/L**	**1025**	**528**	
Chloride	mg/L	33.6	23	
Chloroform	µg/L	7.9	5.2	
Chromium	**µg/L**	**108**	**30**	
Cr(VI)	**µg/L**	**107**	**30**	
Cyanide	µg/L	No measurement	No measurement	
Magnesium	mg/L	34	22	
Manganese	µg/L	1.0	0.5	*
Nitrate (as N)	**mg/L**	**77**	**27**	
Sulfate (as SO_4)	mg/L	67	46	
Trichloroethylene	**µg/L**	**8.0**	**3.2**	
Radioactive Constituents				
Americium-241	pCi/L	No measurement	No measurement	
Carbon-14	pCi/L	No measurement	No measurement	
Cesium-137	pCi/L	No measurement	No measurement	
Cobalt-60	pCi/L	No measurement	No measurement	
Gross alpha	pCi/L	No measurement	No measurement	
Gross beta	pCi/L	No measurement	No measurement	
Iodine-129	**pCi/L**	**0.9**	**0.4**	
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	No measurement	No measurement	
Technetium-99	**pCi/L**	**338**	**146**	

Table 9. Concentrations in Water from Wells that Feed Directly into the Central Treatment Plant

Constituent	Units	95th Percentile Concentration of Wells	Typical Flow-Weighted Concentration	Note
Tritium	**pCi/L**	**8489**	**1601**	
Uranium	**µg/L**	**1.8**	**1.2**	
Uranium	pCi/L	1.2	0.8	

Reference: Hanford Environmental Information System for the 200-ZP-1 nonradiologically active wells.

Notes: Flow-weighted concentrations are calculated from individual well concentration data, which are weighted according to well flows for plant operation at 14,195 L/min (3,750 gal/min).

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

From early 2013, the 200-ZP-1 nonradiologically active wells have typically operated between 4,164 to 6,625 L/min (1,100 to 1,750 gal/min). In this document revision, flow from the 200-ZP-1 nonradiologically active wells is increased to 11,621 L/min (3,070 gal/min) to include the 10 future extraction wells with modeled concentrations. The active extraction wells are sampled quarterly, and the well flows are adjusted to maximize carbon tetrachloride removal.

7.5.2 200-ZP-1 Radiologically Active Well Water

Table 10 summarizes 95th percentile and average concentrations from wells fed to the technetium-99 IX system for technetium-99 removal at the 200 West P&T.

Table 10. Concentrations in Water from Wells that Feed Technetium-99 Ion Exchange (200-ZP-1 Radiologically Active Wells)

Constituent	Units	95th Percentile Concentration of Wells	Typical Flow-Weighted Concentration	Note
Nonradioactive Constituents				
Aluminum	µg/L	19	10	*
Arsenic	µg/L	5.1	3.7	
Calcium	mg/L	78	56	
Carbon tetrachloride	µg/L	994	656	
Chloride	mg/L	22	17	
Chloroform	µg/L	8.3	6.1	
Chromium	µg/L	66	35	
Cr(VI)	µg/L	66	35	
Cyanide	µg/L	43	7.3	
Magnesium	mg/L	27	19	
Manganese	µg/L	1	0.5	*

Table 10. Concentrations in Water from Wells that Feed Technetium-99 Ion Exchange (200-ZP-1 Radiologically Active Wells)

Constituent	Units	95th Percentile Concentration of Wells	Typical Flow-Weighted Concentration	Note
Nitrate (as N)	mg/L	43	27	
Sulfate (as SO_4)	mg/L	44	35	
Total dissolved solids	mg/l	No measurement	No measurement	
Trichloroethylene	µg/L	7.5	4.3	
Radioactive Constituents				
Americium-241	pCi/L	No measurement	No measurement	
Carbon-14	pCi/L	No measurement	No measurement	
Cesium-137	pCi/L	No measurement	No measurement	
Cobalt-60	pCi/L	No measurement	No measurement	
Gross alpha	pCi/L	No measurement	No measurement	
Gross beta	pCi/L	No measurement	No measurement	
Iodine-129	pCi/L	0.8	0.3	*
Neptunium-237	pCi/L	No measurement	No measurement	
Nickel-63	pCi/L	No measurement	No measurement	
Plutonium-239/240	pCi/L	No measurement	No measurement	
Selenium-79	pCi/L	No measurement	No measurement	
Strontium-90	pCi/L	No measurement	No measurement	
Technetium-99	pCi/L	3,157	1,108	
Tritium	pCi/L	5,572	2,904	
Uranium	µg/L	3.4	1.5	
Uranium	pCi/L	2.3	1.0	

Flow-weighted concentrations are calculated from individual well concentration data, which are flow weighted for plant operation at 14,195 L/min (3,750 gal/min).

Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All sample values below detection. The 95th percentiles are obtained from assuming concentrations at the detection limit. Averages are obtained from assuming concentrations at one-half the detection limit.

From early 2013, the 200-ZP-1 radiologically active wells have averaged around 1,703 L/min (450 gal/min) and typically operate near peak capacity to maximize technetium-99 removal. In this revision, the flows from these wells remain constant because the wells are operated near peak capacity and no new radiological wells are planned.

7.6 Modular Storage Unit Water

Table 11 summarizes 95th percentile and average concentrations for water in the MSUs based on 2019 sampling results from MSU 3. In MSU water, significant concentrations have been observed for iodine-129 as well as manganese, a metal that has contributed to injection well fouling in the P&T system. Total dissolved solids can also play a factor when considering the blend ratio for introducing MSU water to the 200 West P&T.

Table 11. Concentrations of Constituents in MSU Water

Constituent	Units	95th Percentile Concentration	Average Concentration	Note	Number of Samples
Nonradioactive Constituents					
1,2-Dichloroethene (total)	µg/L	0.30	0.15	*	2
Aluminum	µg/L	202	139		2
Arsenic	µg/L	7.4	6.6		2
Carbon tetrachloride	**µg/L**	**0.30**	**0.15**	*****	**2**
Calcium	mg/L	37	29		0
Chromium	**µg/L**	**2.3**	**1.7**		**2**
Cr(VI)	**µg/L**	**62**	**43**		**2**
Cyanide	µg/L	8.7	5.6		2
Free cyanide	µg/L	1.9	1.5		2
Iron	µg/L	380	249		2
Magnesium	mg/L	63	62		2
Manganese	µg/L	143	133		2
Nitrate (as N)	mg/L	0.10	0.06		2
Strontium	µg/L	158	118		2
Sulfate (as SO_4)	mg/L	172	168		2
Total dissolved solids	mg/L	3,636	3,505		2
Trichloroethylene	**µg/L**	**3.0**	**1.7**	*****	**2**
Radioactive Constituents					
Americium-241	pCi/L	0.39	0.18	*	2
Carbon-14	pCi/L	No measurement	No measurement		0
Cesium-137	pCi/L	10.1	5.0	*	2
Cobalt-60	pCi/L	10.6	5.0		2

Table 11. Concentrations of Constituents in MSU Water

Constituent	Units	95th Percentile Concentration	Average Concentration	Note	Number of Samples
Gross alpha	pCi/L	13.5	5.8	*	2
Gross beta	pCi/L	40	37		2
Iodine-129	**pCi/L**	**2.8**	**2.6**		**2**
Neptunium-237	pCi/L	No measurement	No measurement		0
Nickel-63	pCi/L	37	18	*	2
Plutonium-238	pCi/L	0.66	0.26	*	2
Plutonium-239/240	pCi/L	0.64	0.29	*	2
Selenium-79	pCi/L	No measurement	No measurement		0
Strontium-90	pCi/L	No measurement	No measurement		0
Technetium-99	**pCi/L**	**43**	**20**	*****	**2**
Total beta radiostrontium	pCi/L	2.6	1.57		2
Tritium	**pCi/L**	**1,784**	**1,545**		**2**
Uranium	**µg/L**	**2.6**	**1.6**		**2**
Uranium	pCi/L	1.7	1.1		2
Uranium-233/uranium-234	pCi/L	1.2	0.86		2
Uranium-235	pCi/L	0.84	0.41		2
Uranium-238	pCi/L	1.0	0.70		2

Reference: Hanford Environmental Information System from 289E MSU 3.

Note: Nonradioactive and radioactive constituents are listed separately, while those identified as a contaminant of concern are in bold.

*All values below detection. The 95th percentile is that of the detection limits, while the average is taken over one-half detection limits.

7.7 Well Flows

For planning purposes, the flows of the various feed 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. While the MSU flow rate is a planning estimate, the average flows for ERDF leachate and 200-DV-1, as well as nominal flows for other sources, are based on operating experience.

Table 12. Water Flow Ranges from Feed Streams that Flow to the 200 West P&T

Water Source	Expected Flow (L/min)/ (gal/min)	Flow Range (L/min)/ (gal/min)	Basis
200-UP-1	568/150	530 to 946/ 140 to 250	Two wells at 189 to 379 L/min per well (50 to 100 gal/min). One well at 151 to 189 L/min per well (40 to 50 gal/min).
200-BP-5	625/165	379 to 1,135/ 100 to 300	Two wells at 189 to 568 L/min per well (50 to 150 gal/min).
200-ZP-1 radiologically active wells	1,325/350	1,155 to 1703/ 305 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.
200-ZP-1 nonradiologically active wells	11,621/ 3,070	5,905 to 11,829/ 1,560 to 3,125	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. The 10 future wells are expected to contribute 1,340 gal/min to reach 3,750 plant capacity.
ERDF leachate*	21/5.65	38 to 303/ 10 to 80	Leachate is pumped periodically (e.g., weekly). Expected flow is the estimated average based on cumulative volume pumped since start (see Appendix B). Leachate transfer pumps have an operating range of 37 to 303 L/min (10 to 80 gal/min).
200-DV-1	3/0.8	1.9 to 9.5/ 0.5 to 2.5	The perched system currently exists of three wells that operate intermittently, producing around 3.8 L/min (1.0 gal/min). The system is expected to be expanded, with the addition of 3 wells in the near term. An upper flow range of 9.4 L/min (2.5 gal/min) is shown here.
MSU water	114/30	76 to 189/ 20 to 50	MSU flow is dependent on contaminant concentration and impact to the treatment process at the 200 West Area. MSU transfer in the past have been between 76 to 189 L/min (20 to 50 gal/min).
A Farm and C Farm	946/250	568 to 946/ 150 to 250	Two wells designed to operate between 284 and 662 L/min (75 and 175 gal/min), with a total flow of 946 L/min (250 gal/min).

*ERDF leachate transfer pump reference: SGW-58344, *Hydraulics for Pumping to 200 West Pump & Treat*.

ERDF = Environmental Restoration Disposal Facility

MSU = modular storage unit

Figure 1 shows the general process flow through the treatment plant, including the following systems: uranium IX, technetium-99 IX, 200-BP-5/200-PO-1 IX, and the air strippers. The 200-BP-5/200-PO-1 IX system will be routed directly to the injection well network, as the groundwater does not require treatment through the air strippers.

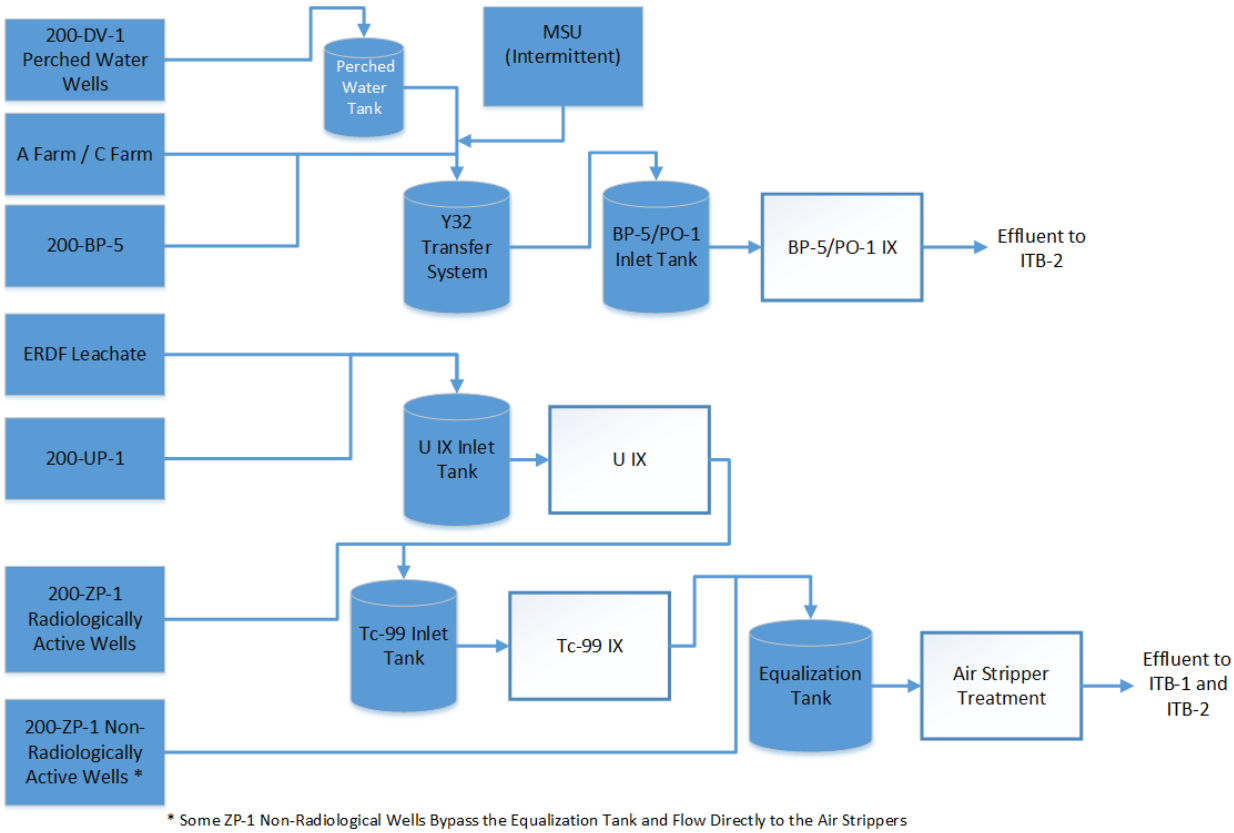

Figure 1. Generalized Process Flow for the 200 West P&T

7.8 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.

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

System	Minimum Capacity (L/min)/(gal/min)	Maximum Capacity (L/min)/(gal/min)	Maximum Sustained Treatment Capacity[a] (L/min)/(gal/min)
Uranium IX	568/150[b]	1,552/410	1,397/369
Technetium-99 IX	1,136/300	2,877/760	2,589/684
	(Two trains at 568 L/min per train [150 gal/min])[b]	(Two trains at 1,438 L/min per train [380 gal/min])	
200-BP-5/200-PO-1 IX	568/150[b]	1,703/450	1,533/405
Central Treatment	2,271/600[c]	14,195/3,750	11,356/3,000[d]

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

System	Minimum Capacity (L/min)/(gal/min)	Maximum Capacity (L/min)/(gal/min)	Maximum Sustained Treatment Capacity[a] (L/min)/(gal/min)

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

b. From supplier (AVANTech, Inc.) Contractor Document Submittal Form A-6004-757.

c. Minimum based on the minimum flow to maintain operation of one air stripper.

d. Maximum sustained flow through the central treatment system is expected to be closer to 12,491 L/min (3,300 gal/min). A better estimate will be determined once the third air stripper is in operation.

IX = ion exchange

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

- 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% 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 (DOWEX 21K) 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 and A532E) to remove technetium-99.
- In addition to impact on hazard classification, new waste streams are to be assessed for the ability of the 200 West P&T to provide adequate treatment. Feed stream acceptance criteria for various contaminants have been identified in terms of maximum influent concentrations that can be treated to meet cleanup levels and drinking water standards. New feed streams must be evaluated with respect to managing blend ratios with all other feed streams to satisfy acceptance criteria.
  - For example, flow of MSU water with high iodine-129 concentrations should be limited appropriately to avoid excess of acceptable levels in the combined influent.

A number of flow combinations are possible. For the sake of example, the following flows and concentrations were assumed:

- Average concentrations of contaminants in all streams, as reported in previous sections of this chapter, were used.
- Flows from each source are from Table 12. This example uses a provisional flow rate for an MSU pumping scenario, such as that in Figure 1, while all other flows are based on operating experience or, in the case of 200-ZP-1 nonradiological wells, based on anticipated flows once additional extraction wells are made available.

8 Recommendations

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

- Update SGW-64439, *Engineering Calculation: 2019 Integrated Mass Balance for the 200 West Pump and Treat Facility*, 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.
- Continue to provide guidelines to balance the flows, concentrations of key contaminants, and mass loadings under expected operating scenarios (e.g., with and without ERDF and MSU water).
- Develop and maintain a database of concentrations for the new wells 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 last revision with new well concentrations and changes to plant capacity.

9 References

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Appendix A

Specific Activity for Uranium in the 200-DV-1 Operable Unit

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Table A-1. Specific Activity for Uranium Isotopes in the 200-DV-1 OU

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*
299-E33-344	16,200	6,250	2.59	1,200	2.16	556	17,200	0.336	51,190	34,600	51,749	0.669
299-E33-350	16,700	6,250	2.67	1,410	2.16	653	17,700	0.336	52,679	35,810	53,334	0.671
299-E33-351	11,600	6,250	1.86	805	2.16	373	12,300	0.336	36,607	24,705	36,982	0.668

Reference: Hanford Environmental Information System (March 19, 2018).

Note: It is assumed that the uranium-233/uranium-234 value from the laboratory is attributed to uranium-234 because uranium-233 is not known to be present in the source. As a result, this table labels uranium-233/uranium-234 solely as uranium-234 for clarity.

*The average specific activity ratio among these three wells is 0.669 pCi/µg uranium.

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Appendix B

Average Flowrate for Environmental Restoration Disposal Facility Leachate

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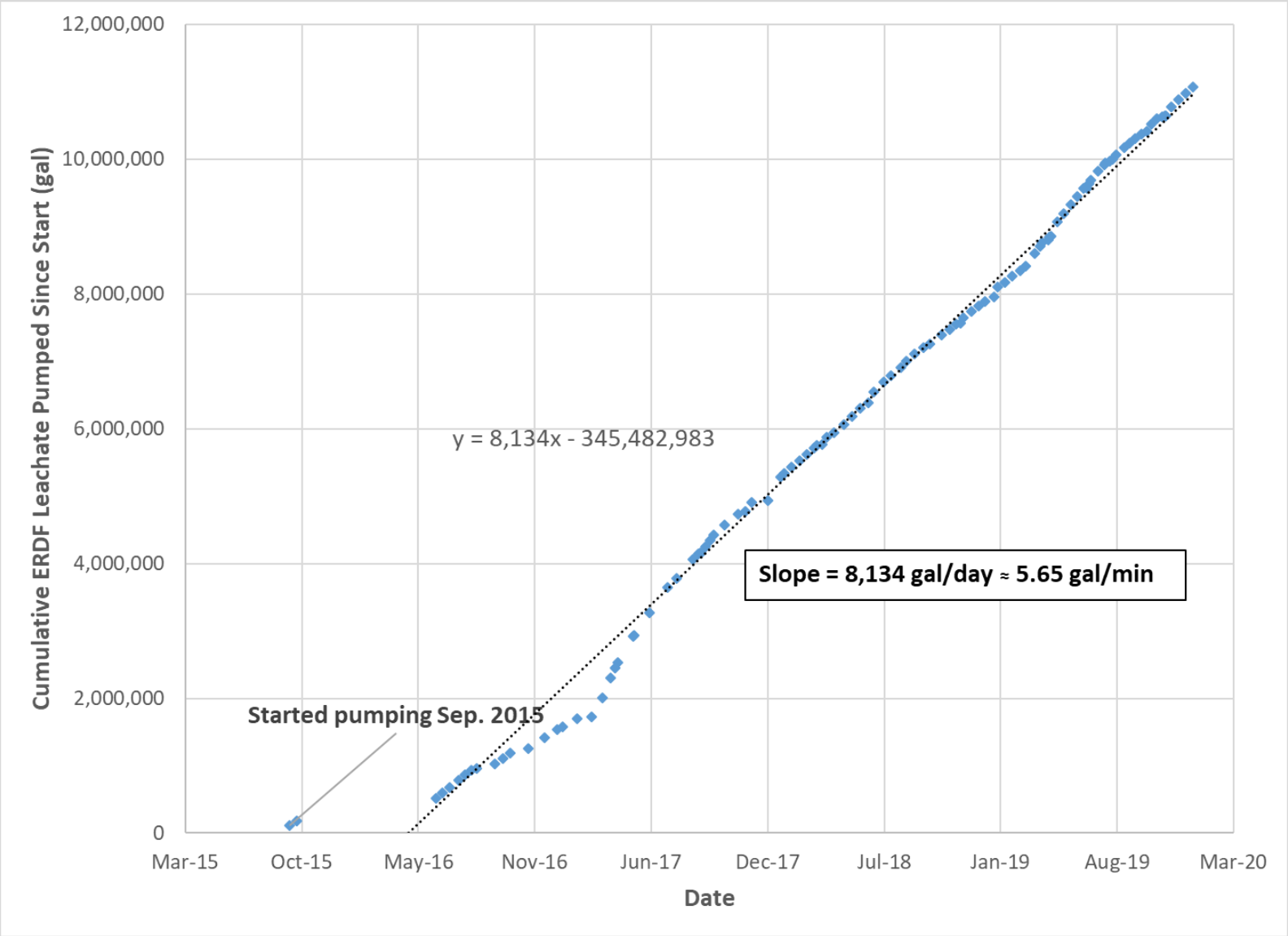

Figure B-1. (Historical) Average Flowrate of ERDF Leachate

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