SGW-40032
Revision 13

Soil and Groundwater Remediation Project Facility Hazard Categorization

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

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SGW-40032
Revision 13
EDC#: ECR-20-001040

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Document Type: HCR Program/Project: S&GRP

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Date Published
September 2020

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DATE:
Oct 15, 2020
HANFORD RELEASE

APPROVED
By Janis D. Aardal at 3:50 pm, Oct 15, 2020

Release Approval | Date | Release Stamp

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Total pages: 33

CHPRC RECORD OF REVISION (ROR)	(1) Document Number SGW-40032

(2) Title
Soil and Groundwater Remediation Project Facility Hazard Categorization

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages ADD ROW	Authorized for Release (5) DA/TA	Date
0	Initial Release	JC Williams	4/6/09
1	Annual Update per GRP-PRO-036	JC Williams	3/25/10
2	Annual Update per ECR-10-002124	JC Williams	2/8/11
3	Annual Update per ECR-11-001714	JC Williams	11/8/11
3A	Revise assumed number of totes at P&T stations per ECR-12-000554	JC Williams	5/9/12
3B	Delete analysis for SSU-R1 per ECR-12-000747	JC Williams	7/13/12
4	Annual Update per ECR-12-0013-93	JC Williams	12/4/12
5	Annual Update per ECR-14-000060	JC Williams	01/20/2014
6	Add analysis for sample staging at WSCF; update perched water analysis	JC Williams	07/14/2014
7	Annual Update per ECR-14-001287	JC Williams	11/03/2014
8	Update analysis for 200 West Pump & Treat per ECR-15-000763	JC Williams	06/23/2015
9	Add analysis for 300 Area Phosphate Injection per ECR-16-000074	JC Williams	02/08/2016
10	Annual Update per ECR-16-001436	JC Williams	12/12/2016
11	Annual Update per ECR-17-001627	JC Williams	01/31/2018
12	Annual Update per ECR-18-001539	JC Williams	10/09/18
13 RS	Annual Update per ECR-20-001040	Oberg, Brian Digitally signed by Oberg, Brian Date: 2020.10.14 16:30:10 -07'00'	

A-6004-786 (REV 3)

CHPRC REVIEW CHECKLIST

Document Reviewed:
SGW-40032, Rev. 13, Soil and Groundwater Remediation Project Facility Hazard Categorization

Scope of Review:
Entire Document

Yes	No	N/A		
☒	☐	☐	*	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐		Problem completely defined.
☐	☐	☒		Accident scenarios developed in a clear and logical manner.
☒	☐	☐		Necessary assumptions explicitly stated and supported.
☐	☐	☒		Computer codes and data files documented.
☒	☐	☐		Data used in calculations explicitly stated in document.
☒	☐	☐		Data checked for consistency with original source information as applicable.
☒	☐	☐		Mathematical derivation checked including dimensional consistency of results.
☒	☐	☐		Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☐	☐	☒		Software input correct and consistent with document reviewed.
☐	☐	☒		Software output consistent with input and with results reported in document reviewed.
☒	☐	☐		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐		Safety margins consistent with good engineering practices.
☒	☐	☐		Conclusions consistent with analytical results and applicable limits.
☒	☐	☐		Results and conclusions address all points required in the problem statement.
☒	☐	☐	*	Format consistent with appropriate NRC Regulatory Guide or other standards.
☒	☐	☐		Review calculations, comments, and/or notes are attached.
☐	☐	☒		For calculations in which codes/spreadsheets (e.g., RADIDOSE, GENII, etc) are used, is the latest revision used? Is the User Authorized?
☒	☐	☐		Hazard controls established are appropriate for the hazards including selection using the appropriate hierarchy (e.g., engineered over administrative).
☐	☐	☒		The preventive or mitigative credit assigned to hazard controls are appropriate, and the basis is documented.
☒	☐	☐		**Document approved.**

MF Meyer Meyer, Matthew F Digitally signed by Meyer, Matthew F Date: 2020.09.09 17:02:07 -07'00' 9/9/2020

Reviewer (Printed Name and Signature) Date

*Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

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Terms

BHC3	below Hazard Category 3
Cr(VI)	hexavalent chromium
ERDF	Environmental Restoration Disposal Facility
GAC	granular activated carbon
HC	hazard category
HGSL	Hanford Geotechnical Sample Library
IDMS	Integrated Document Management System
IX	ion exchange
MSU	modular storage unit
OU	operable unit
P&T	pump and treat
RMA	radioactive material area
S&GRP	Soil and Groundwater Remediation Project
SOF	sum of fractions
SSU	sample storage unit

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1 Purpose and Scope

This report documents the hazard categorization of all nuclear facilities managed by the Soil and Groundwater Remediation Project (S&GRP). Hazard categorization is based on DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. This report has been prepared in accordance with PRC-PRO-NS-8366, *Facility Hazard Categorization*.

All S&GRP facilities are below Hazard Category 3 (BHC3) and do not require a documented safety analysis in accordance with 10 CFR 830, Subpart B, "Nuclear Safety Management," "Safety Basis Requirements."

2 Background

10 CFR 830, Subpart B establishes the requirements for Hazard Category (HC)-1, HC-2, and HC-3 U.S. Department of Energy nuclear facilities to have formal safety basis documentation as defined therein. The categories are based on the quantity of radioactive materials in the facility. HC-1 facilities are those with the potential for significant offsite consequences. HC-2 facilities are those with the potential for significant onsite consequences. HC-3 facilities are those with the potential for significant but localized consequences. PRC-PRO-NS-8366 provides instructions for determining the applicability of 10 CFR 830, Subpart B to S&GRP facilities.

3 Facility Descriptions

Each S&GRP facility is described in the following sections. The hazard categorizations are documented in Chapter 4.

3.1 KW Pump and Treat Facility

The KW pump and treat (P&T) system removes hexavalent chromium (Cr(VI)) from the groundwater near the KW Reactor Building in the 100-K Area. The facility consists of an extraction well network, the 6004-KW process building, an injection well network, and associated piping and instrumentation. The infiltration gallery has been installed and is operation near the 183KW Headhouse site. An additional infiltration gallery is currently being designed for the 183.1KE Headhouse site. Groundwater is extracted from the aquifer and treated by ion exchange (IX) to remove chromium. Radionuclide contaminants are incidentally removed during the chromium removal process, and the treated groundwater is reinjected into the aquifer. Water can be injected by either wells or the infiltration galleries. The process building equipment consists of an 11,355 L (3,000 gal) influent surge tank, two trains of four IX vessels, a pre-treatment IX vessel, an 11,355 L (3,000 gal) effluent surge tank, an outside sulfuric acid storage tank, and associated pumps and piping.

Some extraction wells are within the 105-KW Basin safety basis boundary and are subject to the 100-K Area unreviewed safety question process.

3.2 KX Pump and Treat Facility

The KX P&T system removes Cr(VI) from the groundwater east of the 100-K Area. The facility consists of an extraction well network, 1606-KA transfer building, 1607-KA transfer building, 1608-K process building, an injection well network, and associated piping and instrumentation. Groundwater is extracted from the aquifer and treated by IX to remove chromium. Radionuclide contaminants are incidentally removed during the chromium removal process, and the treated groundwater is reinjected into the aquifer. Each transfer building contains an 11,355 L (3,000 gal) surge tank and associated pumps and piping. The process building equipment consists of a 19,306 L (5,100 gal) influent surge tank, six trains of four IX vessels, a 19,306 L (5,100 gal) effluent surge tank, an outside sulfuric acid storage tank, and associated pumps and piping.

3.3 KR4 Pump and Treat Facility

The KR4 P&T system removes Cr(VI) from the groundwater east of the 100-K Area. The facility consists of an extraction well network, 1606-K transfer building, 1607-K transfer building, 1604-K process building, an injection well network, and associated piping and instrumentation. Groundwater is extracted from the aquifer and treated by IX to remove chromium. Radionuclide contaminants are incidentally removed during the chromium removal process, and the treated groundwater is reinjected into the aquifer. Each transfer building contains a 7,571 L (2,000 gal) surge tank and associated pumps and piping. The process building equipment consists of an 11,355 L (3,000 gal) influent surge tank, three trains of four IX vessels, an 11,355 L (3,000 gal) effluent surge tank, an outside sulfuric acid storage tank, and associated pumps and piping.

3.4 DX Pump and Treat Facility

The DX P&T system removes Cr(VI) from the groundwater in the 100-HR-3 Operable Unit (OU). The facility consists of an extraction well network, 1804-D process building, 1805-D transfer building, 1806-D transfer building, an injection well network, and associated piping and instrumentation. The nearby 186-D maintenance facility does not contain radioactive material. Groundwater is extracted from the aquifer and treated by IX to remove chromium. Radionuclide contaminants are incidentally removed during the chromium removal process, and the treated groundwater is reinjected into the aquifer. The process building equipment consists of a 19,306 L (5,100 gal) influent tank, six trains of four IX vessels, a 19,306 L (5,100 gal) effluent tank, outside sulfuric acid and sodium hydroxide storage tanks, and associated pumps and piping. Each of the two transfer buildings has an 11,355 L (3,000 gal) transfer tank; the 1805-D transfer building also houses an 11,355 L (3,000 gal) effluent tank. The total tank capacity is 72,677 L (19,200 gal).

3.5 HX Pump and Treat Facility

The HX P&T system removes Cr(VI) from the groundwater in the 100-HR-3 OU. The facility consists of an extraction well network, 689 process building, 1602-H transfer building, an injection well network, and associated piping and instrumentation. Groundwater is extracted from the aquifer and treated by IX to remove chromium. Radionuclide contaminants are incidentally removed during the chromium removal process, and the treated groundwater is reinjected into the aquifer. The process building equipment consists of a 37,854 L (10,000 gal) influent tank, eight trains of four IX vessels, a 30,662 L (8,100 gal) effluent tank, outside sulfuric acid and sodium hydroxide storage tanks, and associated pumps and piping. The transfer building has a 19,306 L (5,100 gal) transfer tank. The total tank capacity is 87,822 L (23,200 gal).

3.6 100-N Bioremediation System

The 100-N bioremediation system consists of blowers injecting air into as many as four wells. The bioremediation system's air injection wells are used to encourage aerobic biodegradation of organic contaminants (e.g., petroleum hydrocarbons) in the vadose zone at the 100-N Area. Air blowers (as well as a network of piping and valves, and an automated control system) are used to supply a controlled volume of air to the injection wells.

3.7 Modular Storage Units

The 289-E modular storage units (MSUs) consist of two 3.78 E+06 L (1 million gal) storage tanks, commonly called ModuTanks,™ which store purgewater generated by well drilling and sampling activities. The MSUs are located in the 200 East Area. Purgewater is transferred to the MSUs by tanker truck. Stored water is treated by solar evaporation and can also be transferred to the 200 West P&T by pipeline. Sediment periodically accumulates inside the storage tanks, which requires removal, dewatering, and disposition to the onsite Environmental Restoration Disposal Facility (ERDF). Water may be transferred from one MSU to another. This facility is an active waste disposal site and is listed in the Waste Information Data System as site 600-214.

3.8 Hanford Geotechnical Sample Library

The Hanford Geotechnical Sample Library (HGSL) is located in the 4732-B warehouse in the 400 Area. Soil samples dating back to the 1940s are archived at this location. Samples are checked for radiological contamination in the field, and only uncontaminated samples are transferred to the HGSL. The library is posted as a radiological material area (RMA); however, samples with radiological contamination are not known to have ever been transferred to the HGSL. The S&GRP Radiological Control organization performs periodic surveys, and radiological contamination has not been detected.

3.9 200 West Pump and Treat Facility

The 200 West P&T removes carbon tetrachloride, radionuclides, and other contaminants from the groundwater in the 200 West Area. Wastewater from miscellaneous sources at the Hanford Site may also be treated at the 200 West P&T. The facility consists of an extraction well network, process buildings, transfer buildings, an injection well network, and associated piping and instrumentation. Groundwater is treated to remove contaminants, and the treated groundwater is reinjected into the aquifer.

The facility removes radionuclides using IX. Groundwater contaminated with radionuclides is transferred to the 289-TA radiological process building. Two IX systems are located in the 289-TA building: one optimized for uranium, and one optimized for technetium-99. Effluent from the uranium IX system is directed to the technetium-99 IX system as influent. Additionally, groundwater from wells with low uranium contamination but still requiring IX treatment (existing radiological wells) is transferred directly to the technetium-99 IX system.

Effluent from the 289-TA building is routed to the 289-T central treatment building for further treatment. Additionally, groundwater that does not contain sufficient radiological contamination to require treatment in 289-TA (nonradiological wells) is transferred from the wellhead or extraction transfer building to 289-T. The MSUs also transfer water to the central treatment building. The 289-T building removes nonradiological contaminants such as carbon tetrachloride. The biological processes that previously removed nitrates have been suspended and bypassed. Figure 1 shows the flow paths for the

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200 West P&T. Other facility buildings include the 289-TB, 289-TC, and 289-TF extraction buildings and the 216-ZP-1A, 289-TD, and 289-TE injection buildings.

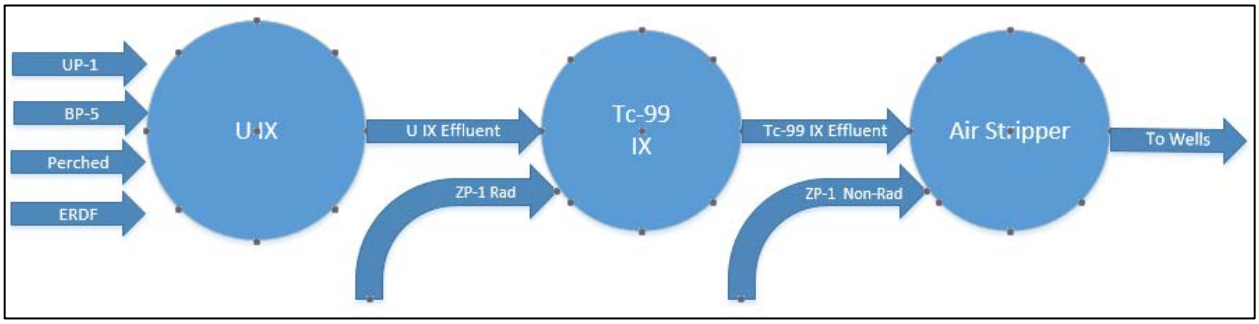

Figure 1. 200 West P&T Flow Diagram

The influent streams are characterized in SGW-57790, *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*. Influent streams entering the uranium IX system are as follows:

- "UP-1" represents influent from three extraction wells located in an area of high uranium groundwater contamination near 221U Plant in the 200-UP-1 OU. The average flow rate is 189 L/min (50 gal/min) per well, for a combined average flow rate of 568 L/min (150 gal/min). Based on operational experience, the maximum flow rate for all three pumps is approximately 1,230 L/min (325 gal/min).
- "BP-5" represents influent from wells near the 216-BY Crib complex in the 200 East Area in the 200-BP-5 OU. The influent is transferred via a dedicated pipeline at approximately 568 L/min (150 gal/min) per well (SGW-58220, *Functional Requirements for Connecting the 200-BP-5 Extraction Well to the 200 West Pump-and-Treat System*), for a combined approximate flow rate of 1,136 L/min (300 gal/min).
- "Perched water" in the 200-DV-1 OU is transferred on a batch basis by pipeline (see Section 3.11). Based on operational experience, the expected transfer rate is 18,927 L (5,000 gal) per week, which is equivalent to an average 1.9 L/min (0.5 gal/min) flow rate over a year (SGW-57790).
- "ERDF leachate" is collected leachate from underground piping in the ERDF complex. It is periodically transferred to the 200 West P&T through a dedicated pipeline. Based on past operational experience, ERDF generates 454,249 L (120,000 gal) of leachate every 3 weeks, for an approximate average flow rate of 15 L/min (4 gal/min) (SGW-57790).

The existing radiological wells transfer water with a higher amount of radioactive contamination from a variety of locations in the 200 West Area to the technetium-99 IX system in 289-TA, bypassing the uranium IX system. Based on operational experience, a combined flow rate of 1,703 L/min (450 gal/min) is a reasonably conservative assumption (SGW-57790).

The 200 West Area nonradiological wells transfer water with a lower amount of radioactive contamination directly to 289-T, bypassing 289-TA. Based on operational experience, a combined flow rate of 7,382 L/min (1,950 gal/min) is a reasonably conservative assumption (SGW-57790).

Some effluent lines from 289-TE to the injection wells are within the Solid Waste Operations Complex and are controlled by PRC-PRO-CM-40297, *Configuration Control 200 West Pump-and-Treat System Injection Lines*. These lines are subject to the Solid Waste Operations Complex unreviewed safety question process.

3.10 Spent Resin Storage Pad

A storage pad for spent IX resin from the 200 West P&T is located approximately 30.5 m (100 ft) outside of the facility boundary. This is a sufficient distance to prevent interaction between the two areas. Resin is staged at the storage pad pending transportation to ERDF for disposal.

3.11 Perched Water Staging

An area of water that is contaminated with uranium and technetium-99 is perched on an impermeable silt formation, above the semipermeable gravel layer of the Cold Creek unit beneath the B Tank Farm complex in the 200 East Area in the 200-DV-1 OU. The contamination is the result of an overflow of metal waste from tank 241-BX-102 in 1951 (designated as Waste Information Data System site UPR-200-E-5). Metal waste was a byproduct of the bismuth phosphate plutonium-separation process in 221B Plant and had a high uranium content. The perched water is being extracted by a series of wells and staged in an 11,356 L/(3,000 gal) collection tank near the BX Tank Farm in the 200 East Area. The water is then transferred to the 200 West P&T by pipeline. The process transfer equipment consists of a 16,656 L (4,400 gal) tank and associated pumps and piping. A backup transfer method is by tanker truck.

3.12 Sample Staging

Individual soil samples may be consolidated in sample storage units (SSUs). Although most collected samples are nonradioactive, one SSU in the 6267 Building (sample packaging, shipping, and receiving facility) is designated as an RMA and is a 28.3 m^3 (1,000 ft^3) walk-in refrigerator. Samples are staged at this location pending shipment to an offsite laboratory for analysis. Soil and/or water samples are stored in the SSU in glass or plastic bottles with a maximum 1 L capacity. Other samples (e.g., construction debris) may also be stored in the SSU.

Samples may also be staged in SSU #1 in the 6269 Building (field sampling operations facility). This SSU is a 2.8 m^3 (100 ft^3) refrigerator that is designated as an RMA (GW-RMA-273). The 6268 sample equipment cleaning facility typically does not contain radioactive material.

3.13 300-FF-5 Uranium Sequestration Project

The 300-FF-5 Uranium Sequestration Project immobilized uranium contamination in the groundwater north of the 300 Area. Phosphate solutions were injected into the vadose zone and aquifer to reduce uranium leachability. The project consisted of phosphate injection equipment, associated piping, injection wells, and monitoring wells that use piezometers to measure migration of the phosphate solution. Radioactive material was not used. The facility is shut down, and equipment has been removed from the site.

4 Hazard Categorization

Each facility owned by S&GRP is categorized according to its inventory of radioactive material using the methodology prescribed by PRC-PRO-NS-8366. Facilities without radioactive material, such as the 100-N Area bioremediation system, the 300-FF-5 Uranium Sequestration Project, and the 216-U-8 Uranium Sequestration Project, do not require categorization.

Some facilities can be demonstrated to be clearly BHC3 based on process knowledge. The 4732-B warehouse, which houses the HGSL, falls into this category.

Categorizations for the KW, KX, KR4, DX, HX, and 200 West P&T facilities; the MSUs; perched water staging; and sample storage are presented in the following sections.

4.1 100-K Area Pump and Treat Facilities

The three P&T facilities in the 100-K Area (KR4, KX, and KW) are similar. Each uses identical IX skids consisting of four vessels using ResinTech® SIR-700 resin. Spent resin is stored onsite. Two totes are required to store the resin from one vessel. Both the totes and the vessels are assumed to contain spent resin with the highest concentration of radionuclides observed. This is conservative; when a lead vessel is loaded, it is removed from service, refilled with new resin, and then placed into service as a polish vessel. The resin trains are never operated with four completely loaded IX vessels. Analytical results of spent SIR-700 samples are documented in GEL Laboratories reports GEL437988 DP[1] and GEL492406 DP,[2] which are available in the Integrated Document Management System (IDMS). Table 1 summarizes the results.

Table 1. Observed Radionuclide Concentration in Spent SIR-700 Resin Samples

Nuclide	437988001	437988002	437988003	437988004	492406	Worst Case
C-14	10.2	62.9	12.9	42.3	12.1	62.9
Sr-90	0.413	0.125	0	0.977	0.2	0.977
Tc-99	23.1	34	5.94	11.6	5.72	34
U-234	676	2,290	1,440	2,360	1,500	2,360
U-235	70.7	200	160	161	70.4	200
U-238	597	1,920	1,240	1,980	1,180	1,980

Note: All concentrations are in pCi/g.

Based on the worst-case radionuclide concentrations, an assumed resin density of 2 g/mL, and a total of 2.3 m^3 (80 ft^3) of resin per IX vessel, the curie content for the IX skids and stored totes can be determined as shown in Table 2.

ResinTech® is a registered trademark of ResinTech, Inc., West Berlin, New Jersey.

[1] GEL437988 DP, 2018, Rev. 1, GEL Laboratories LLC, Charleston, South Carolina.

[2] GEL492406 DP, 2019, GEL Laboratories LLC, Charleston, South Carolina.

Table 2. Spent SIR-700 IX Resin Radionuclide Content

Nuclide	Ci per Vessel	Ci per Skid	Total for 100 Totes (Ci)
C-14	2.85E-04	1.14E-03	1.42E-02
Sr-90	4.43E-06	1.77E-05	2.21E-04
Tc-99	1.54E-04	6.16E-04	7.70E-03
U-234	1.07E-02	4.28E-02	5.35E-01
U-235	9.06E-04	3.62E-03	4.53E-02
U-238	8.97E-03	3.59E-02	4.49E-01

One hundred spent resin totes are assumed to be stored at each facility. This is a bounding assumption, because the facilities do not have room to store this many totes. Individual totes may exceed these values for some nuclides but, in practice, it is not credible for the actual tote inventory to exceed the assumed 100 total totes.

Radionuclides are also present in the groundwater stored in transfer tanks, influent tanks, and effluent tanks. Table 3 shows the maximum observed radionuclide concentrations in 100-K Area groundwater (Table 3 in SGW-48153, *Revised Authorized Limit Application for the Regeneration of Ion Exchange Resin from the 100 Areas*). The inventory of radionuclides in the stored groundwater does not represent a significant contribution to the hazard categorization. Therefore, the 100 Area hazard categorizations are based on the worst-case radionuclide concentrations of resins.

Table 3. 100-K Area Groundwater Radionuclide Concentration

Nuclide	pCi/L
H-3	280,000
C-14	13,000
Sr-90	1,100
Tc-99	95
U	7.2

The 100-K Area P&T facilities have different numbers of IX skids. In addition, the KW P&T system has a pre-treatment IX vessel (nine vessels total). This is modeled as 2.25 skids. Table 4 summarizes the facility configurations.

Table 4. 100-K Area P&T Facility Configurations

Facility	KW	KX	KR4
Number of ion-exchange skids	2.25	6	3

Because the HC-3 threshold quantity for all uranium isotopes in Table 1 is the same, the inventories of the isotopes are added together to calculate the uranium inventory for the IX skids and stored totes. The total inventories for the IX skids and stored totes are used to determine the HC. Table 5 shows the categorization for the KW P&T facility.

Table 5. Hazard Categorization for KW P&T Facility

Nuclide	Ion Exchange (Ci)	Tote (Ci)	Total (Ci)	Hazard Category 3 Threshold Quantity	Ratio
C-14	2.56E-03	1.42E-02	1.68E-02	4.20E+02	4.00E-05
Sr-90	3.98E-05	2.21E-04	2.61E-04	1.60E+01	1.63E-05
Tc-99	1.39E-03	7.70E-03	9.09E-03	1.70E+03	5.35E-06
U	1.85E-01	1.03E+00	1.21E+00	4.20E+00	2.89E-01
				Total	**2.89E-01**

Table 6 shows the hazard categorization for the KX P&T facility.

Table 6. Hazard Categorization for KX P&T Facility

Nuclide	Ion Exchange (Ci)	Tote (Ci)	Total (Ci)	Hazard Category 3 Threshold Quantity	Ratio
C-14	6.84E-03	1.42E-02	2.11E-02	4.20E+02	5.02E-05
Sr-90	1.06E-04	2.21E-04	3.28E-04	1.60E+01	2.05E-05
Tc-99	3.70E-03	7.70E-03	1.14E-02	1.70E+03	6.71E-06
U	4.94E-01	1.03E+00	1.52E+00	4.20E+00	3.62E-01
				Total	**3.62E-01**

Table 7 shows the hazard categorization for the KR4 P&T facility.

Table 7. Hazard Categorization for KR4 P&T Facility

Nuclide	Ion Exchange (Ci)	Tote (Ci)	Total (Ci)	Hazard Category 3 Threshold Quantity	Ratio
C-14	3.42E-03	1.42E-02	1.77E-02	4.20E+02	4.21E-05
Sr-90	5.31E-05	2.21E-04	2.74E-04	1.60E+01	1.72E-05
Tc-99	1.85E-03	7.70E-03	9.55E-03	1.70E+03	5.62E-06
U	2.47E-01	1.03E+00	1.28E+00	4.20E+00	3.04E-01
				Total	**3.04E-01**

4.2 DX Pump and Treat Facility

The DX P&T facility uses six IX skids of four vessels, similar to the 100-K Area facilities. Table 8 shows the maximum observed radionuclide concentrations in 100-D Area groundwater (Table 3 in SGW-48153). Consistent with the categorization for the 100 Area P&T facilities, the inventory of radionuclides in the stored groundwater does not represent a significant contribution to the hazard categorization.

Table 8. 100-D Area Groundwater Radionuclide Concentration

Nuclide	Concentration (pCi/L)	Total Ci
H-3	27,000	3.92E-03
Sr-90	6.4	9.30E-07
Tc-99	16	2.33E-06
U	3.2	4.65E-07

Table 9 shows the hazard categorization for the DX P&T facility. The radionuclide content for the spent resin is taken from Table 2. A total of 100 spent resin totes are assumed to be stored onsite. This is a bounding assumption because the facility does not have room to store this many totes.

Table 9. Hazard Categorization for DX P&T Facility

Nuclide	Ion Exchange (6 skids) (Ci)	Tote (Ci)	Total Ci	Hazard Category 3 Threshold Quantity	Ratio
C-14	6.84E-03	1.42E-02	2.11E-02	4.20E+02	5.02E-05
Sr-90	1.06E-04	2.21E-04	3.28E-04	1.60E+01	2.05E-05
Tc-99	3.70E-03	7.70E-03	1.14E-02	1.70E+03	6.71E-06
U	4.94E-01	1.03E+00	1.52E+00	4.20E+00	3.62E-01
				Total	**3.62E-01**

4.3 HX Pump and Treat Facility

The HX P&T facility uses IX skids similar to those used at the 100-K and DX P&T facilities, except the HX P&T facility uses eight skids. Table 10 shows the maximum observed radionuclide concentrations in 100-H Area groundwater (Table 3 in SGW-48153). Consistent with the categorization for the 100 Area P&T facilities, the inventory of radionuclides in the stored groundwater does not represent a significant contribution to the hazard categorization.

Table 10. 100-H Area Groundwater Radionuclide Concentration

Nuclide	Concentration (pCi/L)	Total Ci
H-3	5,200	9.13E-04
Sr-90	32	5.62E-06
Tc-99	52	9.13E-06
U	8.4	1.48E-06

Table 11 shows the hazard categorization for the HX P&T facility. The radionuclide content for the spent resin is taken from Table 2. A total of 100 spent resin totes are assumed to be stored onsite. This is a bounding assumption because the facility does not have room to store this many totes.

Table 11. Hazard Categorization for HX P&T Facility

Nuclide	Ion Exchange (8 skids) (Ci)	Tote (Ci)	Total Ci	Hazard Category 3 Threshold Quantity	Ratio
C-14	9.12E-03	1.42E-02	2.34E-02	4.20E+02	5.56E-05
Sr-90	1.42E-04	2.21E-04	3.63E-04	1.60E+01	2.27E-05
Tc-99	4.93E-03	7.70E-03	1.26E-02	1.70E+03	7.43E-06
U	6.58E-01	1.03E+00	1.69E+00	4.20E+00	4.02E-01
				Total	**4.02E-01**

4.4 Modular Storage Units

The MSUs are sampled annually for radionuclide content of the water and sediment. Sampling is performed for all radionuclides specified in the sampling authorization form (SAF F13-015[3] for water and SAF F18-022[4] for sludge), which are listed in Table 12. Table 12 provides sampling results from 2018, which are typical of recent sampling events. Any nuclide listed in the sampling authorization form that is not detected, or is below the minimum detection limit (MDL), is assumed to be present at the minimum detection limit. It is assumed that the sediment has a density of 1.7 kg/L and is no more than 10% of the water volume.

[3] SAF F13-015, 2018, *Sampling Authorization Form – Modu Tank Annual Sampling of Purgewater*, Rev. 6, CH2M HILL Plateau Remediation Company, Richland, Washington.

[4] SAF F18-022, 2018, *Sampling Authorization Form – Modu Tank Sludge Sampling*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

Table 12. Hazard Categorization for MSUs

Nuclide	Water (pCi/L)	Sediment (pCi/g)	Water (Ci)	Sediment (Ci)	Total Ci	Hazard Category 3 Threshold Quantity	Ratio
H-3	7.46E+03	2.18E+01	5.64E-02	2.80E-02	8.44E-02	1.60E+04	5.28E-06
Co-60	3.57E+00	3.00E-02	2.70E-05	3.86E-05	6.55E-05	2.80E+02	2.34E-07
Sr-90	2.56E+02	2.98E-01	1.94E-03	3.83E-04	2.32E-03	1.60E+01	1.45E-04
Tc-99	3.48E+01	Not detected	2.63E-04	0.00E+00	2.63E-04	1.70E+03	1.55E-07
I-129	2.62E+00	5.15E-01	1.98E-05	6.62E-04	6.82E-04	6.00E-02	1.14E-02
Cs-137	2.55E+00	2.89E-02	1.93E-05	3.71E-05	5.64E-05	6.00E+01	9.40E-07
Eu-152	0.00E+00	6.51E-02	0.00E+00	8.37E-05	8.37E-05	2.00E+02	4.18E-07
Eu-154	1.76E+01	8.78E-02	1.33E-04	1.13E-04	2.46E-04	2.00E+02	1.23E-06
Eu-155	1.15E+01	6.83E-02	8.69E-05	8.78E-05	1.75E-04	9.40E+02	1.86E-07
U-234	1.18E+00	9.69E-01	8.92E-06	1.25E-03	1.25E-03	4.20E+00	2.99E-04
U-235	2.32E-01	4.53E-01	1.75E-06	5.82E-04	5.84E-04	4.20E+00	1.39E-04
U-238	1.06E+00	5.75E-01	8.01E-06	7.39E-04	7.47E-04	4.20E+00	1.78E-04
Pu-238	3.08E-01	5.18E-01	2.33E-06	6.66E-04	6.68E-04	6.20E-01	1.08E-03
Pu-239/240	2.40E-01	1.40E-02	1.81E-06	1.80E-05	1.98E-05	5.20E-01	3.81E-05
Am-241	2.19E-01	1.76E-01	1.66E-06	2.26E-04	2.28E-04	5.20E-01	4.38E-04
						Total	**1.37E-02**

4.5 Hanford Geotechnical Sample Library

The HGSL stores uncontaminated soil samples (e.g., grab samples, split spoon samples, and core samples). The library is posted as an RMA; however, samples with radiological contamination are not known to have ever been transferred to the HGSL. The S&GRP Radiological Control organization performs periodic surveys, and radiological contamination has not been detected. The facility is clearly BHC3 based on this process knowledge, and the sum of fractions (SOF) is not calculated.

4.6 200 West Pump and Treat Facility

The radiological inventory is based on the maximum inventory that can be accumulated in specific processes. The equipment that can accumulate radiological inventory is the IX process and vapor-phase granular activated carbon (GAC) canisters. The GAC canister sample results were evaluated and have been determined to be insignificant. Most of the potential radionuclides were not detected in samples from the GAC canisters because the 200 West P&T is designed so the GAC remains essentially free of radioactivity. No other processes/equipment in the facility contain or accumulate significant radiological inventory.

Unlike other P&T facilities, the 200 West P&T uses Dowex® 21K resin for the uranium IX system instead of SIR-700. The technetium-99 IX system uses both Purolite® A530E and A532E resins. The A532E resin is expected to have approximately 42% more radionuclide capacity than A530E (SGW-58904, *Tc-99 Capacity of Purolite A530E Resin Using Monitoring Data and of Purolite A532E Resin Using Relative Capacities of A530E and A532E*). The uranium IX system has one train of three vessels, operating in a "lead-lag-polish" sequence. The technetium-99 IX system has two trains of three vessels. The uranium IX vessels contain approximately 8.5 m^3 (300 ft^3) of resin, and the technetium-99 IX vessels contain approximately 9 m^3 (320 ft^3). To ensure a bounding analysis, it is assumed that the uranium IX vessels contain 9.3 m^3 (330 ft^3) of Dowex resin and the technetium IX vessels contain 9.9 m^3 (350 ft^3) of A532E resin.

The uranium content of saturated Dowex resin is determined in SGW-58798, *Uranium Capacity of Dowex 21K Resin for Hazard Categorization Calculations*, based on sampling data of discharged resin. The spent resin contains 18.1 g uranium per liter of resin, which means that one IX vessel can hold, at most, 1.13E-01 Ci of uranium. Other nuclides are assumed to be present in the same proportions as the values from resin sample results (Table 13) documented in GEL Laboratories report GEL437876 DP[5] and TestAmerica Laboratories report SL2743 DP,[6] which are available in IDMS.

Table 13. Sample Results for Dowex 21K Resin

Nuclide	pCi/g
H-3	6.54E+00
C-14	2.71E+01
Co-60	3.51E+02
Ni-63	2.14E+00
Se-79	2.30E+02
Sr-90	2.97E+00
Tc-99	2.25E+04
I-129	5.38E-01
Cs-137	1.51E+00
Np-237	2.04E-01
Pu-238	9.67E-01
Pu-239/240	8.78E-01
Am-241	3.39E-01
U	9.98E+03

Dowex® is a registered trademark of Dow Chemical Company, Midland, Michigan.

Purolite® is a registered trademark of Purolite Corporation, Bala Cynwyd, Pennsylvania.

[5] GEL437876 DP, 2017, GEL Laboratories LLC, Charleston, South Carolina.

[6] SL2743 DP, 2017, TestAmerica Laboratories Inc., Earth City, Missouri.

Based on operational experience, one vessel of Purolite resin contains a maximum of 3.64 Ci of technetium-99 (SGW-58904). Other nuclides are assumed to be present in the same proportions as the values from resin sample results (Table 14) documented in GEL Laboratories report GEL461419 DP[7] and TestAmerica Laboratories report SL3061DP,[8] which are available in IDMS.

Table 14. Sample Results for Purolite Resin

Nuclide	pCi/g
H-3	1.07E+01
C-14	1.93E+01
Co-60	1.64E+02
Ni-63	6.74E+01
Se-79	9.69E+01
Sr-90	3.07E+00
Tc-99	3.04E+05
I-129	2.90E-01
Cs-137	4.62E-01
Np-237	2.53E+00
Pu-238	9.12E+00
Pu-239/240	8.32E+00
Am-241	1.18E+01
U	5.53E+02

Table 15 calculates the HC-3 SOF for Dowex 21K and Purolite A532E resins.

Table 15. Hazard Categorization for 200 West P&T Resin Vessels

Nuclide	Hazard Category 3 Threshold Quantity	Dowex 21K Resin		Purolite A532E Resin	
		Total Ci	Ratio	Total Ci	Ratio
H-3	1.60E+04	7.40E-05	4.63E-09	1.22E-04	7.61E-09
C-14	4.20E+02	3.07E-04	7.30E-07	2.20E-04	5.23E-07
Co-60	2.80E+02	3.97E-03	1.42E-05	1.87E-03	6.67E-06
Ni-63	5.40E+03	2.42E-05	4.49E-09	7.67E-04	1.42E-07
Se-79	3.60E+02	2.60E-03	7.23E-06	1.10E-03	3.06E-06
Sr90	1.60E+01	3.36E-05	2.10E-06	3.49E-03	2.18E-04
Tc-99	1.70E+03	2.55E-01	1.50E-04	3.46E+00	2.04E-03
I-129	6.00E-02	6.09E-06	1.01E-04	3.30E-06	5.50E-05

[7] GEL461419 DP, 2018, GEL Laboratories LLC, Charleston, South Carolina.

[8] SL3061 DP, 2018, TestAmerica Laboratories Inc., Earth City, Missouri.

Table 15. Hazard Categorization for 200 West P&T Resin Vessels

Nuclide	Hazard Category 3 Threshold Quantity	Dowex 21K Resin		Purolite A532E Resin	
		Total Ci	Ratio	Total Ci	Ratio
Cs-137	6.00E+01	1.71E-05	2.85E-07	5.26E-06	8.76E-08
Np-237	4.20E-01	2.31E-06	5.50E-06	2.88E-05	6.86E-05
Pu-238	6.20E-01	1.09E-05	1.77E-05	1.04E-04	1.67E-04
Pu-239/240	5.20E-01	9.94E-06	1.91E-05	9.47E-05	1.82E-04
Am-241	5.20E-01	3.84E-06	7.38E-06	1.34E-04	2.58E-04
U	4.20E+00	1.13E-01	2.69E-02	6.29E-03	1.50E-03
		Totals	**2.72E-02**		**4.28E-03**

Note: Based on volume of 9.3 m^3 (330 ft^3) for Dowex resin and 9.9 m^3 (350 ft^3) for Purolite resin.

If all of the IX vessels were at their maximum radionuclide retention capability, the facility SOF would be 1.07E-01. This represents the maximum possible SOF for in-service vessels because radionuclides in the influent water would not be adsorbed onto fully loaded resin and would pass through the facility to the effluent water. In practice, spent IX resin is changed out prior to the final (polish) vessel being fully loaded.

If an additional 10.2 m^3 (360 ft^3) of spent Dowex were in the stripper tank and 29 m^3 (1,024 ft^3) of spent Dowex resin within eight waste containers in 289-TA, the facility SOF would increase to 2.22E-01. Dowex resin is more limiting than Purolite. This is a bounding assumption because the facility does not have space to store this amount of spent resin.

For wastewater shipments that arrive by tanker truck, S&GRP Engineering will evaluate each shipment on a case-by-case basis to ensure that the shipment does not have a discernible effect on the facility SOF. If the shipment is from a nonradiological source, the shipment can be accepted without further evaluation. If the shipment is perched water from the 200-DV-1 OU, it is covered in this analysis and the shipment can be accepted without further evaluation. For other shipments, the evaluation will be performed in accordance with 2WPT-PRO-NS-53025, *Management of Change Process for 2WP&T Facility*.

4.7 Spent Resin Staging Area

The outdoor spent resin staging area located southwest of the 200 West P&T is assumed to hold a maximum of 101.9 m^3 (3,600 ft^3) of resin, which is equivalent to six ERDF containers or 28 wood burial boxes (4 ft by 4 ft by 8 ft). This is a bounding assumption because the area does not have space to store more than this quantity. The spent resin is assumed to be all Dowex resin, as it is more limiting than Purolite resin. Section 4.6 provides the radionuclide capacity of the saturated Dowex resin. The SOF for the staging area would be 2.97E-01.

4.8 200 West Pump and Treat Expansion

The 289-TA building had space to install two additional IX trains. The 200-BP-5/200-PO-1 IX system is planned to fill the two remaining IX train positions with two trains of three vessels each, for a total of six new vessels operating in a "lead-lag-polish" sequence. The uranium IX train is planned to contain three vessels with 10.2 m^3 (360 ft^3) of Dowex resin, and the technetium-99 IX train is planned to contain three vessels with 10.2 m^3 (360 ft^3) of Purolite A532E resin. If these two trains are installed, the SOF becomes 2.10E-01. If an additional 10.2 m^3 (360 ft^3) of spent Dowex resin were in the stripper tank and 29 m^3 (1,024 ft^3) of spent Dowex resin within eight waste containers in 289-TA, the SOF would increase to 3.24E-01. Figure 2 depicts the expected configuration when the two new IX trains are installed.

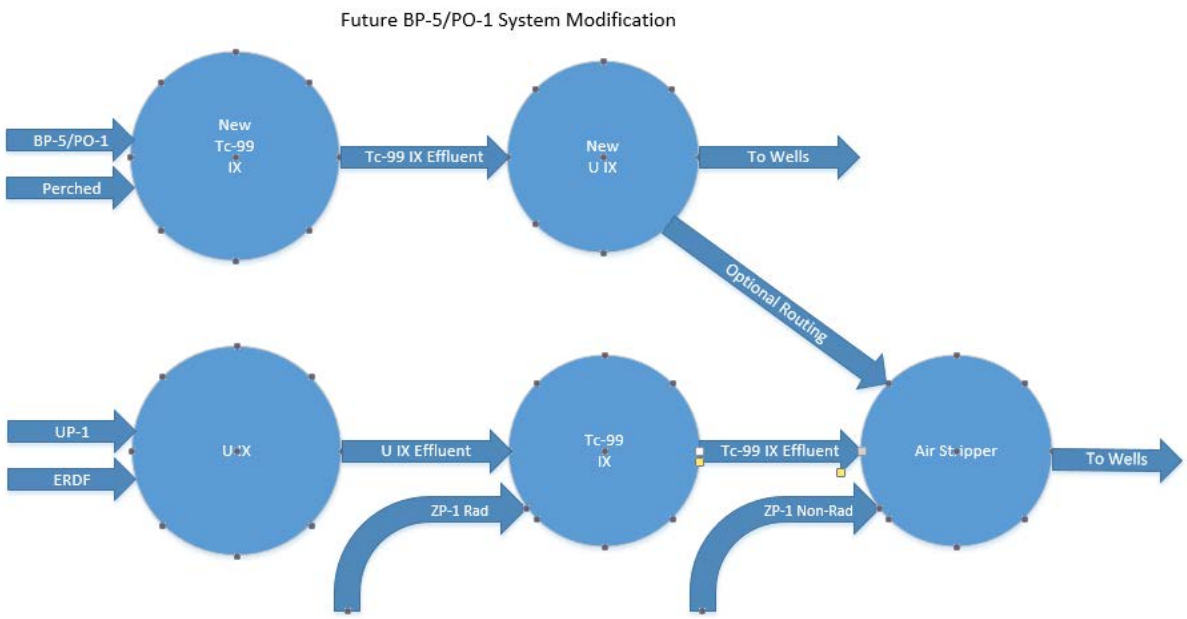

Figure 2. Flow Diagram for 200 West P&T Proposed Expansion

4.9 Perched Water Staging

As discussed in Section 3.11, perched water from the 200-DV-1 OU is extracted via a series of wells and is staged in an 11,355 L (3,000 gal) collection tank near the BX Tank Farm in the 200 East Area before being transferred to the 200 West P&T. This analysis conservatively assumes that the 16,656 L (4,400 gal) transfer tank, which receives water from the 200-BP-5 OU wells and the perched water collection tank, is filled with perched water (for a total volume of 209.5 L [7,400 gal]). The radiological composition of perched water is from SGW-57790. Based on this, the SOF for the staged perched water can be calculated as shown in Table 16.

Table 16. Hazard Categorization for Perched Water Staging

Nuclide	pCi/L	Total Ci	Hazard Category 3 Threshold Quantity	Ratio
H-3	4.21E+04	1.18E-03	1.60E+04	7.36E-08
C-14	1.60E+03	4.49E-05	4.20E+02	1.07E-07
Co-60	3.84E+00	1.08E-07	2.80E+02	3.84E-10
Ni-63	3.00E-02	8.40E-10	5.40E+03	1.56E-13
Se-79	4.70E+00	1.32E-07	3.60E+02	3.66E-10
Sr-90	5.60E+00	1.57E-07	1.60E+01	9.80E-09
Tc-99	5.10E+04	1.43E-03	1.70E+03	8.40E-07
I-129	4.94E+00	1.38E-07	6.00E-02	2.31E-06
Cs-137	2.83E+00	7.93E-08	6.00E+01	1.32E-09
Np-237	8.01E-01	2.24E-08	4.20E-01	5.34E-08
Pu-238	8.50E-02	2.38E-09	6.20E-01	3.84E-09
Pu-239/240	6.00E-02	1.68E-09	5.20E-01	3.23E-09
Am-241	1.60E-01	4.40E-09	5.20E-01	8.46E-09
U	7.12E+04	1.99E-03	4.20E+00	4.75E-04
			Total	**4.78E-04**

Note: Concentrations are from SGW-57790, *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.*

Note that the principal contributor to the SOF is uranium. Because the SOF is <1, this activity is BHC3.

With the expected radionuclide concentrations, the activity remains BHC3 even if staging or transfer tanks are added to support 200 West P&T expansion. The proposed influent from the 200-PO-1 OU is likewise expected to have very low radionuclide concentrations. Section 3.7.2 in PRC-PRO-NS-8366 defines a discernible increase in the facility SOF as 0.01. Adding five 16,656 L (4,400 gal) tanks with double the radionuclide concentrations listed in Table 16 would not result in a discernable increase, as the SOF would only increase by 2.84E-03.

4.10 Sample Staging

The SSU in the 6267 Building is assumed to be filled with 1 L bottles of either soil or groundwater samples. Each groundwater sample is assumed to contain the radionuclide concentrations described in Table 1 of TE-SGRP-09-010-07, *SGRP Characterization in Support of Surveys, Air Sampling, and Dosimetry*. This is a composite of the highest concentration of each nuclide observed in 30,000 samples over a period of 14 years (2000 through 2014) and represents a bounding estimate. As shown in Table 17, the HC-3 SOF for one groundwater sample is 2.01E-08.

Table 17. Hazard Categorization for Groundwater Samples

Nuclide	pCi/L	Ci/L	Hazard Category 3 Threshold Quantity	Ratio
H-3	8.38E+06	8.38E-06	1.60E+04	5.24E-10
C-14	2.09E+04	2.09E-08	4.20E+02	4.98E-11
Co-60	1.04E+03	1.04E-09	2.80E+02	3.71E-12
Ni-63	8.36E+02	8.36E-10	5.40E+03	1.55E-13
Se-79	2.08E+03	2.08E-09	3.60E+02	5.78E-12
Sr-90	1.90E+04	1.90E-08	1.60E+01	1.19E-09
Nb-94	2.00E+01	2.00E-11	2.00E+02	1.00E-13
Tc-99	1.88E+05	1.88E-07	1.70E+03	1.11E-10
Sb-125	2.30E+01	2.30E-11	1.20E+03	1.92E-14
Sn-126	2.40E+01	2.40E-11	1.70E+02	1.41E-13
I-129	7.20E+01	7.20E-11	6.00E-02	1.20E-09
Cs-134	1.00E+02	1.00E-10	4.20E+01	2.38E-12
Cs-137	2.43E+03	2.43E-09	6.00E+01	4.05E-11
Eu-152	2.60E+01	2.60E-11	2.00E+02	1.30E-13
Eu-154	5.70E+01	5.70E-11	2.00E+02	2.85E-13
Th-228	2.50E+01	2.50E-11	1.00E+00	2.50E-11
Th-230	1.90E+00	1.90E-12	6.20E-01	3.06E-12
Pa-231	1.10E+00	1.10E-12	2.00E-01	5.50E-12
Th-232	9.00E-01	9.00E-13	1.00E-01	9.00E-12
U-233/234	3.40E+04	3.40E-08	4.20E+00	8.10E-09
U-235	2.20E+03	2.20E-09	4.20E+00	5.24E-10
U-238	3.50E+04	3.50E-08	4.20E+00	8.33E-09
Np-237	1.30E+00	1.30E-12	4.20E-01	3.10E-12
Pu-238	1.50E+00	1.50E-12	6.20E-01	2.42E-12
Pu-239	4.60E+00	4.60E-12	5.20E-01	8.85E-12
Am-241	5.00E+00	5.00E-12	5.20E-01	9.62E-12
			Total for 1 L	**2.01E-08**

Each soil sample is assumed to contain the radionuclide concentrations described in Table 2 of TE-SGRP-09-010-06. This is a composite of the highest concentration of each nuclide observed in 3,000 soil samples over a period of 14 years (2000 through 2014) and represents a bounding estimate. As shown in Table 18, the SOF for 1 kg of soil is 5.59E-06. Assuming a soil density of 1.7 kg/L, the SOF for a 1 L sample bottle would be 9.50E-06.

Table 18. Hazard Categorization for Soil Samples

Nuclide	pCi/g	Ci/kg	Hazard Category 3 Threshold Quantity	Ratio
H-3	1.10E+03	1.10E-06	1.60E+04	6.88E-11
C-14	4.74E+02	4.74E-07	4.20E+02	1.13E-09
Co-60	3.90E+01	3.90E-08	2.80E+02	1.39E-10
Sr-90	3.25E+03	3.25E-06	1.60E+01	2.03E-07
Tc-99	2.72E+02	2.72E-07	1.70E+03	1.60E-10
I-129	3.90E+01	3.90E-08	6.00E-02	6.50E-07
Cs-134	1.00E-01	1.00E-10	4.20E+01	2.38E-12
Cs-137	1.56E+04	1.56E-05	6.00E+01	2.60E-07
Eu-152	1.80E+02	1.80E-07	2.00E+02	9.00E-10
Eu-154	4.40E+01	4.40E-08	2.00E+02	2.20E-10
Eu-155	2.10E+01	2.10E-08	9.40E+02	2.23E-11
Th-228	4.00E+01	4.00E-08	1.00E+00	4.00E-08
Th-230	1.08E+02	1.08E-07	6.20E-01	1.74E-07
Pa-231	1.30E+01	1.30E-08	2.00E-01	6.50E-08
Th-232	3.70E+01	3.70E-08	1.00E-01	3.70E-07
U-233/234	7.30E+01	7.30E-08	4.20E+00	1.74E-08
U-235	5.00E+00	5.00E-09	4.20E+00	1.19E-09
U-238	7.70E+01	7.70E-08	4.20E+00	1.83E-08
Np-237	2.90E+01	2.90E-08	4.20E-01	6.90E-08
Pu-238	1.40E+00	1.40E-09	6.20E-01	2.26E-09
Pu-239	1.90E+03	1.90E-06	5.20E-01	3.65E-06
Am-241	3.00E+01	3.00E-08	5.20E-01	5.77E-08
Cm-242	2.10E+01	2.10E-08	3.20E+01	6.56E-10
			Total for 1 kg	**5.59E-06**
			Total for 1 L	**9.50E-06**

If the SSU held 10,000 soil samples and 10,000 groundwater samples, the combined SOF would be 9.52E-02. This is a bounding assumption because the SSU is too small to hold this many bottles. Individual samples may exceed these values for some nuclides but, in practice, it is not credible for the actual sample inventory to exceed the assumed 10,000 samples.

Because the soil contamination is distributed throughout the sample, soil samples bound construction debris samples, which have only surface contamination.

Samples may also be staged in SSU #1 in the 6269 Building (field sampling operations facility). This SSU is a 2.8 m^3 (100 ft^3) refrigerator, which is designated as an RMA (GW-RMA-273). Because this SSU is smaller than the SSU in the 6269 Building, it is bounded by this analysis.

5 Hazard Categorization Summary

The hazard categorizations described in Chapter 4 are summarized in Table 19. All facilities are BHC-3.

Table 19. S&GRP Property Hazard Categorization

Property	Hazard Category 3 Sum of Fractions
KW P&T facility	2.89E-01
KX P&T facility	3.62E-01
KR4 P&T facility	3.04E-01
DX P&T facility	3.62E-01
HX P&T facility	4.02E-01
Modular storage units (ModuTanks)	1.37E-02
200 West P&T facility	2.22E-01
Spent resin staging area	2.97E-01
Perched water staging	4.78E-04
Sample staging	9.52E-02

P&T = pump and treat

6 References

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Appendix A

Peer Review Checklist

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CHPRC REVIEW CHECKLIST

Document Reviewed:
SGW-40032, Rev. 13, Soil and Groundwater Remediation Project Facility Hazard Categorization

Scope of Review:
Entire Document

Yes	No	N/A		
☒	☐	☐	*	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐		Problem completely defined.
☐	☐	☒		Accident scenarios developed in a clear and logical manner.
☒	☐	☐		Necessary assumptions explicitly stated and supported.
☐	☐	☒		Computer codes and data files documented.
☒	☐	☐		Data used in calculations explicitly stated in document.
☒	☐	☐		Data checked for consistency with original source information as applicable.
☒	☐	☐		Mathematical derivation checked including dimensional consistency of results.
☒	☐	☐		Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☐	☐	☒		Software input correct and consistent with document reviewed.
☐	☐	☒		Software output consistent with input and with results reported in document reviewed.
☒	☐	☐		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐		Safety margins consistent with good engineering practices.
☒	☐	☐		Conclusions consistent with analytical results and applicable limits.
☒	☐	☐		Results and conclusions address all points required in the problem statement.
☒	☐	☐	*	Format consistent with appropriate NRC Regulatory Guide or other standards.
☒	☐	☐		Review calculations, comments, and/or notes are attached.
☐	☐	☒		For calculations in which codes/spreadsheets (e.g., RADIDOSE, GENII, etc) are used, is the latest revision used? Is the User Authorized?
☒	☐	☐		Hazard controls established are appropriate for the hazards including selection using the appropriate hierarchy (e.g., engineered over administrative).
☐	☐	☒		The preventive or mitigative credit assigned to hazard controls are appropriate, and the basis is documented.
☒	☐	☐		**Document approved.**

MF Meyer — Meyer, Matthew F — Digitally signed by Meyer, Matthew F Date: 2020.09.09 17:02:07 -07'00' — 9/9/2020

Reviewer (Printed Name and Signature) — Date

*Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

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