DOE/RL-2013-31
Revision 0

100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2013-31
Revision 0

100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan

Date Published
May 2016

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office
P.O. Box 550
Richland, Washington 99352

APPROVED
By Janis D. Aardal at 12:58 pm, May 10, 2016

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Signature Page

Title: *100-HR-3 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*

Michael Clone		5/18/2016
Print Name	Signature	Date

U.S. Department of Energy,
Richland Operations Office

NINA M. MENARD		5/31/16
Print Name	Signature	Date

Washington State
Department of Ecology

This page intentionally left blank.

Contents

1 Introduction 1-1

1.1 Purpose 1-2
1.2 Scope 1-3
1.3 Site Description and Background 1-3
1.4 Conceptual Site Model 1-4
1.4.1 Physical Setting 1-4
1.4.2 Hydrogeology 1-4
1.4.3 Groundwater Flow 1-6
1.4.4 Contaminant Transport in Groundwater 1-6
1.5 Nature and Extent of Contamination 1-12
1.5.1 Waste Site Contamination 1-12
1.5.2 Groundwater Contamination 1-16

2 Basis for Remedial Action 2-1

2.1 Selected Remedy 2-1
2.1.1 Interim Remedial Action History 2-1
2.1.2 DR-5 and HR-3 Pump and Treat System Operations 2-5
2.1.3 DX and HX Pump and Treat Systems 2-8
2.1.4 In Situ Redox Manipulation Barrier 2-10
2.1.5 Institutional Controls 2-10
2.2 Remedial Action Objectives 2-11
2.3 Remedial Action Goals 2-12
2.4 Remedial Action Monitoring 2-13
2.4.1 Operational Monitoring 2-13
2.4.2 Remedy Performance Monitoring 2-14
2.4.3 Remedial Process Optimization 2-22
2.5 Applicable or Relevant and Appropriate Requirements Compliance 2-23
2.6 Other Remedial Action Requirements 2-25
2.7 Interfaces with Other Projects 2-25

3 Remedial Design Approach 3-1

3.1 Design Basis 3-1
3.2 Conceptual Design 3-1
3.2.1 HR-3 P&T System 3-1
3.2.2 DR-5 Pump and Treat System 3-2
3.2.3 DX and HX Pump and Treat Systems 3-2
3.2.4 Supplemental Support Tasks 3-2
3.3 Design Approach 3-5

3.3.1 DX and HX Pump and Treat Systems 3-8
3.3.2 In Situ Redox Manipulation Permeable Reactive Barrier 3-17
3.3.3 Operations and Maintenance Plan 3-19
3.4 Managing and Communicating Uncertainties 3-19
3.4.1 Conceptual Site Model 3-19
3.4.2 Remedial System Performance 3-20
3.4.3 Resource Allocation 3-20
4 Remedial Action Management and Approach 4-1
4.1 Project Organization 4-1
4.2 Change Management 4-3
4.3 Operational Approach 4-4
4.3.1 Up-Time Requirements 4-5
4.3.2 Effluent Monitoring 4-5
4.3.3 Pond Decommissioning for the ISRM System 4-5
4.3.4 Data Use and Interpretation 4-11
5 Environmental Management and Controls 5-1
5.1 Air Emissions 5-1
5.2 Reporting Requirements for Non-Routine Releases 5-1
5.3 Waste Management 5-1
5.4 Cultural and Ecological Resources 5-2
5.5 Safety and Health Program 5-3
5.5.1 Worker Safety Program 5-3
5.5.2 Health and Safety Plan and Activity Hazards Analysis 5-3
5.6 Quality Assurance Program 5-4
5.6.1 Quality Assurance Implementation 5-4
5.6.2 Responsibilities and Authority 5-5
5.6.3 Document Control 5-5
5.6.4 Quality Assurance Records 5-5
5.6.5 Audits/Assessments 5-5
5.6.6 Self Assessments 5-5
6 Remedial Action Completion 6-1
6.1 Remedial Action Completion Timeline 6-2
6.2 Groundwater Remediation Steps 6-3
6.2.1 Step 1 - Start Remediation 6-3
6.2.2 Step 2 - Active Remediation with Performance Monitoring 6-3
6.2.3 Step 3 - End Remediation 6-5
6.2.4 Step 4 - Start Compliance Monitoring 6-7
6.2.5 Step 5 - End Compliance Monitoring 6-7

6.3 Interim Remedy Reporting 6-7
6.4 Final Closeout Report 6-8
6.5 Decontamination and Decommissioning 6-9
6.5.1 Interim Decontamination 6-10
6.5.2 DR-5 and HR-3 Decontamination and Decommissioning 6-10
6.5.3 DX and HX Decontamination and Decommissioning 6-10
7 Cost and Schedule 7-1
7.1 Cost Summary 7-1
7.2 Schedule 7-1
8 References 8-1

Appendices

A Summary of Regulatory Requirements ..... A-i
B DX and HX Pump and Treat Systems Functional Design Criteria Documents ..... B-i

Figures

Figure 1-1. Operable Units Included in the 100-D/H Area 1-1
Figure 1-2. Conceptual Hydrogeologic Cross Section from West to East of the 100-HR-3 Operable Unit 1-5
Figure 1-3. 100-HR-3 Operable Unit Unconfined Aquifer Thickness for April to August 2012 1-7
Figure 1-4. 100-HR-3 Operable Unit Groundwater Contours at High River Stage 1-8
Figure 1-5. 100-HR-3 Operable Unit Groundwater Contours at Low River Stage 1-9
Figure 1-6. Interpolated Presence of Ringold Formation unit E at 100-HR-3 1-11
Figure 1-7. Facilities and Waste Sites Where Sodium Dichromate was Handled at 100-D 1-14
Figure 1-8. Facilities and Waste Sites Where Sodium Dichromate was Handled at 100-H 1-15
Figure 1-9. Hexavalent Chromium Plume in the 100-D Area for 2013 – Low River Stage 1-19
Figure 1-10. Well Network near the In Situ Redox Manipulation Barrier 1-20
Figure 1-11. Hexavalent Chromium Plume in the 100-D/H Area for 2013 – Low River Stage 1-22
Figure 1-12. Hexavalent Chromium Plume in the 100-H Area for 2013 – Low River Stage 1-23
Figure 2-1. Monthly Cr(VI) Removed and Groundwater Volume Treated by the HR-3 P&T System .2-6
Figure 2-2. Monthly Cr(VI) Removed and Groundwater Volume Treated by the DR-5 P&T System .2-7
Figure 2-3. Monthly Cr(VI) Removed and Groundwater Volume Treated by the DX P&T System.....2-9
Figure 2-4. Monthly Cr(VI) Removed and Groundwater Volume Treated by the HX P&T System.....2-9
Figure 3-1. General Well Construction Diagram for Monitoring of Unconfined Aquifer and for Extraction/Injection Wells 3-9
Figure 3-2. General Well Construction Diagram for Monitoring of Semiconfined to Confined Aquifer 3-10
Figure 3-4. Aerial View of DX Pump and Treat Facility 3-13
Figure 3-5. DX Pump and Treat System Schematics 3-14
Figure 3-6. Aerial View of HX P&T Facility 3-15
Figure 3-7. HX Pump and Treat System Schematics 3-16
Figure 3-8. Annual and Cumulative Volume Treated at 100-HR-3 Operable Unit Pump and Treat Systems 3-17
Figure 3-9. Annual and Cumulative Cr(VI) Mass Removed by 100-HR-3 Operable Unit P&T Systems 3-18
Figure 4-1. 100-HR-3 Interim Action Project Organization 4-1
Figure 6-1. Steps in Groundwater Remediation 6-2
Figure 6-2. Flowchart Showing the Steps to Evaluate the Progress of Remediation 6-6

Tables

Table 1-1. Status of 100-HR-3 Interim Action Compliance Wells 1-21
Table 2-1. Chronological Summary of CERCLA Actions and Associated Activities at the 100-HR-3 Groundwater Operable Unit 2-2
Table 2-2. DR-5 and HR-3 Interim Action P&T Systems 2-6
Table 2-3. DX and HX Interim Action P&T Systems 2-8
Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring 2-15
Table 2-5. Monitoring Data Quality Objective Principal Study Questions 2-21
Table 3-1. Documents Written to Support DX and HX Expansion 3-6
Table 4-1. Project Modifications and Approval Mechanisms for Change Management 4-3
Table 4-2. Remedial Action Work Tasks 4-6
Table 6-1. Anticipated Cleanup Levels for 100-HR-3 Groundwater 6-1
Table 6-2. Recommended Outline for Final Closeout Report (from OSWER Directive 9320.2-22) ... 6-8
Table 7-1. 100-HR-3 Operable Unit Interim Remedial Action Actual Costs 7-1
Table 7-2. Remediation Goals and Milestones for the 100-HR-3 Operable Unit 7-2

Terms

ARAR	applicable or relevant and appropriate requirement
AWLN	automated water level network
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFM	capture frequency map
COC	contaminant of concern
COPC	contaminant of potential concern
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium
CSM	conceptual site model
D&D	decontamination and decommissioning
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant differences
ESHR	Environmental, Safety, Health, and RadCon
ETF	Effluent Treatment Facility
FDC	functional design criteria
FY	fiscal year
gpm	gallons per minute
HASP	health and safety plan
HHE	human health and the environment
IC	institutional control
ICFM	interpolated capture frequency map

ISMS	Integrated Safety Management System
ISRM	in situ redox manipulation
IX	ion exchange
LFI	limited field investigation
LTS	Long-Term Stewardship
MCL	maximum contaminant level
MSA	Mission Support Alliance
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit
P&T	pump and treat
PPE	personal protective equipment
PRB	permeable reactive barrier
PSTF	Purgewater Storage and Treatment Facility
PSQ	principal study question
QA	quality assurance
QC	quality control
QRA	qualitative risk assessment
RAG	remedial action goal
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RD/RAWP	remedial design/remedial action work plan
RDR/RAWP	remedial design report/remedial action work plan
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RPO	remedial process optimization
RUM	Ringold Formation upper mud
S&GRP	Soil and Groundwater Remediation Project

SAP	sampling and analysis plan
TPA	Tri-Party Agreement
TPA-CN	Tri-Party Agreement-Change Notice
TSD	treatment, storage, and disposal
UCL	upper confidence limit
UPR	unplanned release
VPP	Voluntary Protection Program
WCH	Washington Closure Hanford
ZVI	zero valent iron

1 Introduction

The U.S. Department of Energy (DOE) Hanford Site is a 1,517 km^2 (586 mi^2) federal facility located in southeastern Washington State along the Columbia River. For administrative purposes, the Hanford Site was divided into four National Priorities List (NPL) sites (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," hereinafter called the National Contingency Plan [NCP], Appendix B, "National Priorities List") under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in 1989, one of which is the 100 Area. In May 1989, in anticipation of the NPL listing, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) entered into Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*, also known as the Tri-Party Agreement (TPA). This agreement established a procedural framework and schedule for developing, implementing, and monitoring CERCLA response actions and *Resource Conservation and Recovery Act of 1976* (RCRA) compliance and permitting on the Hanford Site. The DOE Richland Operations Office (DOE-RL) is the lead agency responsible to perform the remedial actions, and Ecology is the lead regulatory agency for the 100-HR-3 OU, as identified in Section 5.6 and Appendix C of the TPA (Ecology et al., 1989a).

The 100-D/H Area is a part of the 100 Area NPL site (40 CFR 300, Appendix B) and encompasses approximately 20 km^2 (7.8 mi^2) bordered to the west, north, and east by the Columbia River. The 100-D/H Area includes four source operable units (OUs): 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2, and one groundwater OU (100-HR-3). Figure 1-1 shows the 100-D/H Area and the OUs. The 100-HR-3 OU encompasses groundwater contamination from 100-D/H Area sources and does not include groundwater contamination from other source areas.

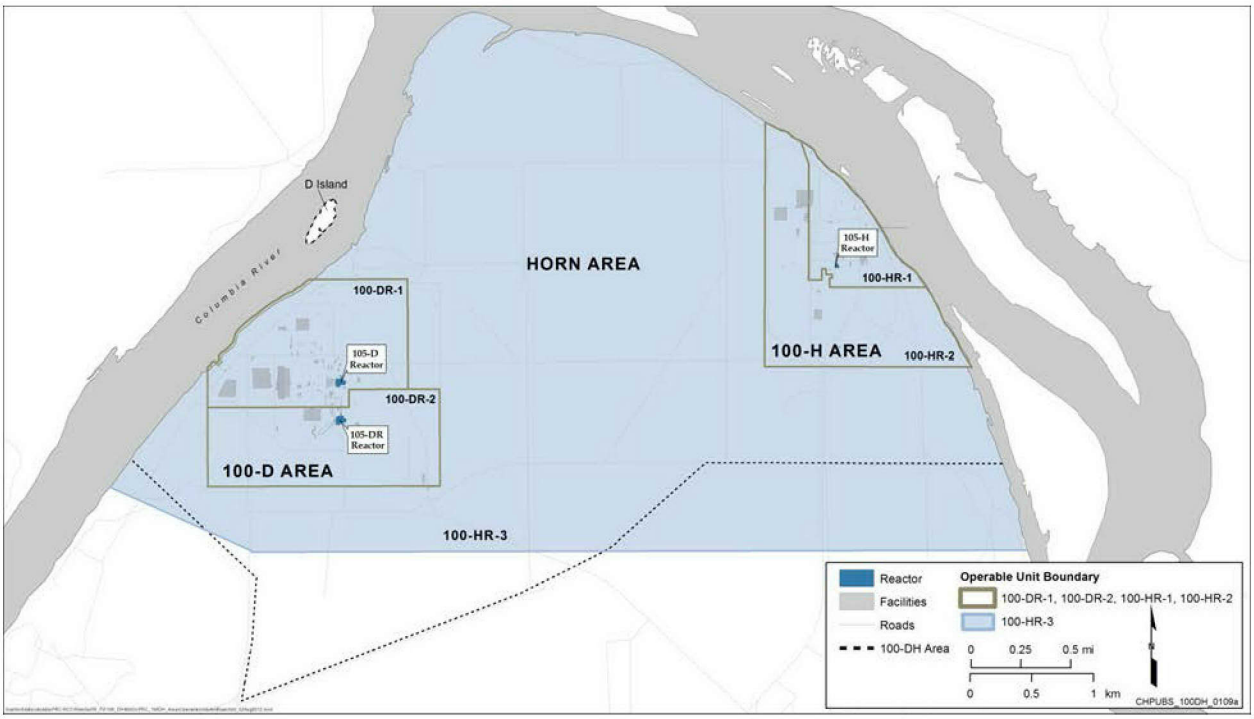


Figure 1-1. Operable Units Included in the 100-D/H Area

Interim remedial actions were selected for the 100-HR-3 OU in accordance with CERCLA, the TPA (Ecology et al., 1989a), and the NCP (40 CFR 300). The interim remedial actions are described in EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim*

Remedial Actions, Hanford Site, Benton County, Washington, hereinafter called interim action record of decision (ROD), issued in 1996, and EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, hereinafter called interim action ROD amendment, issued in 1999. Explanations of significant differences (ESDs) were issued for the 100-HR-3 OU in April 2003 (EPA/ESD/R10-03/606, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*) and in August 2009 for the 100-HR-3 and 100-KR-4 OUs (EPA et al., 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site Benton County, Washington*). The interim actions are intended to capture and remediate areas of contaminated groundwater and provide information that leads to the final remedy. Interim cleanup levels for contaminated groundwater were established in the interim action ROD and interim action ROD amendment.

This remedial design/remedial action work plan (RD/RAWP) supports implementation of interim remedial actions, as established in the interim action ROD (EPA/ROD/R10-96/134) and interim action ROD amendment (EPA/AMD/R10-00/122), within the 100-HR-3 OU. This RD/RAWP establishes the general size, scope, and character of the interim remedial action project and identifies the technical requirements of the interim remedial actions. The interim remedial actions are intended to continue, until the observed groundwater contamination conditions meet the remedial action objectives (RAOs), or the interim remedial actions are replaced by final remedial actions.

1.1 Purpose

The purpose of the RD/RAWP is to describe how interim remedial actions are designed, installed, and operated to meet the interim RAOs identified in the interim action ROD (EPA/ROD/R10-96/134) and interim action ROD amendment (EPA/AMD/R10-00/122) for the 100-HR-3 OU. System requirements for implementing remedial actions are described in DOE/RL-2013-49, *100-HR-3 Pump and Treat System Operations and Maintenance Plan*, hereinafter called the operations and maintenance (O&M) plan. DOE/RL-2013-30, *Sampling and Analysis Plan for the 100-HR-3 Groundwater Operable Unit*, describes remedy performance monitoring to evaluate effectiveness of the interim remedial actions in meeting the performance criteria required by the interim action ROD and interim action ROD amendment (EPA/AMD/R10-00/122). RCRA monitoring for the 183-H Solar Evaporation Basins is addressed in a separate sampling and analysis plan (SAP).

The 100-HR-3 RD/RAWP is being revised to include design and completion of the DX and HX pump and treat (P&T) systems and operation of these systems to meet interim RAOs identified in the interim action ROD (EPA/ROD/R10-96/134) and interim action ROD amendment (EPA/AMD/R10-00/122). A separate RD/RAWP is planned for the 100-KR-4 OU. The revision includes an outline for completion of the remedial action in Chapter 6. This RD/RAWP supersedes the following previous remedial design report/remedial action work plans (RDR/RAWPs) for the 100-HR-3 OU:

- DOE/RL-96-84, Rev. 0, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
- DOE/RL-96-84, Rev. 0-A, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
- DOE/RL-99-51, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*

The lead regulatory agency for the 100-HR-3 OU is Ecology. DOE and Ecology are currently developing final decision documents for the 100-HR-3 OU. When a final decision is reached, this RD/RAWP will be revised or replaced with a new work plan that will implement the final remedies.

1.2 Scope

The scope of the RD/RAWP includes the plan and schedule for successful implementation of the interim remedial actions selected to meet the requirements of the interim action ROD (EPA/ROD/R10-96/134) and interim action ROD amendment (EPA/AMD/R10-00/122) for cleanup of groundwater in the 100-HR-3 OU.

The interim action ROD selected the following interim remedial actions for the 100-HR-3 OU:

- Removing hexavalent chromium (Cr(VI)) from groundwater that discharges to the Columbia River using P&T technology
- Monitoring groundwater near the river and effluent from the treatment system to determine system performance in meeting the RAOs for protection of the Columbia River
- Monitoring potential co-contaminants including nitrate, strontium-90, tritium, uranium, and technetium-99
- Establishing institutional controls (ICs) to protect human health from groundwater contaminants

The interim action ROD amendment added application of a permeable groundwater treatment barrier as an additional selected remedy to reduce the mobility and toxicity of chromium in groundwater.

The following remedial action are being implemented to meet the interim action ROD and interim action ROD amendment:

- Two P&T systems (DX and HX)
  - DOE/RL-2013-49 implements monitoring of the P&T systems
- In situ chemical treatment using in situ redox manipulation (ISRM) technology
  - DOE/RL-2013-30 implements a groundwater monitoring program for the operative portion of the ISRM barrier
- ICs

1.3 Site Description and Background

The 100-D/H Area includes three deactivated nuclear reactors and support facilities that operated to produce plutonium from 1944 to 1967. The reactors were built to irradiate uranium fuel rods from which plutonium and other special nuclear materials were extracted. Large volumes of river water were used as cooling water during reactor operations. The river water was treated to remove particulates, and sodium dichromate was added to the treated water as a corrosion inhibitor. The addition of sodium dichromate included both dry and highly concentrated liquid stock solutions. Leaks of sodium dichromate concentrate from pipelines and spills resulted in high concentrations of Cr(VI) contamination in soil and groundwater.

The reactors and processes associated with operations generated large quantities of liquid and solid wastes. Contaminated waste generated from reactor operations contained radionuclides, hazardous chemicals, or both. Large quantity discharges to the environment included contaminated cooling water releases to retention basins, cribs, and trenches. During upset conditions, such as fuel element failures, the cooling water was diverted from the regularly used retention basins to other disposal areas, such as

ditches or other engineered structures, and was allowed to infiltrate directly into the soil column. These practices resulted in extensive groundwater recharge mounds, consisting primarily of contaminated cooling water, and wide distribution of contamination in the unconfined aquifer.

1.4 Conceptual Site Model

The following subsections briefly describe the conceptual site model (CSM), which includes the site setting, physical characteristics, and nature and extent of contamination. The 100-D/H remedial investigation/feasibility study (RI/FS) (DOE/RL-2010-95, *Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*) contains detailed information describing the Hanford Site, River Corridor, and 100-HR-3 OU.

1.4.1 Physical Setting

The 100-D/H Area encompasses approximately 20 km^2 (7.8 mi^2) and is located on the northernmost part of the Hanford Site. This land area is bordered to the west, north, and east by the Columbia River (Figure 1-1). As described in the interim action ROD (EPA/ROD/R10-96/134), the 100-HR-3 OU includes groundwater underlying the 100-D/DR and 100-H Reactor Areas and a portion of the 600 Area. The south boundary of the 100-HR-3 OU is approximately 4.1 km (2.5 mi) south of the northernmost point of the 100-D/H Area. The southern boundary is a straight line from the Columbia River on the west to the Columbia River on the east, with the exception of the western 1.3 km (0.8 mi) end, which angles up to the north (Figure 1-1). The 100-D/H topography is gently sloping with elevations ranging from approximately 154 m (505 ft) along the western boundary of the 100-D Area to 115 m (377 ft) south of the 100-H Area along the river shoreline. The topography is relatively flat inland from the Columbia River with elevation changes greatest near the river, where the riverbank slopes steeply. The majority of land surface is an undisturbed shrub-steppe community with riparian areas immediately adjacent to the river shoreline.

1.4.2 Hydrogeology

The primary stratigraphic units controlling groundwater flow in the unconfined aquifer in the 100-D, 100-H, and the Horn areas are, from shallowest to deepest:

- Hanford formation—a sand and gravel-dominated deposit encountered at the ground surface and extending down to the vicinity of the current water table at 100-H. The unconfined aquifer is primarily within the Hanford formation in 100-H.
- Ringold Formation unit E—a sand and gravel-dominated deposit that exhibits variable cementation. The unconfined aquifer is primarily within the Ringold Formation unit E in 100-D.
- Ringold Formation upper mud (RUM)—a fine-textured silt-dominated deposit exhibiting very low hydraulic conductivity and effectively defining the bottom of the unconfined aquifer. Within the RUM, thin sand-to-gravel layers form zones with variable hydraulic conductivities, with some water bearing units.

Figure 1-2 presents a conceptual hydrogeologic profile of the 100-HR-3 OU. Deposits making up the unconfined aquifer at 100-HR-3 include the Hanford formation and Ringold Formation unit E. The Hanford formation facies consists of moderately to very poorly sorted, large to very large, cobble-to boulder-sized clasts in open framework gravels that include discrete sand lenses, with little, or no, silt and clay-sized material. Ringold Formation unit E is a denser, compact and well-graded formation versus the looser, coarser-grained Hanford gravel-dominated facies. The Ringold Formation unit E is composed of fluvial matrix-supported gravels and sands with intercalated fine- to coarse-grained sand and silt layers. The thickness of the unconfined aquifer is determined by the difference between the water table elevation and the surface of the RUM, which forms the base of the unconfined aquifer.

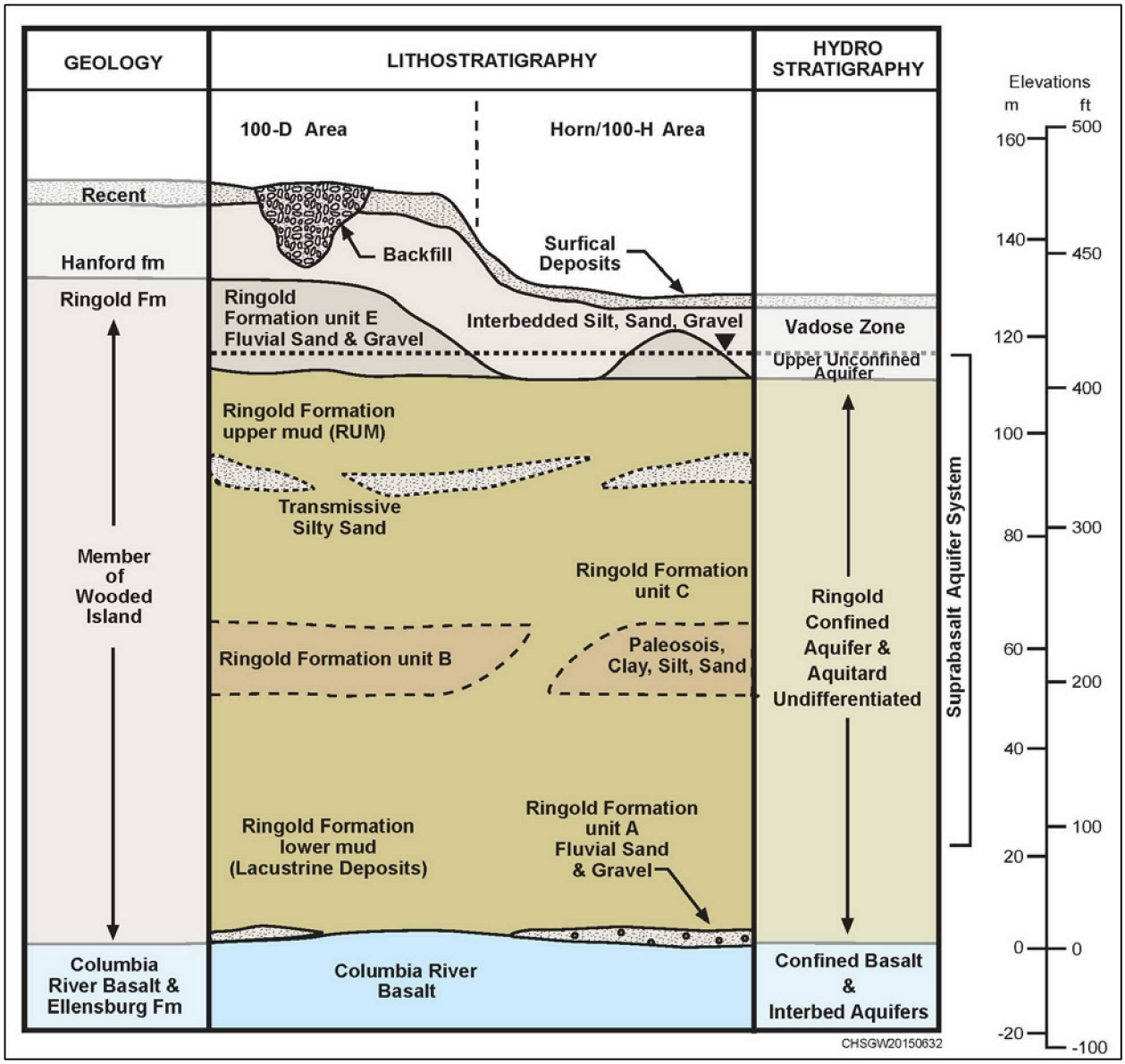


Figure 1-2. Conceptual Hydrogeologic Cross Section from West to East of the 100-HR-3 Operable Unit

The unconfined aquifer thickness at 100-HR-3 generally thins from west to east, from 100-D toward 100-H, with the thinnest areas found in the northern area of the Horn (Figure 1-3). Thickness of the unconfined aquifer ranges from near 0 to 12 m (39 ft) across the area. The thickness of the unconfined aquifer mimics the topography of the RUM (DOE/RL-2008-42, *Hydrogeological Summary Report for 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit*). The unconfined aquifer is present within the Ringold Formation unit E in 100-D, transitioning to the Hanford formation in the Horn and into 100-H. Further details on the unconfined aquifer are provided in Section 3.6 of the 100-D/H RI/FS report (DOE/RL-2010-95).

The RUM is dominated by a fine-grained overbank paleosol facies association that is up to 61 m (200 ft) thick (WHC-SD-EN-TI-132, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*). The silt- and clay-rich RUM has low hydraulic conductivity values relative to the Hanford formation and Ringold Formation unit E. Within the RUM, thin sand-to-gravel layers form

zones with variable hydraulic conductivities that range from low to high and form confined or semiconfined aquifers. This uppermost confined or semiconfined aquifer is the first water bearing unit of the RUM, bounded by the silt and clay of the RUM to the top, and by either a continuation of the RUM or the Ringold lower mud unit below. The presence of a nontransmissive layer, consisting of silt or clay type material, defines the lower boundary of the confined aquifer.

1.4.3 Groundwater Flow

Groundwater in the 100-HR-3 OU flows generally to the east-northeast direction, from 100-D across the Horn, toward 100-H. Flow in 100-H is to the east and northeast, generally towards the river. In the southern and central portions of 100-D, groundwater flows to the northwest, towards the Columbia River. Hydraulic gradients are generally flatter during high river stage (ranging from approximately 0.0014 to 00023) when compared to low river conditions (ranging from approximately 0.0017 to 0.0031).

Operation of P&T systems has created changes in historical groundwater flow direction and velocity throughout 100-HR-3. These changes are expressed as depressions and mounds in the water table, often very localized, affecting the local flow direction and gradient. The flow directions and gradients experienced during low and high river stage have the most effect on contaminant transport in the River Corridor than during transitional periods. The water table contours during high and low river stage are presented on Figures 1-4 and 1-5, respectively. The effect of the P&T system is noticeable where groundwater depressions are present around some DX P&T system extraction wells.

In addition to changes due to remedial actions, daily and seasonal fluctuations in the river stage affect groundwater flow. As would be expected, longer term changes in the river stage produce more extensive and longer observed changes in the water levels, hydraulic gradient, and flow directions in the unconfined aquifer. The high and low river stages, which typically last a few months, affect the groundwater flow near the river and extend some distance inland, depending mostly on geology.

During high river stage periods, the local groundwater gradient magnitude is reduced near the river; the vicinity very near the river may actually exhibit a flow direction reversal, with river water intruding slowly into the aquifer (i.e., seasonal bank storage). In addition, this change (i.e., increased elevation) of the boundary condition causes the groundwater inland of the river to backup during high river stage, thus creating the seasonal rise in groundwater elevation typically observed inland of the river. As the river stage declines following the seasonal freshet, the boundary condition again adjusts, the groundwater gradient steepens toward the river, and velocity increases. This condition continues until the groundwater head again equilibrates with the low river stage condition. Seasonal groundwater elevation transients are observed up to several kilometers inland from the river as the water table and river stage equilibrate, although the magnitude of the increase progressively decreases with distance from the river. Typically, as a result of the change in gradient and velocity as the river stage changes, contaminant concentrations are lower during high river stage and greater during low river stage.

1.4.4 Contaminant Transport in Groundwater

Contaminant transport in groundwater is influenced greatly by the geology of the area. Both Ringold Formation unit E and the Hanford formation are present in the 100-HR-3 OU, within the unconfined aquifer. The RUM underlies the unconfined aquifer and contains relatively thin water bearing units. The geographic distribution and characteristics of these formations have an effect on the migration of groundwater in 100-HR-3 and, as a result, on the transport of contaminants in groundwater, as described in the following subsections.

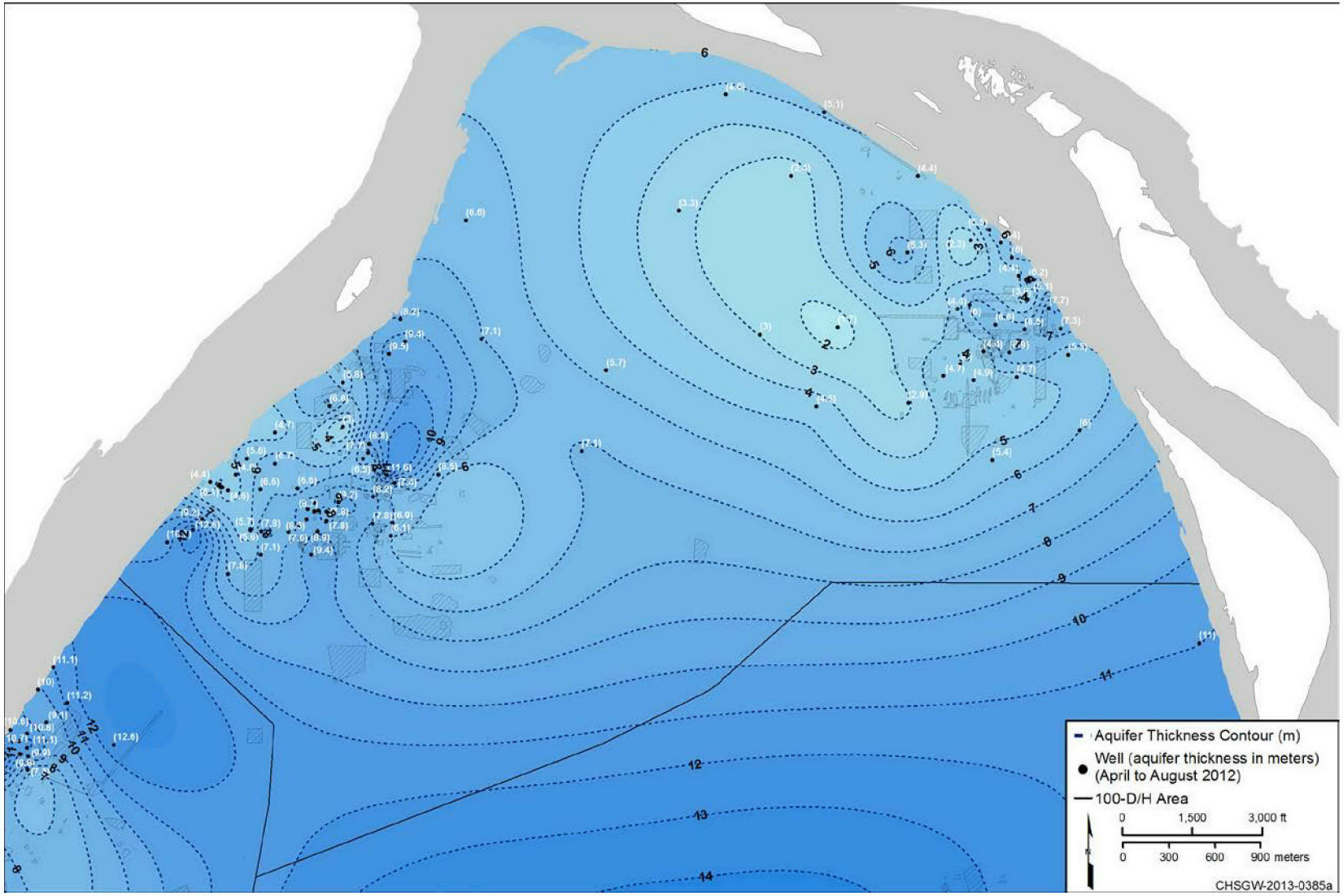
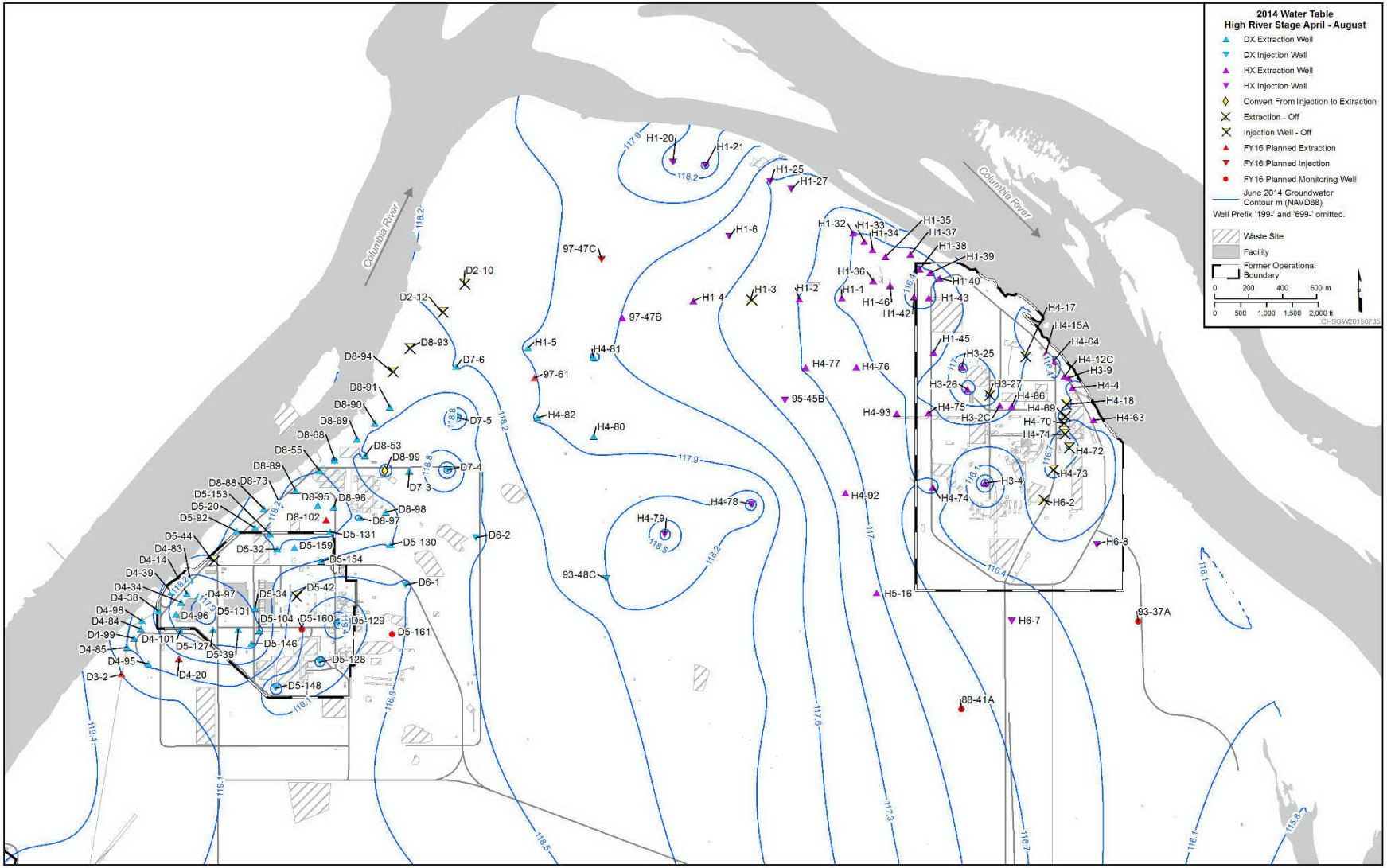
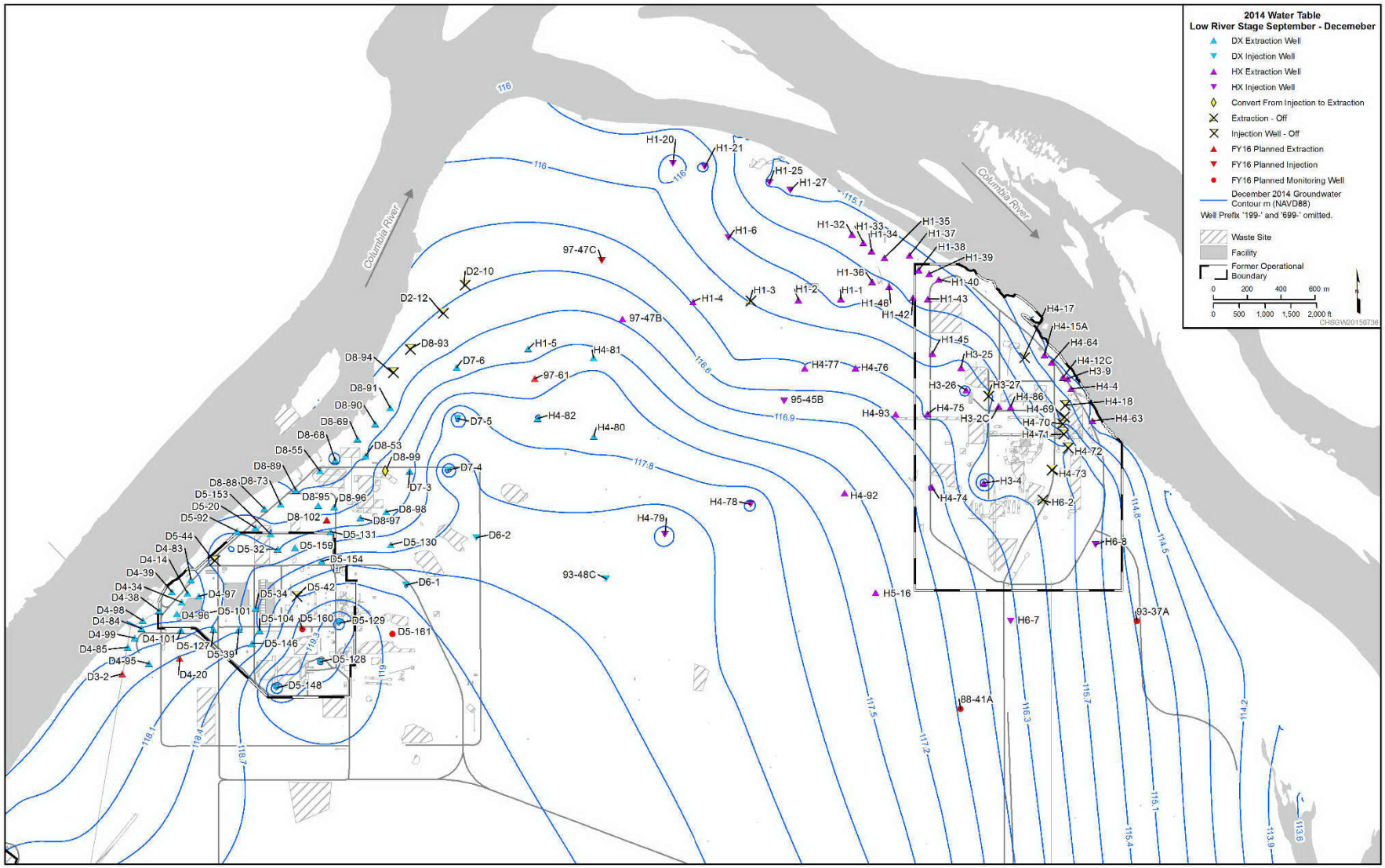


Figure 1-3. 100-HR-3 Operable Unit Unconfined Aquifer Thickness for April to August 2012



Reference: NAVD88, *North American Vertical Datum of 1988*.

Figure 1-4. 100-HR-3 Operable Unit Groundwater Contours at High River Stage



Reference: NAVD88, *North American Vertical Datum of 1988*.

Figure 1-5. 100-HR-3 Operable Unit Groundwater Contours at Low River Stage

1.4.4.1 Unconfined Aquifer

The unconfined aquifer is primarily within the Ringold Formation unit E in 100-D, overlain by the Hanford formation. During historical reactor operations at 100-D and intentional discharges to the 116-DR-1&2 Trench in 1967, cooling water recharge mounds raised the water table above the top of the Ringold Formation unit E and into the more hydraulically conductive Hanford formation, allowing rapid, widespread distribution of contamination. In the unconfined aquifer, the contaminated groundwater followed the natural gradient and migrated across the Horn, towards the east. As groundwater originating in 100-D migrated across the Horn, it spread out in the Hanford formation, causing the large area of moderate to low levels of Cr(VI) contamination currently present.

Across the Horn (inter-area between the 100-D and 100-H Areas), the Hanford formation becomes the primary aquifer, with only pockets of Ringold Formation unit E present. Along the east side of the study area at 100-H, it was previously thought that Ringold Formation unit E was absent, with the unconfined aquifer only present within the Hanford formation (WHC-SD-EN-TI-132; WHC-SD-EN-TI-155, *Geology of the 100-K Area, Hanford Site, South-Central Washington*; WHC-SD-ER-TI-003, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*). More recent geologic information has indicated that Ringold unit E is present in small areas of 100-H (SGW-46279, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*; ECF-Hanford-13-0020, *Process for Constructing a Three-dimensional Geologic Framework Model of the Hanford Site 100 Area*). Therefore, while the dominant geologic unit of the unconfined aquifer is the Hanford formation, small areas are present where the unconfined aquifer is within the Ringold unit E.

1.4.4.2 Contamination into the RUM

A groundwater monitoring well (699-97-48C), completed in the RUM aquifer, has Cr(VI) contamination. Well 699-97-48C is located between two pockets of Ringold Formation unit E, east (downgradient) of the 116-DR-1&2 Retention Basins where large volumes of reactor cooling water were discharged. It is theorized that the presence of the Ringold Formation unit E in that area (Figure 1-6) helped force the mounded groundwater into the channel of Hanford formation material lying between two pockets of Ringold Formation unit E. The elevated hydraulic head formed by the groundwater mounding may have been sufficient to cause contaminated water to migrate into the underlying aquifer within the RUM, resulting in the contamination currently observed in Well 699-97-48C.

During reactor operation, the groundwater mounding in 100-H would have accelerated contamination transport towards the Columbia River, following the natural gradient. The hydraulic head formed during groundwater mounding at 100-H may have forced contamination into the RUM aquifer in this area as well, causing the contamination found in the RUM at 100-H. Additional evidence of this pathway is the fact that the clay/silt material of the RUM between the unconfined aquifer and the first water bearing unit is quite thin in areas of 100-H (only a few feet thick in some wells, such as 199-H4-90) and appears to contain more sand and gravel than is present in 100-D, where the material is nearly all clay and silt.

At 100-H, several wells completed in the first water bearing unit of the RUM currently exhibit Cr(VI) concentrations at levels of about 100 µg/L. These data indicate that in the past, most likely under operational conditions when vertical head gradients were elevated, aquifer intercommunication occurred (as discussed in detail in DOE/RL-2010-95). Current conditions indicate that the confined aquifer may be leaky or connected to the river in some areas. During a constant rate pump test of Well 199-H3-2C (SGW-47776, *Aquifer Testing and Rebound Study in Support of the 100-H Deep Chromium Investigation*), the unconfined aquifer was found to exhibit characteristics of a leaky aquifer, with groundwater levels in adjacent wells showing drawdown in response to pumping of the first water bearing unit in the RUM. This is further supported by the rise of groundwater levels in these wells after the pump

was turned off. The lithologic description in the borehole log suggests that the shallow portion of the RUM unit at Well 199-H3-2C contains a greater percentage of sand, which is the likely cause of the hydraulic connection. The pump test also shows a response to river stage in RUM well 199-H4-12C and piezometer 199-H4-15CS, indicating communication with the Columbia River (DOE/RL-2010-95).

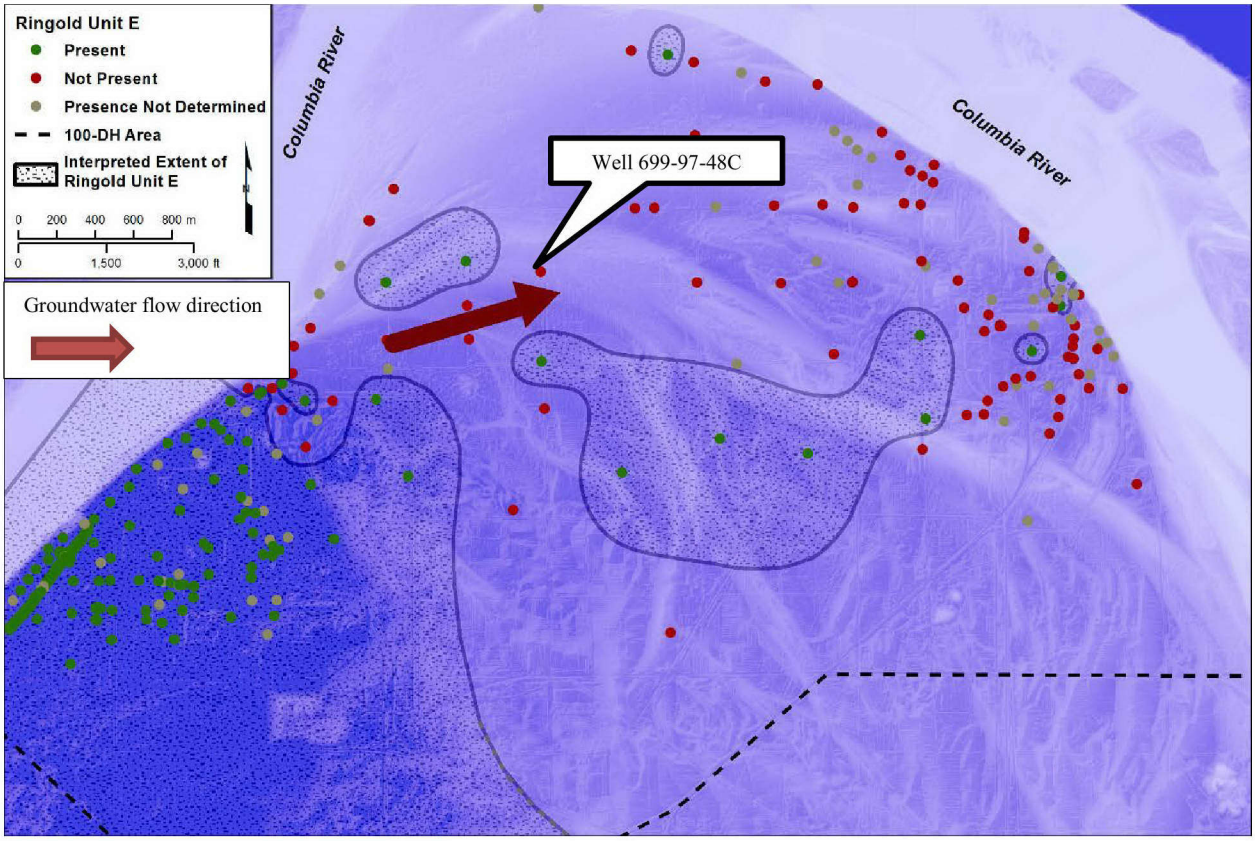


Figure 1-6. Interpolated Presence of Ringold Formation unit E at 100-HR-3

1.4.4.3 Continuing Source Material

The CSM for Cr(VI) in the River Corridor has previously assumed that Cr(VI) moves readily through the vadose zone with the addition of water. Once reaching groundwater, it moved easily within the aquifer regardless of the sodium dichromate concentration of the source. This CSM still appears to be accurate for areas where low concentrations of sodium dichromate were released to the environment, such as with cooling water discharged to the 116-DR-1&2 Trench. However, the recent investigation following the 100-D-100 waste site removal action, which was the result of high-concentration sodium dichromate releases, supports a different CSM. At the 100-D-100 waste site, data indicate that chromium substitute calcite was precipitated in the periodically rewetted zone and within the aquifer sediment. Most of the chromium mass associated with the precipitate is found near the water table and in the upper portion of the aquifer material. The presence of chromium substitute calcite provides a slow leaching source of Cr(VI) to the aquifer, resulting in a long-term secondary source (SGW-58416, *Persistent Source Investigation at the 100-D Area*). The discovery of this mineral led DOE to remove this source material from below the water table at 100-D-100. Removal of this type of secondary source material, where present, has the potential to decrease the time frame and costs of groundwater remediation at these locations.

1.5 Nature and Extent of Contamination

DOE has completed six field investigations within the 100-D/H Area: four limited field investigations (LFIs), one RCRA facility investigation/corrective measures study, and one comprehensive RI/FS report (DOE/RL-2010-95). Results of the LFIs and RCRA investigation are presented in the following documents:

- DOE/RL-93-29, *Limited Field Investigation Report for the 100-DR-1 Operable Unit*
- DOE/RL-93-51, *Limited Field Investigation Report for the 100-HR-1 Operable Unit*
- DOE/RL-94-53, *Limited Field Investigation Report for the 100-HR-2 Operable Unit*
- DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*
- DOE/RL-93-46, *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-2 Operable Unit, Hanford Site, Richland, Washington*

The LFIs provided an initial characterization of the nature and extent of contamination, identified contaminant concentrations in waste sites that were above human health direct contact risk levels, and determined that Cr(VI) in groundwater was above drinking water standards (DWSs) and was entering the Columbia River at concentrations considered toxic to aquatic organisms. Based on these findings and the associated qualitative risk assessments (QRAs), interim remedial actions were implemented in the 100-D/H Area to remediate contaminated soil and treat Cr(VI) contaminated groundwater.

The nature and extent of waste site and groundwater contamination are summarized in the following subsections. The RI/FS (DOE/RL-2010-95) presents a thorough evaluation of the 100-D/H Area nature and extent of contamination.

1.5.1 Waste Site Contamination

Liquid wastes were disposed in basins, cribs, trenches, and ponds. Liquid waste discharged to the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 OU waste sites contained metals, anions, radionuclides, and organic chemicals. Mobile contaminants such as nitrate and Cr(VI) have migrated through the vadose zone to the groundwater. Solid wastes from reactor operations were disposed in burial grounds, at depths up to 8 m (25 ft) below ground surface (bgs). The largest volume of waste from reactor operations was cooling water discharges containing Cr(VI) and radionuclides.

Between 1995 and November 2012, interim remedial actions were completed for 180 waste sites in the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 OUs. Post-cleanup confirmation sampling results at these sites were evaluated and demonstrated that RAOs were met.

Figures 1-7 and 1-8 show facilities and waste site locations where sodium dichromate was handled in 100-D and 100-H, respectively. Interim remedial actions have been completed at the majority of the waste sites associated with sodium dichromate handling and processes. Verification soil data collected from sites where remediation was completed prior to development of a final action ROD were evaluated against groundwater and river protectiveness criteria as part of the RI/FS process. None of these sites was determined to warrant additional remedial action based on potential risk to groundwater or the river.

Verification soil data collected from sites where remediation was completed during development of the final action ROD, or where remediation is currently ongoing, will be evaluated under the framework of an RD/RAWP for the source OUs. A brief overview of these sites and associated data is presented here to provide a contextual understanding of potential sources of groundwater contamination.

In addition to the CERCLA interim remedial actions, three RCRA treatment, storage, and disposal (TSD) units have undergone closure within the 100-D/H Area. These closures were conducted under the following plans:

- 1997 – DOE/RL-97-48, *183-H Solar Evaporation Basins Postclosure Plan* (unit has been closed and is in modified post-closure care)
- 1999 – DOE/RL-92-71, *100-D Ponds Closure Plan* (clean closure)
- 2004 – DOE/RL-90-25, *105-DR Large Sodium Fire Facility Closure Plan* (units have been closed)

The soil and associated structures for these TSD units have met the closure actions for closure under RCRA. Potential groundwater contamination from the 183-H Solar Evaporation Basins TSD unit includes Cr(VI), nitrate, and uranium. P&T system modification in the area near the basins may be implemented through this RD/RAWP to provide capture.

100-D-73. The 100-D-73 waste site consists of the footprint of the former 108-D Building where concentrated Cr(VI) solution was initially prepared during historical operations. Remediation of the site extended up to 5.5 m (18 ft) bgs, including removal of localized stained concrete with 3,020 mg/kg Cr(VI). No significant Cr(VI) inventory remains after interim remediation and reclassification of the site have been completed.

100-D-77. The 100-D-77 waste site consists of the footprint of the former 183-DR facility, used for water treatment for the 105-DR Reactor, including handling, storage, and injection of sodium dichromate. Remediation included the former head house and yard area, where sodium dichromate and sulfuric acid solutions were stored, and the sample room area, where sodium dichromate was injected into cooling water. Remediation extended to a maximum depth of 9.5 m (31 ft) bgs in the head house area, and encountered no significant Cr(VI) contamination. Interim remediation and reclassification of the site have been completed.

100-D-30. The 100-D-30 waste site addresses residual sodium dichromate contamination in soil and concrete rubble associated with the former 185-D facility sodium dichromate trench and mixing tanks. During remediation, Cr(VI) contamination was detected in concrete and soils underlying the facility. Remediation of the site has extended to the groundwater interface, with Cr(VI) contamination detected throughout the soil column.

100-D-104. The 100-D-104 waste site addresses an area of vadose zone contamination, including Cr(VI), discovered immediately southeast of the former 185-D Building and 100-D-30 waste site. Initial observations and analytical results at this site were suggestive of multiple historical releases, including both sodium dichromate and sulfuric acid, though released concentrations or quantities are unknown. The most likely source of the releases is a former acid neutralization French drain located in the immediate area. Additionally, an external sodium dichromate storage tank was located nearby and may have had releases to the drain or immediate vicinity. Remediation of the site has extended to the groundwater interface, based on observed Cr(VI) contamination in soils, joining with the adjacent 100-D-30 excavation. These sites were historical sources of groundwater contamination.

100-D-100. The 100-D-100 waste site addresses an area of stained soil discovered adjacent to the former railroad spur servicing the 183-DR Head House. The stained area is near the former railcar unloading station (100-D-12 waste site) but on the opposite (southern) side of the former railroad junction. Remediation of the site has revealed significant Cr(VI) soil contamination and depth, ultimately extending to the groundwater interface. This site is a historical source of groundwater contamination.

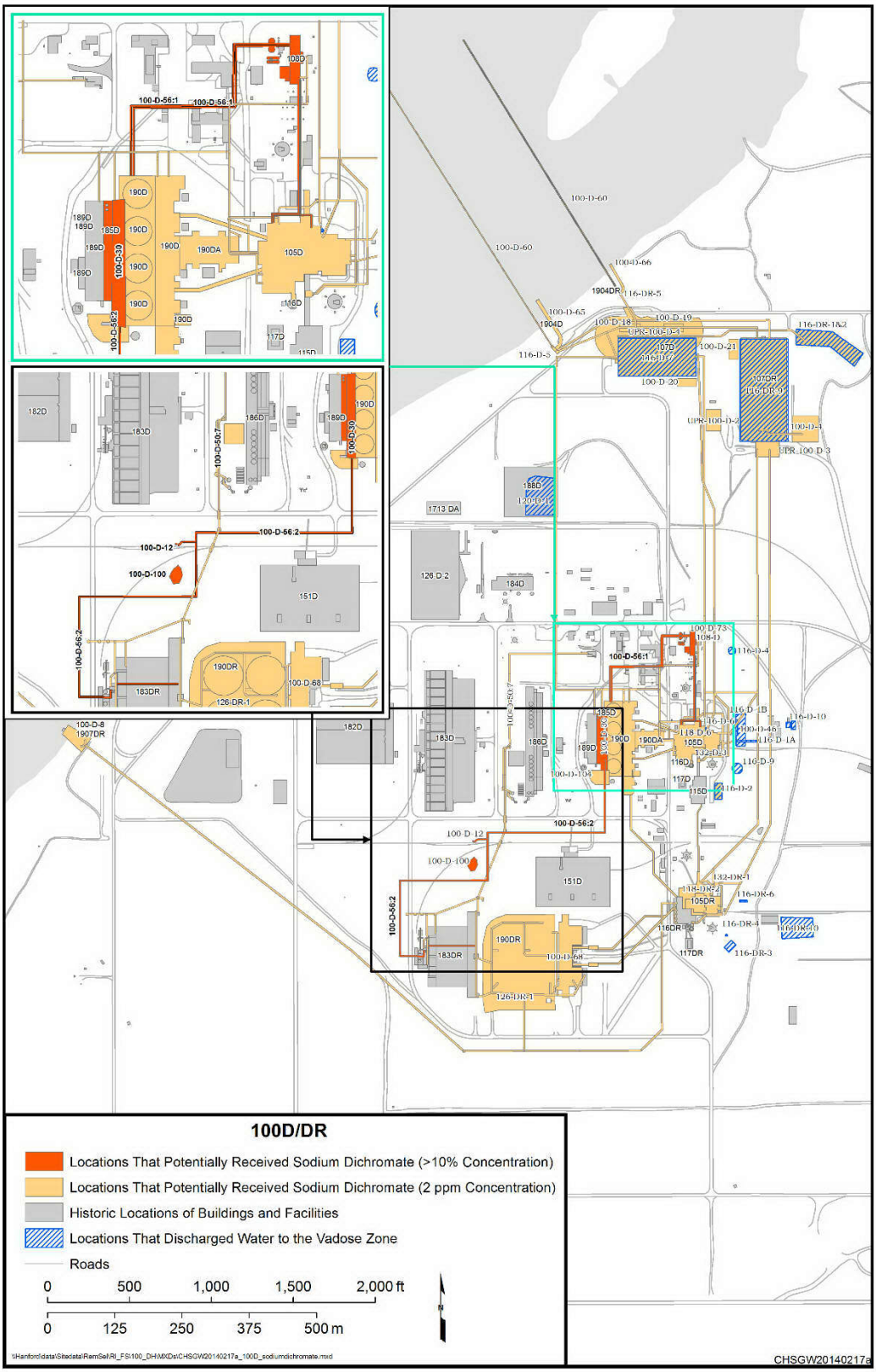


Figure 1-7. Facilities and Waste Sites Where Sodium Dichromate was Handled at 100-D

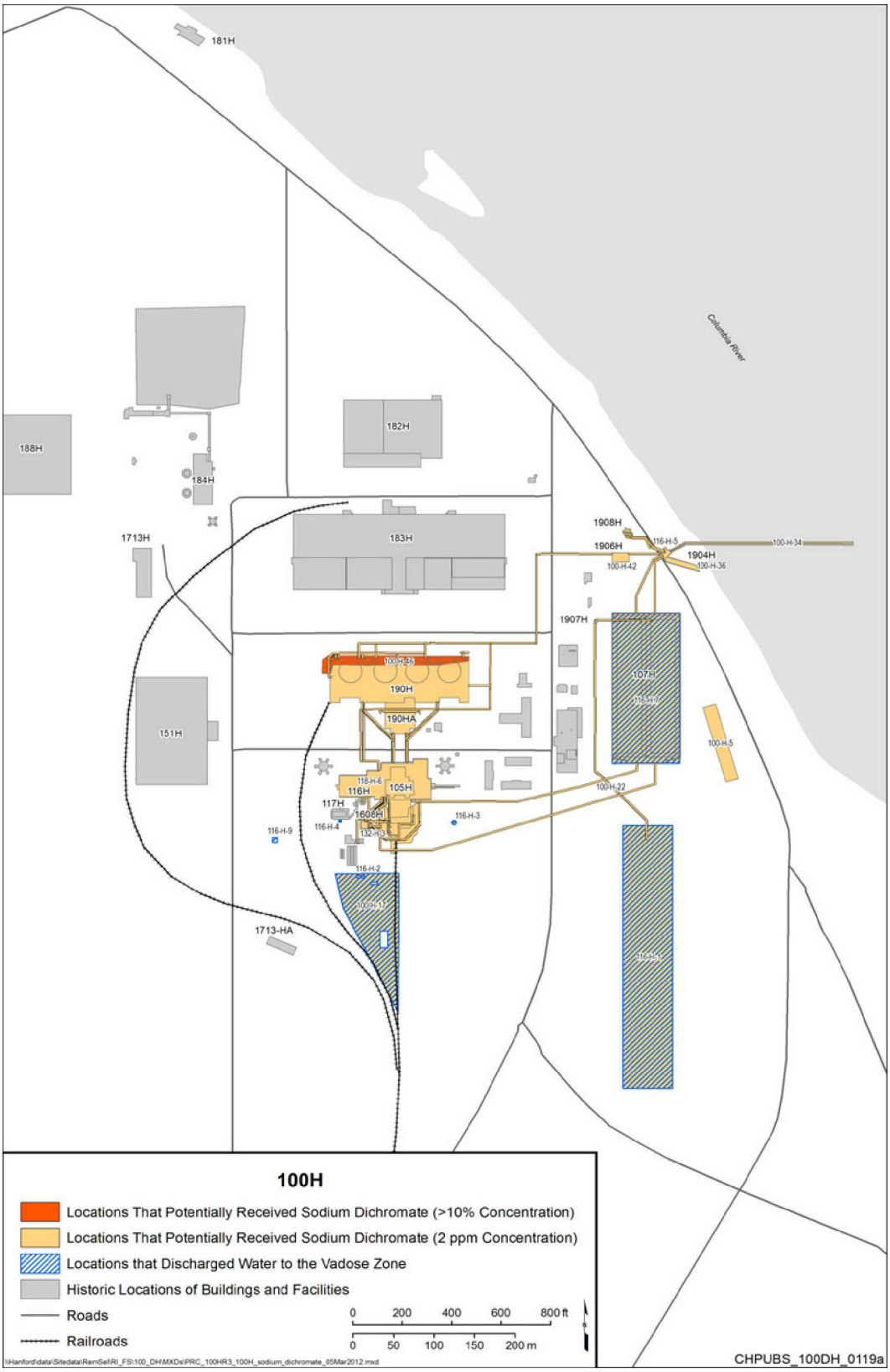


Figure 1-8. Facilities and Waste Sites Where Sodium Dichromate was Handled at 100-H

100-H-46. The 100-H-46 waste site consisted of contaminated soils, concrete structures, and drain pipes beneath the former 190-H Main Process Pump House sodium dichromate process equipment, piping, unloading dock, and railroad spur. Stained concrete was identified during remediation of residual structural components, but no substantial soil contaminant plume was identified. Remediation extended to the groundwater interface at a portion of the site based on Cr(VI) detections above the soil cleanup level. Interim remediation and reclassification of the site have been completed.

The intent of waste site remediation is to remove any continuing contaminant contributions from the vadose zone. Ongoing waste site remediation activities provide additional information for source characterization. With the removal of these vadose zone sources, a reduction in groundwater contaminant levels is anticipated, dependent on the rate at which Cr(VI) is flushed through the aquifer to the ongoing P&T system.

1.5.2 Groundwater Contamination

The principal groundwater contaminant for the 100-HR-3 OU is Cr(VI). The interim action ROD (EPA/ROD/R10-96/134) identified nitrate, strontium-90, tritium, uranium, and technetium-99 as co-contaminants in the 100-HR-3 OU. Total chromium, strontium-90, and nitrate are identified as groundwater contaminants in the 100-D/H RI/FS report (DOE/RL-2010-95). Cr(VI) contamination in groundwater is associated with reactor cooling water discharges to the retention basins and trenches, and unplanned releases (UPRs) of concentrated sodium dichromate solutions in product transfer areas. Sodium dichromate handling and cooling water discharge locations, which were the sources of Cr(VI), are identified in the 100-D/H RI/FS report (DOE/RL-2010-95) and shown on Figures 1-7 and 1-8.

Groundwater remediation by extraction and treatment was initiated in 1997 under the interim action ROD (EPA/ROD/R10-96/134) with startup of the first P&T system. The objective of remediation was to remove contamination from groundwater and address immediate threats to the Columbia River. The initial two P&T systems (DR-5 and HR-3) were expanded under an interim action ROD ESD (EPA et al., 2009) to include additional treatment capacity.

The interim action ROD amendment approved installation of an ISRM barrier, a new technology for treating Cr(VI) contaminated groundwater in the 100-D Area. The barrier did not achieve the required level of performance and resulted in a determination from Ecology and EPA that expansion of the P&T system was to be used to provide a protective remedy for this area.

Cr(VI) is the groundwater contaminant of concern (COC) that the selected remedy targets. The following sections discuss four groundwater Cr(VI) plumes that make up the 100-HR-3 OU. The groundwater Cr(VI) plumes discussed include the southern and northern plumes in the 100-D Area, the plume across the Horn, and the 100-H Area plume in the eastern portion of 100-D/H (DOE/RL-2011-118, *Hanford Site Groundwater Monitoring for 2011*). The plume discussions identify the sources, concentrations, and plume characteristics.

Cr(VI) plume located in the southern portion of 100-D. This plume (Figure 1-9) is being partially intercepted and treated using ISRM technology (Figure 1-10). An area hydraulically upgradient of the ISRM barrier with elevated Cr(VI) concentrations and the plume area downgradient of the ISRM barrier are being remediated using P&T technology in the DX system. This area of Cr(VI) contamination is referred to as the southern plume and has the highest concentrations of Cr(VI) at the Hanford Site.

The southern plume generally migrates to the west, toward and through the ISRM treatment zone. Data for wells within the ISRM treatment zone indicate that a northern section of the ISRM barrier is not treating all of the Cr(VI) reaching the barrier in this area. Barrier breakthrough of Cr(VI) resulted in a determination from Ecology and EPA that expansion of the P&T system was to be used to provide a

protective remedy for this area (11-AMCP-0002, "Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Washington July 2010, Memo to File Regarding: Supplemental Actions for the In-Site Reduction/Oxidation Manipulation Barrier Performance for the 100-HR-3 Groundwater Operable Unit Interim Remedy").

Remediation at waste site 100-D-100, associated with a UPR, extended to groundwater and removed the vadose zone source material. An investigation of the interaction of Cr(VI) contamination in the vadose zone, aquifer sediment, and groundwater was conducted during the remediation. Results of the investigation are summarized in SGW-58416. The investigation recommended excavation of the upper aquifer material, approximately 3.3 m (10 ft) below the top of the water table at low river state, to remove persistent source material. Groundwater monitoring results indicated effective source removal. This area was a primary source of the 100-D south area Cr(VI) plume.

Cr(VI) plume located in the northern portion of 100-D. The northern plume is being remediated using P&T technology in the DX system. A single waste site has not yet been identified (as of July 2014) that coincides with the area of higher concentrations at the 100-D northern plume. However, remediation at the 100-D-104/100-D-30 waste site, associated with the 185-D/190-D facilities, continued to groundwater with removal of the vadose zone source. The 100-D-104/100-D-30 waste site appears to be a main contributor to the 100-D north area Cr(VI) plume. Another potential source was waste site100-D-73 associated with the 108-D Building.

Separation of groundwater contamination into discrete northern and southern plumes has been attributed, in large part, to chronic leakage of raw water from the 182-D Reservoir and associated piping. Until 2004, the 182-D Reservoir chronically leaked enough to sustain a local water table mound that created a "clean zone" between the northern and southern plumes in 100-D. This mound appears to have diverted groundwater flow north and south of the 182-D Reservoir, with corresponding diversion and local dilution of contaminants in groundwater. These leaks and their effect on groundwater flow have diminished since the reduction of storage volume in the reservoir in 2004. The current level of leakage has localized influences on groundwater flow, which are partially masked by flow changes created by nearby P&T activities (DOE/RL-2011-25, *Calendar Year 2010 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations and 100-NR-2 Groundwater Remediation*). Updated in 2012, HNF-5828, *Hanford Site Water System Master Plan*, calls for maintaining the export water system over the life of the Hanford Site cleanup mission. The near-term goals identified for 2016 through 2035 include installing vertical drive turbine pumps to bypass the 182-D Reservoir, allowing for closure of the facility. No specific time frame is specified for closure of the 182-D Reservoir.

The northern plume is larger than the southern plume and migrates generally to the north and northwest. The long-term persistence of Cr(VI) concentrations in the northern plume suggests the presence of a continuing source, possibly in the vadose zone.

Cr(VI) plume that extends across the Horn, between 100-D and 100-H. The Cr(VI) plume that extends through the Horn and 100-H Area is shown on Figure 1-11. Groundwater in the Horn generally exhibits much lower Cr(VI) concentrations than those found in the 100-D plumes. The Horn has very few waste sites; therefore, Cr(VI) detected in the groundwater likely migrated across the Horn from 100-D rather than having originated from local releases.

The portion of this plume in the Horn, referred to as the Horn plume, is currently undergoing interim remediation using wells associated with both the DX and the HX P&T systems. The plume is large and diffuse in comparison to the plumes in 100-D and 100-H. Cr(VI) sources in 100-D appear to be the primary contributors to groundwater contamination in the unconfined aquifer in the Horn area, based on the apparent groundwater flow direction northeast and east from 100-D toward 100-H.

A contributor to groundwater contamination at 100-D/H Area was the infiltration test at the 116-DR-1&2 Trench conducted in 1967 (BNWL-CC-1352, *Ground Disposal of Reactor Coolant Effluent*). The large volume of cooling water discharged to the 116-DR-1&2 Trench infiltrated the vadose zone, reaching the water table and expanding the groundwater mound already present from reactor operations. This created high hydraulic head conditions, forcing the water to migrate from the Ringold Formation unit E at 100-D into the Hanford formation of the Horn.

Local artificial recharge conditions caused by discharges of contaminated cooling water from these trenches and leaks from the retention basins resulted in buildup of extensive groundwater mounds in the unconfined aquifer beneath the reactor operating areas at 100-D and 100-H. Monitoring well hydrographs from 100-D and 100-H indicate that wastewater infiltration elevated groundwater levels as much as 10 m (33 ft) at 100-D and 7 m (21 ft) at 100-H. These extensive mounds altered groundwater flow patterns and groundwater velocity for years and account for the observed current distribution of groundwater contaminants across the entire width of the Horn area from 100-D to 100-H.

Cr(VI) plume located in the 100-H Area. The Cr(VI) plume at 100-H is characterized by much lower concentrations than the 100-D plumes. Figure 1-12 shows the 100-H plume. Cr(VI) was detected at a concentration of 90.8 μg/L in Well 199-H4-86 on November 15, 2013, the maximum concentration in the unconfined aquifer within the 100-H Reactor Area. Facilities and waste sites associated with former sodium dichromate handling are potential sources of Cr(VI) contamination.

This plume, referred to as the 100-H plume, is being remediated using P&T technology in the HX system. The Cr(VI) plume at 100-H was originally from a combination of sources within 100-H and the Cr(VI) plume migrating from 100-D, across the Horn. As discussed previously, infiltration tests at the 116-DR-1&2 Trench contributed to plume migration and groundwater contamination across 100-D/H Area.

Other contaminant of potential concern (COPCs) that are present at the 100-HR-3 OU include nitrate, strontium-90, uranium, and technetium-99. Plume maps and discussion of these contaminants are presented in the 100-D/H RI/FS (DOE/RL-2010-95) and the 2012 annual groundwater report (DOE/RL-2013-22, *Hanford Site Groundwater Monitoring Report for 2012*).

Status of IAROD Compliance Wells. Table 1-1 provides the status of the compliance wells that were originally designated for monitoring under the interim action ROD and interim action ROD amendment. Some of the wells continue to be used for performance monitoring, while several are now part of the P&T network. Changes in use for the compliance wells (e.g., conversion to an extraction well) are identified in the annual P&T reports.

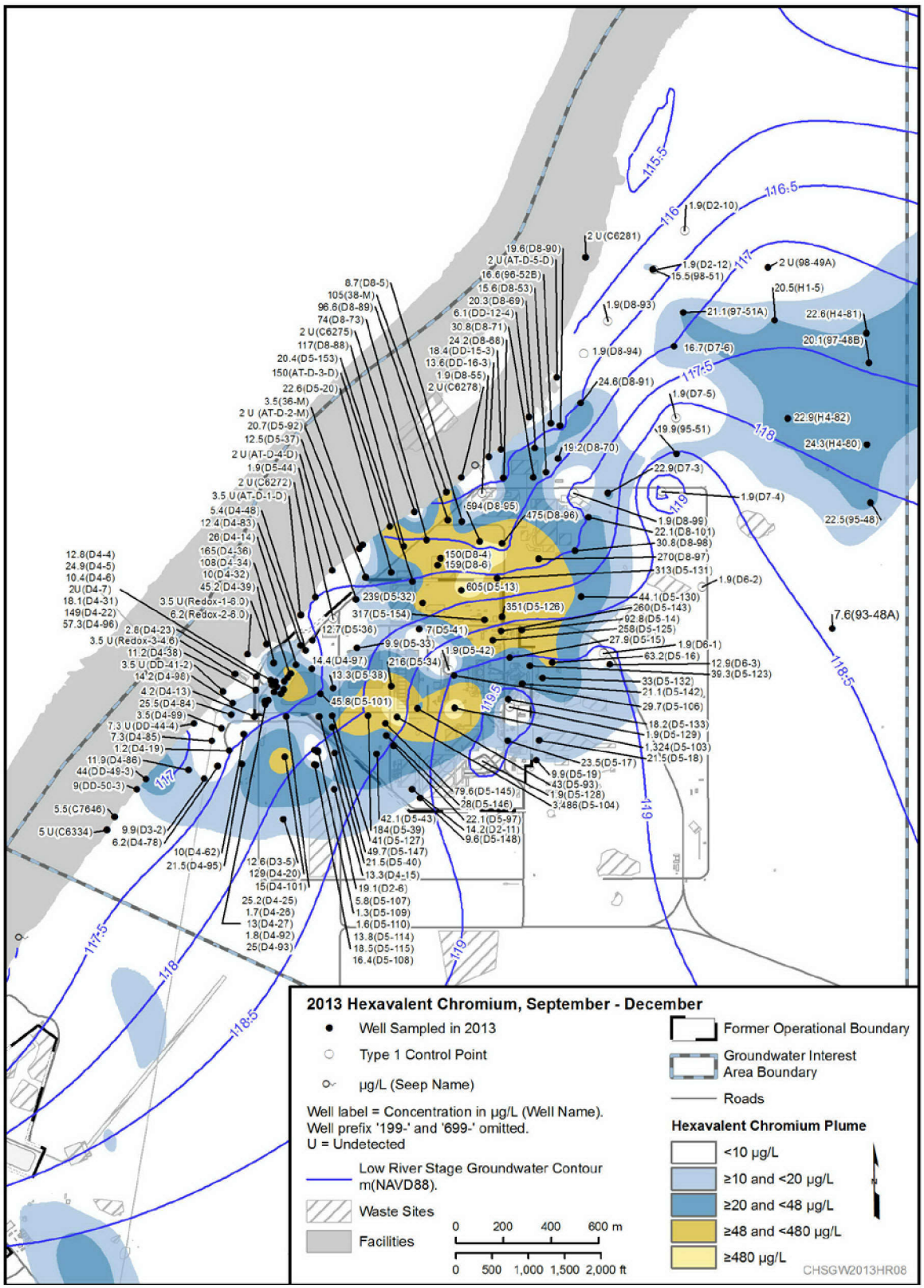


Figure 1-9. Hexavalent Chromium Plume in the 100-D Area for 2013 – Low River Stage

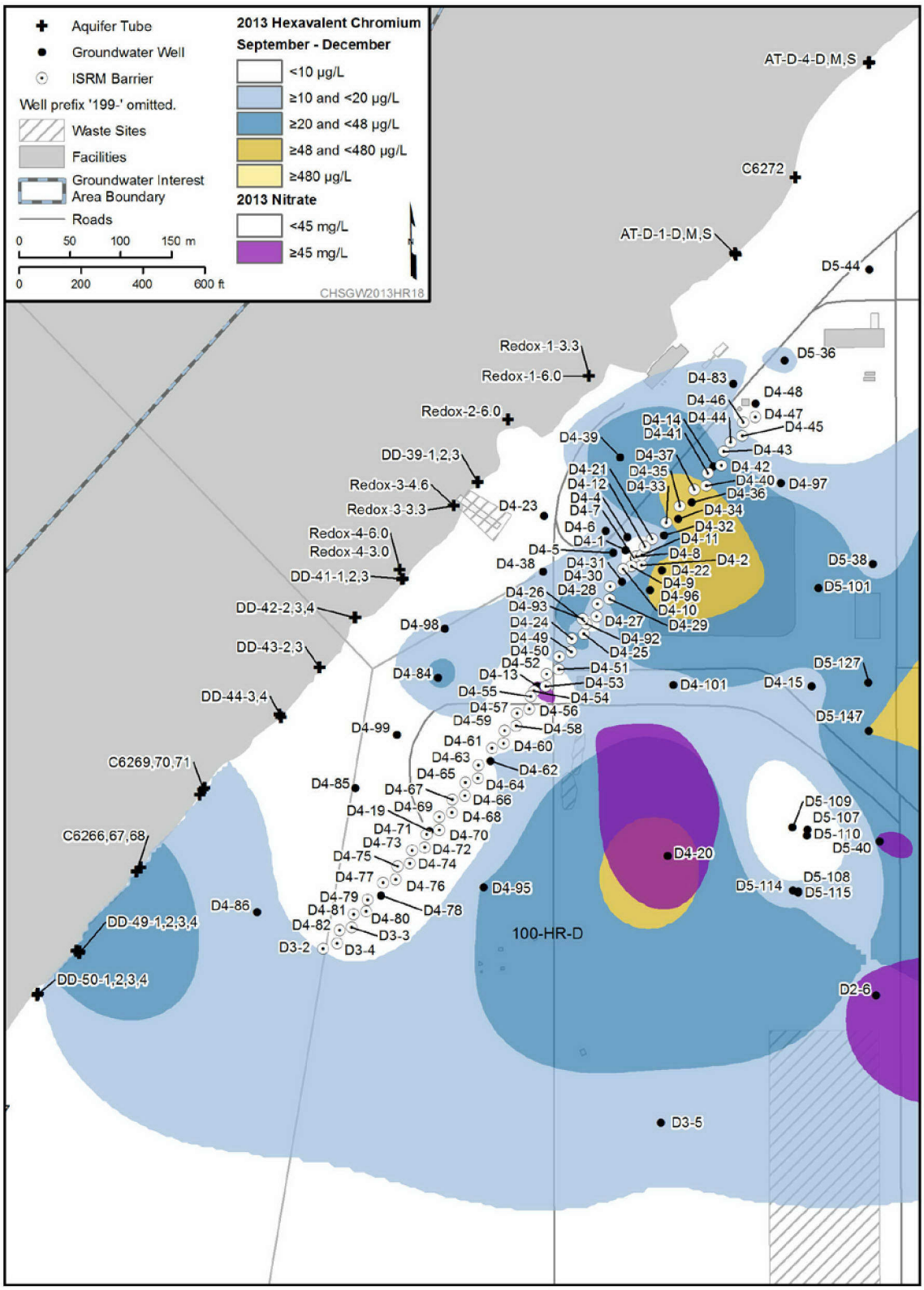


Figure 1-10. Well Network near the In Situ Redox Manipulation Barrier

Table 1-1. Status of 100-HR-3 Interim Action Compliance Wells

Well Number	Original Use	Current Use
199-D8-68	100-HR-3 Interim Action Compliance Well[a]	Decommissioned (2/28/06)
199-D8-69	100-HR-3 Interim Action Compliance Well[a]	DX Extraction Well
199-D8-70	100-HR-3 Interim Action Compliance Well[a]	Monitoring Well
199-H4-4	100-HR-3 Interim Action Compliance Well[a]	HX Extraction Well
199-H4-5	100-HR-3 Interim Action Compliance Well[a]	Monitoring Well
199-H4-63	100-HR-3 Interim Action Compliance Well[a]	HX Extraction Well
199-H4-64	100-HR-3 Interim Action Compliance Well[a]	HX Extraction Well
199-D4-23	ISRM Interim Action Compliance Well[b]	Monitoring Well
199-D4-38	ISRM Interim Action Compliance Well[b]	DX Extraction Well
199-D4-39	ISRM Interim Action Compliance Well[b]	DX Extraction Well
199-D4-83	ISRM Interim Action Compliance Well[b]	DX Extraction Well
199-D4-84	ISRM Interim Action Compliance Well[b]	DX Extraction Well
199-D4-85	ISRM Interim Action Compliance Well[b]	DX Extraction Well
199-D4-86	ISRM Interim Action Compliance Well[b]	Monitoring Well

ISRM = in-situ redox manipulation

a. Specified in DOE/RL-96-84, Rev. 0A, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*.

b. Specified in DOE/RL-2003-63, *Sampling and Analysis Plan for In Situ Redox Manipulation Project*.

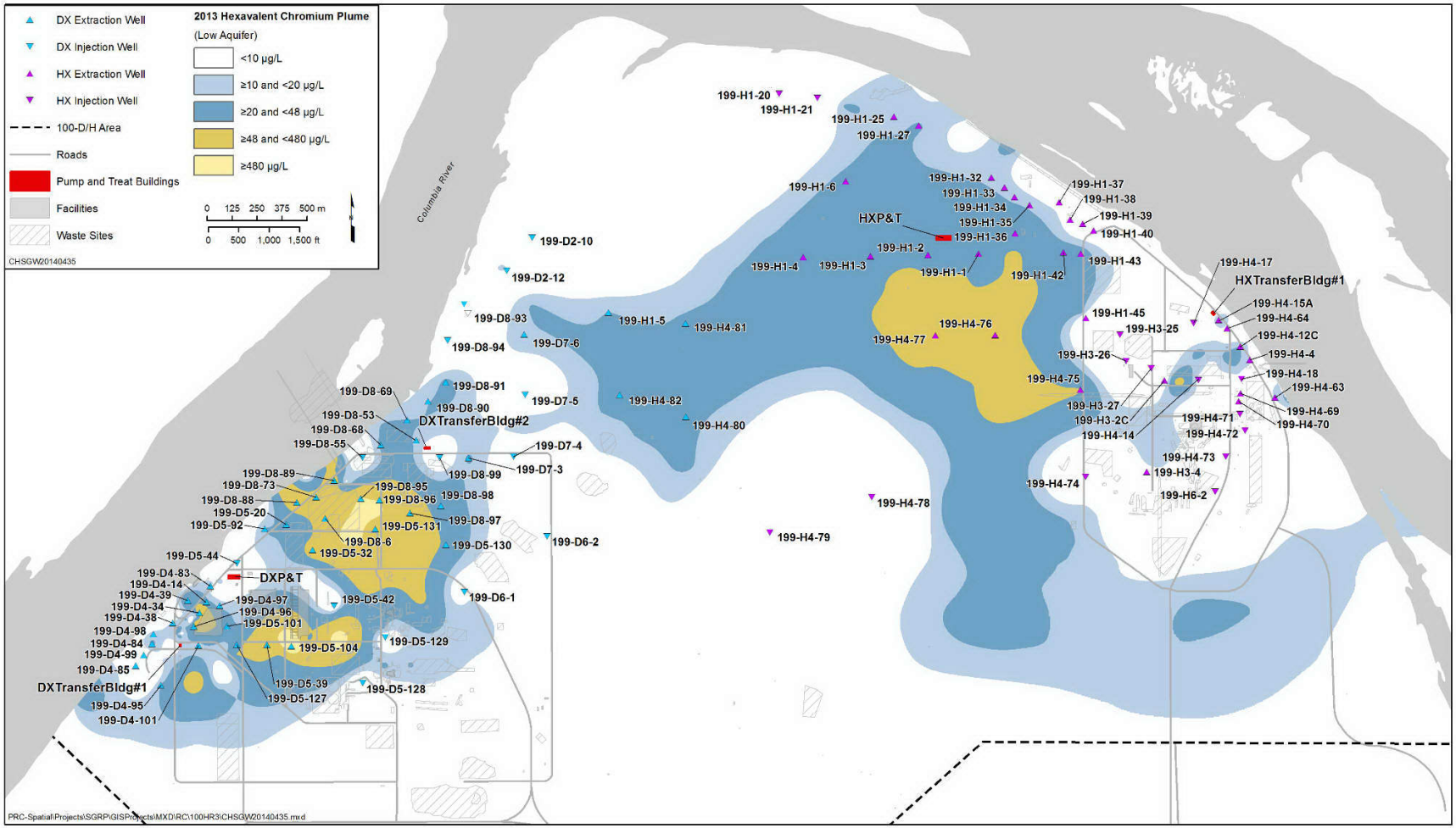


Figure 1-11. Hexavalent Chromium Plume in the 100-D/H Area for 2013 – Low River Stage

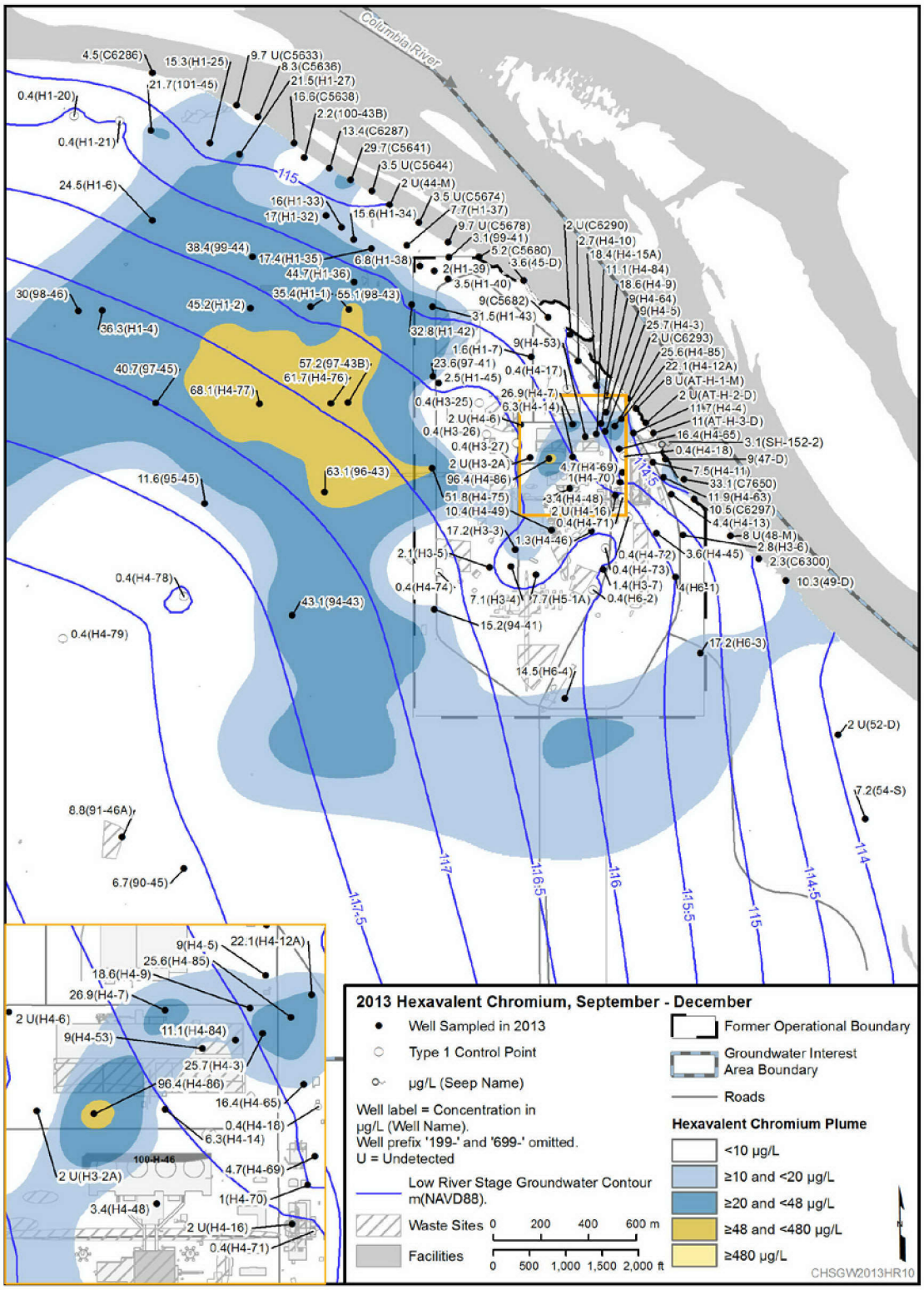


Figure 1-12. Hexavalent Chromium Plume in the 100-H Area for 2013 – Low River Stage

This page intentionally left blank.

2 Basis for Remedial Action

A QRA, performed as part of the LFI (DOE/RL-93-43), determined the principal risk drivers at the 100-HR-3 OU. The QRA also qualitatively evaluated human health and environmental risks to help determine if the OU was a candidate for an interim remedial action. The QRA evaluated risks for a predefined set of human and environmental exposure scenarios. If the estimated risks exceeded certain thresholds, interim remedial actions were considered necessary to reduce the risks posed by the contaminants. The QRA used groundwater data from the first four rounds of LFI sampling. The data were evaluated for consistency and compliance with EPA data management guidance.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected, presented an imminent and substantial endangerment to public health, welfare, or the environment. Groundwater contaminated with chromium was identified in the 100-D/H reactor areas at concentrations in excess of ecological-based risk thresholds. The groundwater also discharges to the Columbia River primarily via upwelling through the river bottom, an environment known to be critical to sensitive ecological receptors such as embryonic salmon. Concentrations of several contaminants existed in groundwater at the OU that exceeded human health levels.

The selected interim remedy protects human health and the environment (HHE) through groundwater remediation and ICs. The interim remedial action is reducing the concentration of Cr(VI) in plume areas and the overall size of the plumes, thereby reducing potential adverse effects to the Columbia River. These actions provide site-specific performance information that is used to evaluate alternative technologies, determine optimum process sizing, and estimate costs. The interim remedial actions are expected to be consistent with final remedial actions.

2.1 Selected Remedy

P&T technology was selected by the interim action ROD (EPA/ROD/R10-96/134) as the interim remedy for 100-HR-3. The interim action ROD amendment (EPA/AMD/R10-00/122) selected in situ chemical treatment through installation of an ISRM barrier as an additional interim remedy for remediation of a Cr(VI) groundwater plume west of the 100-D/DR Reactors (100-D Area) within the 100-HR-3 OU. As the lead agency, DOE implemented these interim remedies within the 100-HR-3 OU in accordance with the RDR/RAWPs (DOE/RL-96-84, Rev. 0 and Rev. 0A; DOE/RL-99-51).

Changes to the interim actions were implemented through the ESDs (EPA/ESD/R10-03/606; EPA et al., 2009), a Non-Significant Change (11-AMCP-0002), and Tri-Party Agreement-Change Notices (TPA-CNs) to both the RD/RAWP and associated waste management plan (DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*). These documents provide information used for interim remedy designs and details for the expansions and modifications to the existing interim remedies.

This RD/RAWP presents a consolidation of the interim remedies performed under the previous decisions and implementing documents, and supersedes previous RD/RAWP documents. The interim remedial actions are intended to continue until the observed groundwater contamination conditions meet the interim RAOs or the interim actions systems are replaced by final remedial actions.

2.1.1 Interim Remedial Action History

Table 2-1 summarizes previous investigations, interim remedial actions, and other activities in the 100-HR-3 OU. Additional details about the project history and remedial performance are provided in DOE/RL-2015-05, *Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation.*

Table 2-1. Chronological Summary of CERCLA Actions and Associated Activities at the 100-HR-3 Groundwater Operable Unit

Month/Year	Activity	Documentation
August 1994	A pilot-scale P&T system was deployed as a treatability test.	DOE/RL-94-54, *Pilot-Scale Treatability Test Plan for the 100-HR-3 Operable Unit*
September 1994	A qualitative risk assessment was completed, identifying Cr(VI) as a contaminant of concern for ecological receptors in the Columbia River.	DOE/RL-93-43, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*
August 1995	The proposed plan recommended the use of a P&T system as an interim remedial action to mitigate Cr(VI) migration into the Columbia River.	DOE/RL-94-67, *100-HR-3 Operable Unit Focused Feasibility Study* DOE/RL-94-102, *Proposed Plan for Interim Remedial Measure at the 100-HR-3 Operable Unit*
December 1995	The pilot scale treatability test report indicated that removing Cr(VI) from extracted groundwater in the 100-HR-3 OU using a resin treatment IX system was viable.	DOE/RL-95-83, *The Pilot-Scale Treatability Test Summary for the 100-HR-3 Operable Unit*
April 1996	The interim action ROD (EPA/ROD/R10-96/134) specified installing a P&T system in the 100-HR-3 OU to intercept portions of the Cr(VI) plumes that affect the Columbia River.	EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*
September 1996	The RD/RAWP was issued and identified the design and work to accomplish the interim remedial action using P&T.	DOE/RL-96-84, Rev. 0, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
April 2003	This RD/RAWP revision included an updated requirement for an annual report and an addendum with a summary of major modifications made to the systems since they went online in 1997.	DOE/RL-96-84, Rev. 0A, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
July 1997	The HR-3 P&T system began full-time operation in the northern plume (100-D) and the 100-H plume, using a common treatment building in 100-H. The HR-3 P&T system processes the extracted groundwater through an IX system that removes the Cr(VI) and returns the treated groundwater to the aquifer in 100-H. The IX system resin is regenerated offsite.	TPA (Ecology et al., 1989a) Milestone M-16-06B

Table 2-1. Chronological Summary of CERCLA Actions and Associated Activities at the 100-HR-3 Groundwater Operable Unit

Month/Year	Activity	Documentation
September 1997	The ISRM treatability test was initiated using one well. By fall 1999, the treatment zone in the treatability test area had been extended to include six treatment wells. The success of these six treatment wells provided sufficient data to support advancing from treatability testing to emplacing a large-scale treatment zone.	PNNL-13349, *100-D Area In Situ Redox Treatability Test for Chromate-Contaminated Groundwater*
October 1999	An amendment to the interim action ROD (EPA/AMD/R10-00/122) modified the selected remedial action by authorizing deploying an innovative treatment technology (ISRM) to address the Cr(VI) in the southern plume (100-D). The southern plume is not within the treatment zone for the HR-3 P&T system interim action.	EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*
July 2000	The RDR/RAWP was issued to implement the ISRM technology. A three-year, three-phase emplacement schedule was developed. Phase I of the large-scale deployment of the ISRM technology was initiated in FY 2000. Phase II was initiated in FY 2001, and Phase III was initiated in FY 2002. The permeable reactive barrier was completed in fall 2004.	DOE/RL-99-51, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*
April 2003	An ESD was issued to provide notice of revisions to the project schedule and cost estimate associated with the ISRM remedial action. The ESD allowed use of the ISRM pond and provided requirements for decommissioning the pond.	EPA/ESD/R10-03/606, *Explanation of Significant Difference for the 100-HR-3 Operable Unit Record of Decision, Hanford Site, Benton County, Washington*
July 2004	The DR-5 P&T system began operation in the southern and northern plumes (100-D). The DR-5 P&T system processes the extracted groundwater through an IX system that removes the Cr(VI) and returns the treated groundwater to the aquifer in 100-D. The IX system resin is regenerated onsite.	DOE/RL-2005-18, *Calendar Year 2004 Annual Summary Report for the 100-HR-3, 100-KR-4, and 100-NR-2 Operable Unit Pump-and-Treat Operations*
September 2008	Identifies and summarizes RPO activities conducted in FY 2008 and proposed for FY 2009 to systematically evaluate and enhance the interim remedial actions for the 100-D Area.	SGW-38338, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document*
August 2009	An ESD was issued to provide notice of revisions to the cost estimate and reinjection locations associated with the P&T interim action. An expansion of the P&T system was identified in the future cost estimate. The ESD also revised the re-injection standards and location requirements for treated water.	EPA et al., 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site, Benton County, Washington*

Table 2-1. Chronological Summary of CERCLA Actions and Associated Activities at the 100-HR-3 Groundwater Operable Unit

Month/Year	Activity	Documentation
March 2010	The RI/FS work plan was approved. Field work began for drilling 25 boreholes and installing 15 monitoring wells; 5 trenches were completed, and 5 aquifer tubes were installed. Field work was completed in April 2011.	DOE/RL-2008-46-ADD1, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 1: 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*
March 2010	The RI/FS sampling and analysis plan was approved.	DOE/RL-2009-40, *Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study*
December 2010	The DX P&T system began operating.	12-AMCP-0036, "Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-016-111C By December 31, 2011"
March 2011	The DR-5 P&T system was shut down after operating since July 2004. The total volume of groundwater treated was 386 million L (102 million gal), with removal of 336.9 kg (742.7 pounds) of Cr(VI).	
May 2011	The HR-3 P&T system was shut down after operating since June 1997. The total volume of groundwater treated was 4,171 million L (1,102 million gal), with removal of 405.6 kg (892.4 pounds) of Cr(VI).	
October 2011	The HX P&T system began operating.	11-AMCP-0049, "Completion of Hanford Federal Facility and Consent Order (Tri-Party Agreement) Milestone M-016-111B Due December 31, 2010"
November 2012	Summary of DOE Actions Meeting Milestone M-016-110-T01.	12-AMRP-0172, "Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Target Milestone M-016-110-T01, 'DOE Shall Take Actions Necessary to Contain or Remediate Hexavalent Chromium Groundwater Plumes in Each of the 100 Area National Priority List Operable Units Such That Ambient Water Quality Standards for Hexavalent Chromium are Achieved in the Hyporheic Zone and River Water Column'"

Table 2-1. Chronological Summary of CERCLA Actions and Associated Activities at the 100-HR-3 Groundwater Operable Unit

Month/Year	Activity	Documentation
September 2014	100-D/H RI/FS Report (Rev. 0) was issued.	DOE/RL-2010-95, *Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*
2016*	TPA milestone for DOE to implement remedial actions selected in all 100 Area Records of Decision for Groundwater Operable Units so that no contamination above DWSs or ambient water quality standards enters the Columbia River unless otherwise specified in a CERCLA decision due by 12/31/2016.	TPA (Ecology et al., 1989a) Milestone M-016-110-T04 (Ecology et al., 1989a)
2020*	TPA milestone for DOE to take actions necessary to remediate hexavalent chromium groundwater plumes such that hexavalent chromium will meet drinking water standards in each of the 100 Area NPL operable units due by 12/31/2020.	TPA (Ecology et al., 1989a) Milestone M-016-110-T02 (Ecology et al., 1989a)

* Indicates a planned future activity when this document was prepared.

Cr(VI)	=	hexavalent chromium	OU	=	operable unit
DOE	=	U.S. Department of Energy	RAWP	=	remedial action work plan
DWS	=	drinking water standard	RD	=	remedial design
ESD	=	explanation of significant difference	RI/FS	=	remedial investigation/feasibility study
FY	=	fiscal year	ROD	=	record of decision
ISRM	=	in situ redox manipulation	RPO	=	remedial process optimization
IX	=	ion exchange	TPA	=	Tri-Party Agreement

2.1.2 DR-5 and HR-3 Pump and Treat System Operations

The HR-3 P&T system began operation in 1997 under the interim action ROD (EPA/ROD/R10-96/134), which selected 9 extraction wells and a withdrawal rate of 225 gallons per minute (gpm) for the 100-H Area and 10 extraction wells and an extraction rate of 100 gpm for the 100-D Area. The 100-H Area and 100-D Area were selected to have three and five injection wells, respectively. The HR-3 P&T system began operating in 1997 in the 100-H Area, and the DR-5 P&T system began operating in July 2004 in the 100-D Area. The DR-5 P&T system began operation as a treatability test facility and was then placed into service for groundwater treatment. There was not a decision document specific to DR-5 implementation.

The DR-5 and HR-3 P&T systems pumped over 1,203 million L (317.9 million gal) and removed over 744 kg (1,640 lb) of Cr(VI) from groundwater during operations. Table 2-2 lists the total volume of water treated and the mass of chromium removed by each system. Figures 2-1 and 2-2 show the monthly groundwater treatment rate and Cr(VI) removal over the lifetime of the systems.

Table 2-2. DR-5 and HR-3 Interim Action P&T Systems

Performance	DR-5	HR-3
Dates of Operation	2004 to 2011	1997 to 2011
Groundwater Processed (million L/million gal)	101.50/26.81	1,101.91/291.09
Mass of Hexavalent Chromium Removed (kg/lb)	338/745	406/895

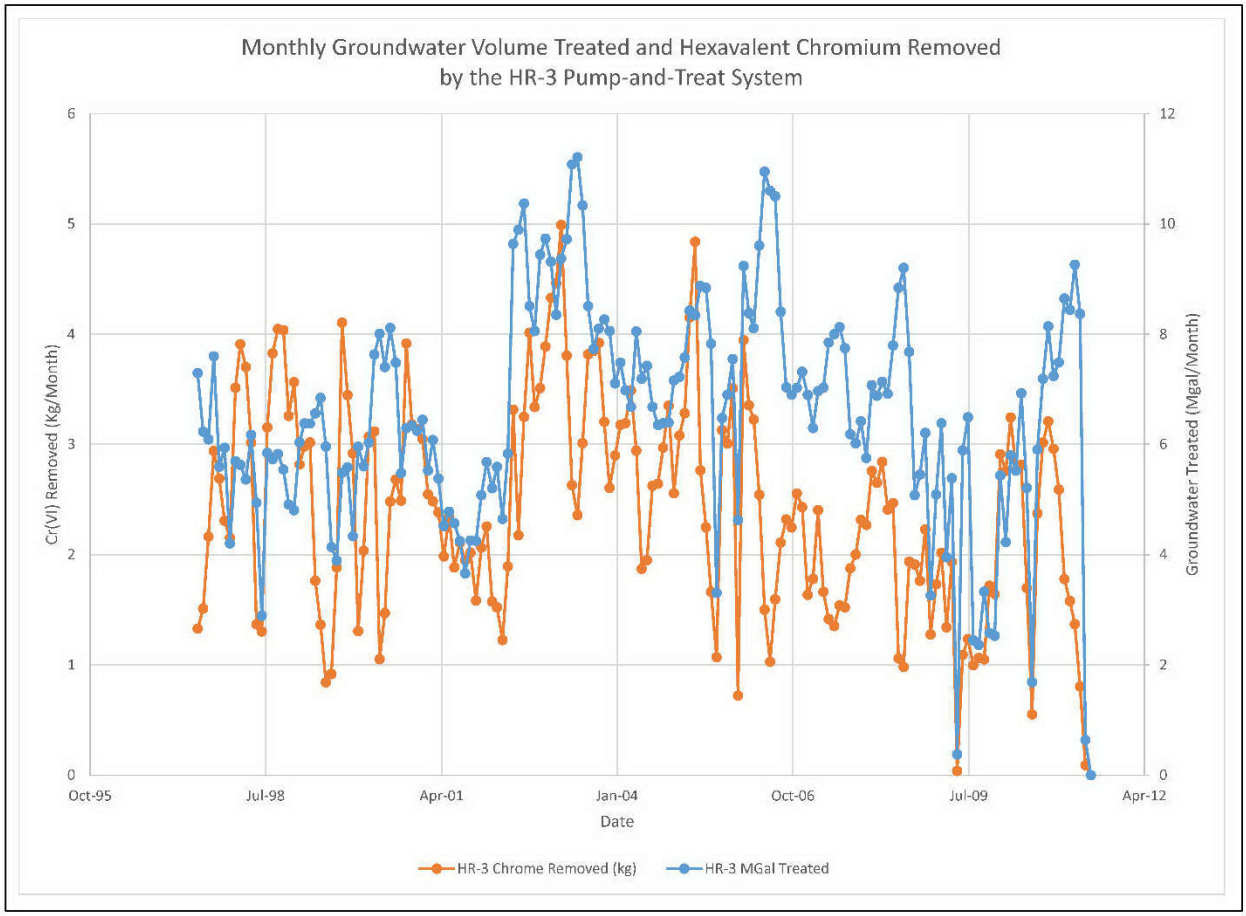


Figure 2-1. Monthly Cr(VI) Removed and Groundwater Volume Treated by the HR-3 P&T System

In 2000, an interim cleanup action began using ISRM technology. Use of this technology was approved by the interim action ROD amendment (EPA/AMD/R10-00/122). The purpose of the ISRM was chemical reduction of Cr(VI) to trivalent chromium (Cr(III)).

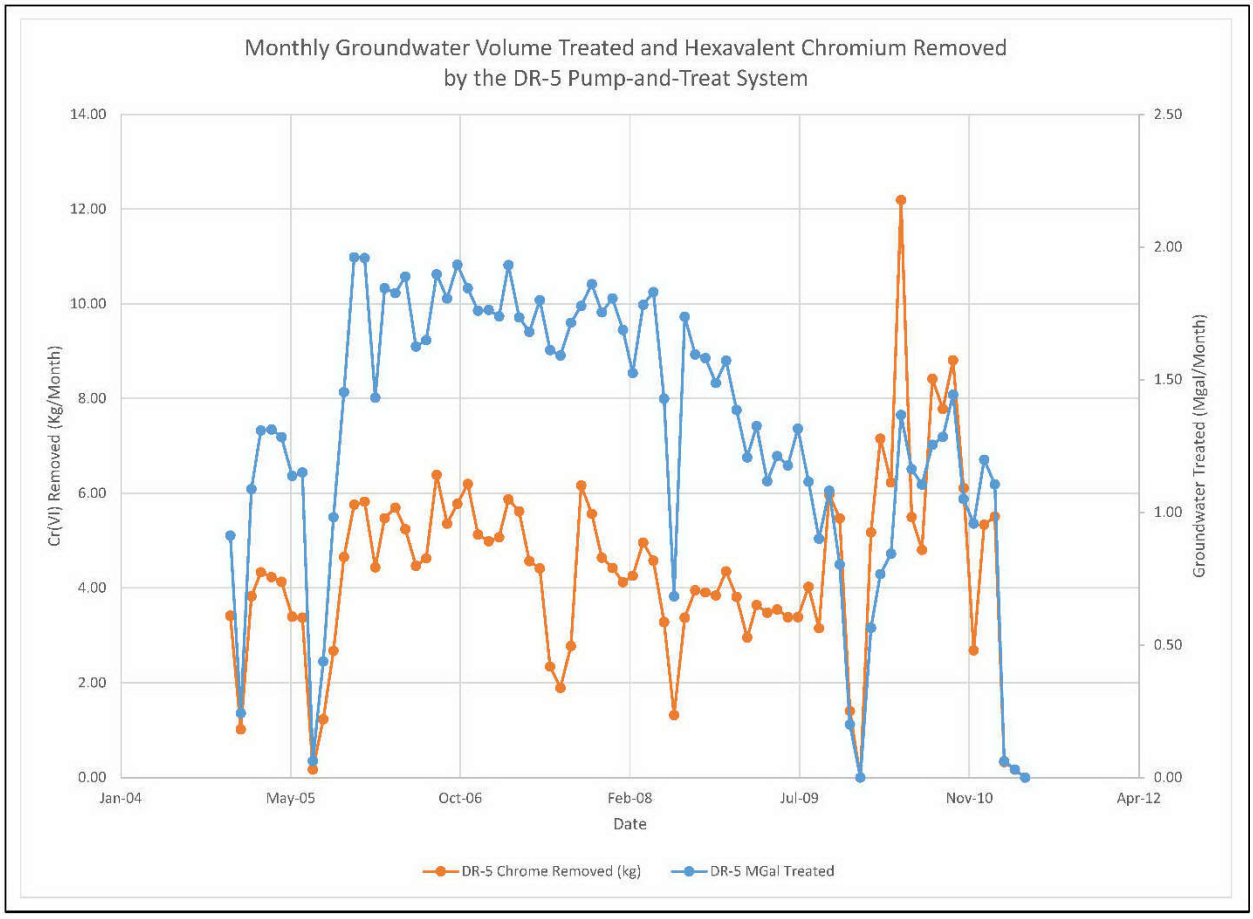


Figure 2-2. Monthly Cr(VI) Removed and Groundwater Volume Treated by the DR-5 P&T System

To meet TPA interim milestones and target dates (Table 2-1) and comply with interim action RAOs, several activities were initiated in 2008. A remedial process optimization (RPO) study was started to determine how to optimize the remedial strategy and provide continuing improvement of Cr(VI) remediation in the 100-HR-3 OU by 2012 (SGW-38338, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document*). RPO activities included refinement of the CSM, system performance evaluation, technology screening, alternative development, groundwater modeling, decision analyses, optimization of system O&M, and optimization of long-term monitoring. These activities are reviewed annually in a report on remedy status. Current status for the M-016-110-T01 milestone was provided on November 14, 2012 (12-AMRP-0172, "Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Target Milestone M-016-110-T01, 'DOE Shall Take Actions Necessary to Contain or Remediate Hexavalent Chromium Groundwater Plumes in Each of the 100 Area National Priority List Operable Units Such That Ambient Water Quality Standards for Hexavalent Chromium are Achieved in the Hyporheic Zone and River Water Column'").

The ESD (EPA et al., 2009) also recognized that the interim action has a limited scope that is focused on Cr(VI), and it identified multiple remedial actions currently underway for cleanup at 100-D/H and indicated that final decisions will address co-contaminants not targeted by the interim remedial action.

The RPO review recommended implementing additional P&T system capacity to address the Cr(VI) groundwater concentrations that still exceed cleanup levels established in the interim action ROD and

interim action ROD amendment. The regulatory basis for the expansion is documented in the August 2009 ESD (EPA et al., 2009).

2.1.3 DX and HX Pump and Treat Systems

Because of additional investigations following installation of the HR-3 and DR-5 systems, the extent of the Cr(VI) plume was revised and two new P&T systems were designed for hydraulic control and Cr(VI) mass removal to protect the Columbia River. The DX system began operating in December 2010, and the HX system began operating in October 2011. The DX and HX systems are designed to provide treatment capacity of 2,300 L/min (600 gpm) and 3,000 L/min (800 gpm), respectively. The combined systems have pumped over 2,559 million L (676 million gal) and removed over 1,549 kg (3,415 lb) of Cr(VI) between startup and June 30, 2015. Table 2-3 lists the total volume of water treated and the mass of Cr(VI) removed by each system. The total number of extraction and injection wells is also shown in the table. Summaries of the monthly volume of groundwater treated and Cr(VI) removed for the DX and HX P&T systems are shown in Figures 2-3 and 2-4, respectively.

Table 2-3. DX and HX Interim Action P&T Systems

Performance	DX	HX
Date of Operation	December 2010 to June 30, 2015	October 2011 to June 30, 2015
Groundwater Processed (million L/million gal)	1,325.96/350.28	1,233.46/325.85
Mass of Hexavalent Chromium Removed (kg/lb)	1,445/3,186	104/229
Wells*		
Number of Extraction Wells	44	30
Number of Injection Wells	10	14

* System status as of June 30, 2015.

These expanded systems were installed as upgrades for the HR-3 and DR-5 P&T systems, which were shut down in May 2011 and March 2011, respectively. Groundwater and system performance monitoring data are evaluated for the DX and HX well networks to identify and manage system upgrades for optimization of groundwater cleanup activities. Ongoing RPO includes modifications to the remedy (DX/HX systems) that are made periodically to improve capture, remove mass, and generally improve system performance in meeting the remedy goals. The RPO process considers and evaluates the following information:

- Source area data
- Groundwater monitoring data
- Updated contaminant fate and transport modeling results
- Extraction/injection well performance data

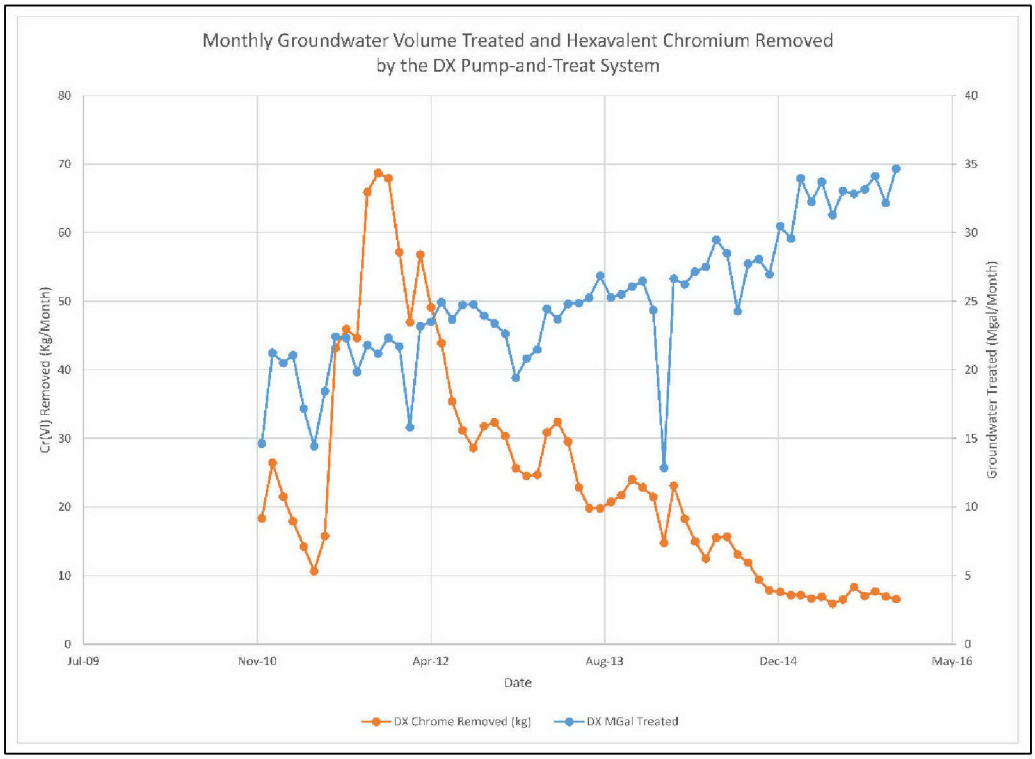


Figure 2-3. Monthly Cr(VI) Removed and Groundwater Volume Treated by the DX P&T System

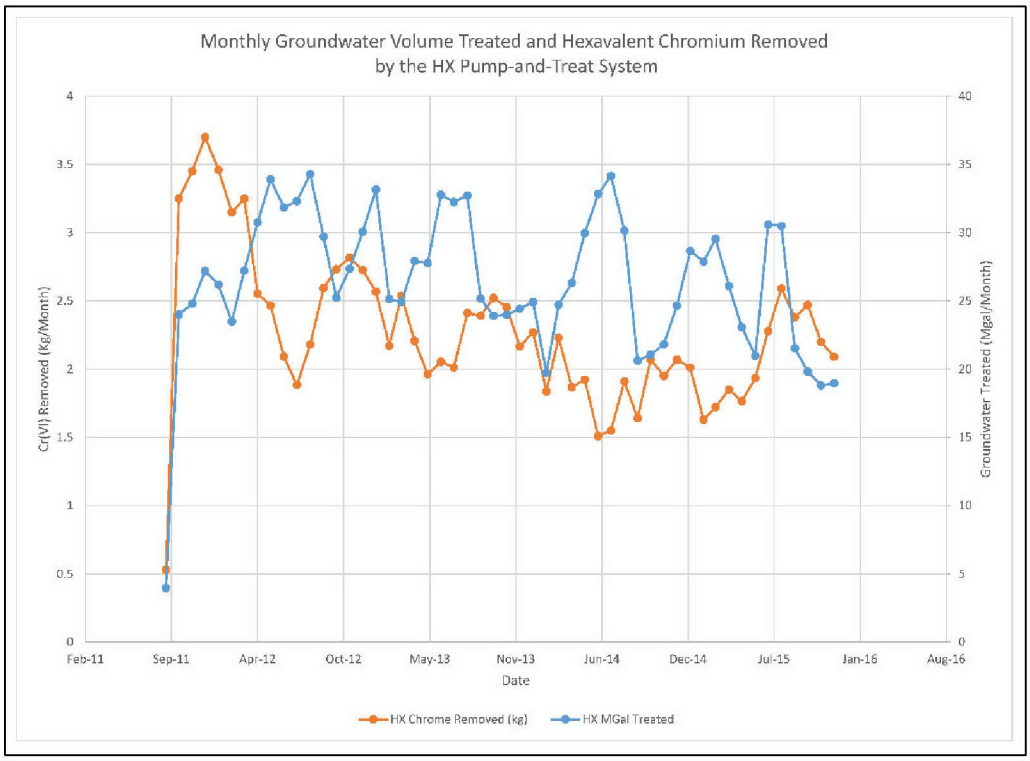


Figure 2-4. Monthly Cr(VI) Removed and Groundwater Volume Treated by the HX P&T System

Action items may include any combination of system realignment, such as installing/removing extraction/injection/compliance wells, converting injection wells to extraction wells or vice versa, changing extraction/injection rates, and removing contamination from source areas to eliminate contaminant contributions to groundwater. Changes to the P&T systems are identified in the annual P&T reports.

2.1.4 In Situ Redox Manipulation Barrier

Prior to installation of the DX P&T system, additional cleanup action was deemed necessary in the southern portion of the 100 D Area. As approved by the 1999 interim ROD amendment, an in situ chemical treatment technology was applied in 2000. The permeable reactive barrier (PRB) uses ISRM technology to create a treatment zone in which ferric iron (iron III) is reduced to ferrous iron (iron II) within the aquifer sediments. This is accomplished by injecting sodium dithionite ($Na_2S_2O_4$) into the aquifer through wells and then withdrawing the unreacted reagent and reaction products. The sodium dithionite serves as a reducing agent for iron, changing ferric iron (iron III) to ferrous iron (iron II), and producing a reducing environment. As groundwater migrates through the treatment zone, mobile Cr(VI) is reduced to less toxic and less mobile Cr(III), which precipitates from solution. The iron reduction of Cr(VI) occurs through the following reaction:

$$6Fe^{+2}+Cr_2O_7^{=}+14H^{+}\rightarrow 6Fe^{+3}+2Cr^{+3}+7H_2O$$

Due to breakthrough of contaminants at the ISRM barrier, a letter of nonsignificant change to the ROD was issued in 2010, which indicated that the barrier would no longer be actively maintained (11-AMCP-0002). The notice of nonsignificance shifted the groundwater remedy at the ISRM barrier to the P&T system. Groundwater at the ISRM site is still monitored as part of CERCLA interim action monitoring, with Cr(VI) as the target contaminant. Where it is still active, the barrier treatment process reduces oxygen content in the aquifer; consequently, dissolved oxygen (DO) is also monitored.

2.1.5 Institutional Controls

The 100-HR-3 OU interim ROD (EPA/ROD/R10-96/134) requires ICs during the interim action to prevent human exposure to contaminated groundwater. The interim action ROD amendment includes a provision that identifies ICs are unchanged from the interim action ROD. ICs are instruments (e.g., administrative and/or legal restrictions) designed to control or eliminate specific pathways of exposure to contaminants. Groundwater use is restricted until cleanup levels are achieved. DOE/RL-2001-41, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*, hereinafter called the Sitewide IC Plan, identifies the current ICs for the Hanford Site. It also describes how ICs are implemented and maintained, serving as a reference point for selecting ICs in the future. The Sitewide IC Plan (DOE/RL-2001-41) was updated to include the requirements selected in the 100-HR-3 OU interim action ROD and interim action ROD amendment.

The following ICs are included in the Sitewide IC Plan (DOE/RL-2001-41) for the 100-HR-3 OU:

- Access Controls—Access control is the selective restriction of access to a place or other resources. The term access control refers to the practice of permitting authorized access or denying unauthorized access to facilities. At the Hanford Site, access controls include warning notices, entry restrictions, and fences.

- Entry Restrictions—DOE strives to prevent entry into waste sites in accordance with Condition II M of *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, hereinafter called the RCRA Permit, IC requirements of the CERCLA decision documents, and applicable work plans. Entry restrictions are ICs that prevent or limit access to particular geographical areas. Procedural requirements are in place to restrict entry to Hanford waste sites.

- Land Use Management—DOE restricts the use of land on waste sites and prohibits activities that would interfere with the remedial activity in accordance with the IC requirements of the CERCLA decision documents and as described in applicable work plans. DOE prohibits activities that would damage the monitoring systems and its components identified in the CERCLA decision documents. Such monitoring systems could include wells and systems monitoring engineered barrier performance. Land-use management ICs include land-use and real property controls, site evaluation requirements, and excavation permits.

ICs in the Sitewide IC Plan (DOE/RL-2001-41) were implemented per the following EPA guidance documents:

- EPA-540-R-09-001, *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites* (OSWER 9355.0-89)
- EPA-540-R-09-002, *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites* (OSWER 9200.0-77)

In addition to the ICs identified above, locks are maintained on wells to prevent unauthorized access. ICs are inspected annually, and the results are documented in the facility operating record or logbook.

2.2 Remedial Action Objectives

The 100-HR-3 OU interim action ROD and interim action ROD amendment include the following RAOs:

- Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River.
- Protect human health by preventing exposure to contaminants in the groundwater.
- Provide information that will lead to the final remedy.

The interim action ROD specifies that the first RAO will be achieved using P&T along and inland of the river shoreline to intercept the Cr(VI) plumes and prevent discharge of Cr(VI) to the Columbia River substrate at concentrations exceeding those that are considered protective of aquatic life. Results of groundwater monitoring from monitoring wells and aquifer tubes are evaluated to identify locations where Cr(VI) plumes discharge to surface water. To meet the RAO, extraction wells are placed to intercept these plumes and prevent discharge. The interim action ROD amendment specifies that the first RAO will be achieved using a series of injection wells to form a permeable barrier to intercept the southern Cr(VI) plume (100-D).

Achievement of the second RAO is obtained using ICs. ICs are in place to prevent removal of contaminated groundwater for consumptive purposes and to restrict access to areas where exposure to groundwater (i.e., seeps and springs) may occur.

The third RAO is achieved by evaluating the interim actions using site-specific data. These evaluations are used to identify the following items:

- Treatment system costs
- Treatment efficiency (e.g., resin performance, well extraction, and injection)
- Hydraulic impacts (e.g., changes to groundwater gradients)
- Effectiveness of contaminant removal from the aquifer

These evaluations are provided in the annual groundwater monitoring and P&T reports, such as DOE/RL-2015-07, *Calendar Year 2014 Hanford Site Annual Groundwater Monitoring Report*, and DOE/RL-2015-05.

In addition, approaches to remediation through application of other technologies (i.e., zero valent iron [ZVI] injection to the ISRM and biostimulation treatability tests with molasses and emulsified vegetable oil) have been evaluated. Information on these technologies and the results of testing are provided in the following:

- ZVI injection (DOE/RL-2008-49, *Treatability Test Plan for Injecting Zero-Valent Iron Into an In Situ Redox Manipulation Well*; DOE/RL-2009-35, *Treatability Test Report on Mending the In Situ Redox Manipulation Barrier Using Nano-Size Zero Valent Iron*).
- Biostimulation treatability testing (PNNL-17619, *Hanford 100-D Area Biostimulation Soluble Substrate Field Test: Interim Data Summary for the Substrate Injection and Process Monitoring Phases of the Field Test*; PNNL-18784, *Treatability Test Results Hanford 100-D Area Biostimulation Treatability Test Results*)

Potential co-contaminants identified in the interim action ROD for the 100-HR-3 OU included nitrate, strontium-90, tritium, uranium, and technetium-99. Groundwater monitoring for the 183-H Solar Evaporation Basins RCRA permit includes Cr(VI) (measured as total chromium using filtered samples) and nitrate as dangerous waste constituents, and fluoride, technetium-99, and uranium as waste indicators. The interim actions are designed to address Cr(VI) contamination in groundwater.

The 100-D/H RI/FS (DOE/RL-2010-95) presents results from an evaluation of temporal and spatial groundwater monitoring data. The RI/FS evaluation concluded that Cr(VI), total chromium, nitrate, and strontium-90 are COCs for the 100-HR-3 OU. COPC and COC concentrations will continue to be evaluated and it is anticipated future remedial actions may be identified, if needed, to address these contaminants.

Appendix A provides a summary of the decision document requirements and implementing methodology for meeting the requirements. The interim action ROD and interim action ROD amendment further specify that the first RAO pertains to discharge of Cr(VI) to the Columbia River. The interim actions include monitoring groundwater near the river to determine system performance in meeting the RAO for protection of the Columbia River. Cr(VI) concentrations in samples from wells are compared to the remedial action goals (RAGs) to determine if the remedial actions are effective. The wells for monitoring the 100-HR-3 OU interim actions are identified in DOE/RL-2013-30. Aquifer tube data, collected following procedures in DOE/RL-2000-59, *Sampling and Analysis Plan for Aquifer Sampling Tubes*, are also used to monitor Cr(VI) concentrations in groundwater discharges to the river.

2.3 Remedial Action Goals

The RAG for the interim actions is to achieve a concentration of less than 20 µg/L Cr(VI) in groundwater for the P&T system compliance wells and the ISRM barrier compliance wells. This Cr(VI) concentration was identified to achieve the surface water quality standard at the river using the preliminary dilution factor of 1:1. The interim action ROD identified a RAG of 22 µg/L Cr(VI). The RAG was revised to 20 µg/L Cr(VI) in the interim action ROD amendment because the chronic ambient water quality standard for Cr(VI) was revised from 11 µg/L to 10 µg/L in November 1997. The 2009 ESD (EPA et al., 2009) stipulated that injection wells that are not located upgradient of the extraction wells must reduce the effluent chromium concentrations to the maximum extent practicable, and not to exceed 20 µg/L.

2.4 Remedial Action Monitoring

The selected remedy combines P&T, ICs, and an evaluation of remedy effectiveness to achieve the RAOs. The IAROD also stipulates that compliance monitoring will include analysis of results in a timely manner to support modifications to the treatment system in order to meet RAOs. Monitoring will be conducted to evaluate the effectiveness of the remedial action to attain the cleanup levels identified in the interim action ROD and interim action ROD amendment. Monitoring will be used to assess the different components associated with the remedial action. The monitoring associated with the remedy implementation is described in the remainder of this section.

Operational monitoring is designed to evaluate how well the treatment process functions and facilitate operation of the system. Operational monitoring includes P&T process monitoring, and treatment process water monitoring. P&T process monitoring includes collection and evaluation of data on the operational components of the treatment system. Treatment process water monitoring includes collection and analysis of samples from extraction wells, influent tanks, and effluent tanks to evaluate the removal of Cr(VI) by the system. Operational monitoring is described in Chapter 4 of the O&M plan (DOE/RL-2013-49)

Performance monitoring is designed to assess remedy performance and determine progress toward achieving the RAOs. Performance monitoring includes collection and evaluation of groundwater quality and groundwater elevation data. The assessment of performance includes evaluating how well the remedial action complies with the river protection objective and quantifies mass removal of Cr(VI). Performance monitoring data and operational monitoring data are used for remedial process optimization. Performance monitoring is described in the 100-HR-3 SAP (DOE/RL-2013-30), Table 3-4.

Compliance monitoring is conducted at the end of the remedial action to demonstrate achievement of cleanup. Compliance monitoring is described in Section 6 of the 100-HR-3 RD/RAWP (DOE/RL-2013-31).

2.4.1 Operational Monitoring

Operational monitoring is described in the 100-HR-3 O&M plan (DOE/RL-2013-49). Operational monitoring includes P&T process monitoring and treatment process water monitoring.

P&T process monitoring includes measurements of a number of system parameters such as flow rate, water level measurements, pH, temperature, pressure, and drive frequency. These parameters are monitored through that portion of the active remediation to provide data integral to the O&M program.

P&T system operators maintain a handwritten daily log designed to assist in tracking and evaluating the performance of the system in accordance with the 100-HR-3 O&M plan (DOE/RL-2013-49). Selected data stored in the supervisory control and data acquisition (Section 3.1 of the O&M plan) is retrieved electronically and downloaded. The following parameters are recorded on an as-needed basis:

1. Number and designation of ion exchange (IX) columns in service at water treatment facilities
2. Column resin installation and change-out dates
3. Number and operating status of extraction wells
4. Extraction well pumping rate
5. Flow rate and operating status for each injection well
6. Samples taken and location of sampling
7. Injection well water levels
8. Extraction well water levels
9. River level

Treatment process water monitoring includes collecting and analyzing process water and effluent. Process water samples are collected from the extraction wells, influent tanks, IX resin vessels, and effluent tanks to monitor the contaminant concentrations through the treatment process and ensure the system is operating as expected. Extraction well samples are collected at a sample port located downstream from the filter. Treatment process water monitoring data is also used to evaluate IX resin performance, assess aquifer and Cr(VI) plume response, and optimize extraction and injection well pumping rates. Treatment effluent monitoring is conducted to ensure the system maintains treated water levels below the interim action RAG of 20 µg/L for Cr(VI) and to monitor effluent for COPC concentrations, as discussed in Chapter 4 of this document. Monitoring of co-contaminants is discussed in the 100-HR-3 SAP.

2.4.2 Remedy Performance Monitoring

Remedy performance monitoring is conducted in accordance with DOE/RL-2013-30. The 100-HR-3 SAP identifies sampling locations, frequencies, and analytes to assess whether the remedial action is achieving the RAOs for river protection, the progress of Cr(VI) cleanup, and the effects of additional contaminants on the cleanup decisions, with monitoring targeting periods when dilution by river water at the monitoring points is minimal. Groundwater analytical results are used to evaluate concentration trends, plume boundaries, and plume capture. Results from operational monitoring (discussed in Section 2.4.1), such as Cr(VI) concentrations in extraction wells and water level data, are also included in remedy performance assessment. This RD/RAWP and the 100-HR-3 SAP are intended to consolidate the previous monitoring requirements identified in multiple documents. Table 2-4 identifies previous controlling documents (with the exception of DOE/RL-97-01) that are being superseded.

Hydraulic monitoring includes water level data collected hourly through the automated water level network (AWLN). The data are supplemented with localized dynamic water level data from each of the P&T system extraction and injection wells and manual depth-to-groundwater measurements collected routinely during groundwater sampling. The combined data are used to evaluate the effect of the P&T systems on the water table and to evaluate groundwater flow direction and gradient. The hydraulic effects of the P&T systems are superimposed on seasonal fluctuations in the river levels and inland groundwater elevation to evaluate the effectiveness of providing hydraulic containment and capture of Cr(VI) plumes.

Evaluation of hydraulic capture compares the estimated extent of hydraulic containment for the 100-HR-3 OU P&T systems with the estimated extent of chromium contamination in groundwater. The assessment uses a joint evaluation of groundwater levels, pumping rates (extraction and injection), and water quality data. The extent of hydraulic containment is estimated using two methods:

- Water level mapping using an extension of the hybrid universal kriging/analytic element method technique detailed in SGW-42305, *Collection and Mapping of Water Levels to Assist in the Evaluation of Groundwater P&T Remedy Performance*
- Groundwater modeling using the 100 Area groundwater model, which is documented in SGW-46279, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes
Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units (DOE/RL-96-90, Rev. 0)	Original	01-Apr-1997	Sampling wells (monitoring, extraction, and injection) and system monitoring (influent and effluent)
	TPA-CN-298	05-Oct-2009	Changes for sampling at 53 existing wells and 16 new wells for the RI/FS per Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study
	TPA-CN-323	18-Feb-2010	Modifies the groundwater sampling at 53 existing wells incorporating agreed upon changes to the analyte crosswalk based on results of October 2009 sampling
	TPA-CN-330	18-Feb-2010	Adds Appendix D: 128-H-1 Burn Pit and Biostimulation Site Groundwater Sampling Activities in the 100-HR-3 Operable Unit at Wells 199-D2-6, 199-D5-40, 199-D5-109, 199-D5-114, 199-H1-41, 199-H1-43, 199-H3-25, 199-H4-6, and 699-97-41
CCN 062039, "Sampling Changes to the 100-HR-3 and 100-KR-4 Operable Units (OU)"	Original	16-Sept-1998	Identifies changes in wells, sampling frequencies, analytes, and additional aquifer tube sampling
Description of Work and Sampling and Analysis Plan for Pore Water Sampling at Groundwater-River Interface Adjacent to 100-D/DR, -K, and -H Reactor Areas (BHI-00620, Rev. 0)	Original	April 1996	Porewater sampling at 100-D/H Areas
Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units Interim Action (DOE/RL-96-84, Rev. 0)	Original	01-Sep-1996	Sampling wells (monitoring, extraction, and injection) and system monitoring (influent and effluent)
	DOE/RL-96-84, Rev. 0A	01-Apr-2003	Rev. 0A: diagram changes and reporting change
	TPA-CN-657	06-July-2015	Updates document to allow for single use, high capacity ResinTech SIR-700 ion exchange resin as an approved alternate resin for use within the DX and HX groundwater P&T systems

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes
Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation (DOE/RL-99-51)	Original	17-July-2000	Sampling monitoring wells and water level monitoring
Sampling and Analysis Plan for In Situ Redox Manipulation Project (DOE/RL-2003-63)	Original	7-Oct-2004	Updates the monitoring requirements to include ISRM barrier wells and determine a long-term monitoring approach for the ISRM treatment zone
"Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Washington July 2010, Memo to File Regarding: Supplemental Actions for the In Situ Reduction/Oxidation Manipulation Barrier Performance for the 100-HR-3 Groundwater Operable Unit Interim Remedy" (11-AMCP-0002)	Original	29-Nov-2010	Indicates the P&T expansion and performance monitoring modification will be addressed through a revision to the RD/RAWP and Interim Action Monitoring Plan
Sampling and Analysis Plan for Aquifer Sampling Tubes (DOE/RL-2000-59, Rev. 1)	Original	24-Feb-2009	Subsequent TPA-CNs on this document were not for 100-HR-3
	TPA-CN-556	29-Nov-2012	Changes in sample frequency for aquifer tubes downgradient of the ISRM barrier
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 2)	Original	June 2000	Appendix A identifies 100-HR-3 and 100-KR-4 Well, Aquifer Sampling Tube, and Seep Lists
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 3)	Original	August 2000	Appendix A identifies 100-HR-3 and 100-KR-4 Well, Aquifer Sampling Tube, and Seep Lists
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 4)	Original	May 2003	Appendix A identifies 100-HR-3 and 100-KR-4 Well, Aquifer Sampling Tube, and Seep Lists
	Original	August 2005	Appendix A identifies 100-HR-3 and 100-KR-4 Well, Aquifer Sampling Tube, and Seep Lists

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 5)	TPA-CN-169	August 2007	Updates Appendix A, Table A-1, to include 4 additional chrome source investigation wells and 12 Horn investigation wells planned for construction/installation
	TPA-CN-187	12-Oct-2007	Updates Appendix A, 100-HR-3 and 100-KR-4 Well Name, Aquifer Sampling Tube, and Seep Lists to include 27 Aquifer Tubes in 100-HR-3)
	TPA-CN-203	26-Mar-2008	Updates Appendix A; Table A-2 updated to add 36 aquifer tubes for 100-HR-3
	TPA-CN-222	4-June-2008	Updates Appendix A; Table A-1 updated to include 15 hydraulic hammer penetration (well IDs C6436 through C6450) and up to four new wells (D5-123, 124, 125, and 126)
	TPA-CN-257	25-June-2009	Updates Appendix A; Table A-1: added 21 RPO wells, added one ZVI injection well
	TPA-CN-377	August 2010	Updates Appendix A, Table A-1, to include 10 boreholes and 5 wells
	TPA-CN-409	February 2011	Updates Appendix A, Table A-1, to include 1 well (199-D5-143)
	TPA-CN-464	August 2011	Updates Appendix A, Table A-1, to include 1 well (199-D5-144)
	TPA-CN-550	6-November 2012	Updates Appendix A, Table A-1, to include 6 replacement wells
	TPA-CN-580	25-July 2013	Updates Appendix A; Table A-1: Deletes decommissioned wells and adds 10 new wells
	TPA-CN-616	22-April 2014	Updates Appendix A, Table A-1, to add 4 characterization borings at 100-D-100 (199-D5-155, 199-D5-156, 199-D5-157, and 199-D5-158)

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes
	TPA-CN-623	30-April 2014	Updates Appendix A, Tables A-1 and A-3 to add 19 new characterization/monitoring/extraction/injection wells
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 6)	TPA-CN-291*	19-Aug-2009	Updates Appendix A; Table A-1 to include 15 RPO wells (H1-20, 21, 25, 27, 43, 45, H3-25, 26, 27, H4-69, 70, 71, 72, 73, and H6-2)
Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit (DOE/RL-97-01, Rev. 7)	TPA-CN-316*	25-Jan-2010	Updates Appendix A; Table A-1 to include 33 RPO wells
	TPA-CN-354*	May 2010	Updates Appendix A; Table A-1 to add 10 RI/FS wells
Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells (DOE/RL-2009-09, Rev. 1)	Original	24-August 2009	Installation and sampling of extraction and injection wells for RPO; adds 37 new wells to 100-HR-3 P&T system, updated from 21 in Rev. 0
Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2 and 100-HR-3 Operable Units Remedial Investigation /Feasibility Study (DOE/RL-2009-40)	Original	25-March 2010	Installation and sampling of monitoring wells within 100-HR-3 in support of the RI/FS (DOE/RL-2008-46, ADD1)
	TPA-CN-368	19-Aug 2010	Updates sampling and analysis plan to correct the analytical requirements; removes Well 199-D5-41 from the spatial and temporal sampling list
	TPA-CN-402	4-Nov 2010	Updates waste management approach for test pit excavation; does not apply to groundwater monitoring
	TPA-CN-460	5-May 2011	Allows for drilling and sampling for Well R5 to a total depth of approximately 5 ft into the Ringold Formation Upper Mud Unit and the well to be completed within the unconfined aquifer
Sampling and Analysis Plan for the Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells (DOE/RL-2012-45)	Original	27-Nov 2012	Installation and sampling of monitoring wells within 100-HR-3 to replace wells that were decommissioned to support source area remediation

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan (DOE/RL-2013-35)	Original	23-July 2013	Installation and sampling of monitoring wells within 100-HR-3 to support existing monitoring network and remediation system; provides overall project scope, organization, and quality assurance criteria
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 1: 199-D5-153, 199-D5-154, 199-H4-90, 199-H4-91 (DOE/RL-2013-35-ADD1)	Original	22-July 2013	Installation and sampling of identified wells
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 2: 199-D3-6, 699-97-60, 699-97-61, 199-H1-8, AND 199-H4-92 (DOE/RL-2013-35-ADD2)	Original	28-Oct 2013	Installation and sampling of identified wells
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 3: 100-D-100 Waste Site and Underlying Groundwater Remediation (DOE/RL-2013-35-ADD3)	Original	24-Apr 2014	Installation and sampling of identified wells
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 4: 699-93-48C and 199-D5-159 (DOE/RL-2013-35-ADD4)	Original	28-Sept 2014	Installation and sampling of identified wells
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 5: Wells 199-H6-7, 199-H6-8, 199-H5-16, 199-H4-93, and 699-95-45B (DOE/RL-2013-35-ADD5)	Original	28-Oct 2014	Installation and sampling of identified wells
100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 6: Wells 699-97-47B and 199-H1-46 (DOE/RL-2013-35-ADD6)	Original	23-Jan 2015	Installation and sampling of identified wells

Table 2-4. Controlling Documents for 100-HR-3 Groundwater Operable Unit CERCLA Monitoring

Controlling Document	Modifying Documents	Date	Notes

Note: Complete reference citations are provided in Chapter 8.

* TPA-CN was originally issued against the incorrect revision of the Interim Action Waste Management Plan. The TPA-CN was corrected in the Administrative Record in August 2015.

Treatability Test documents are not included in this table.

ISRM = in situ redox manipulation

P&T = pump and treat

RI/FS = remedial investigation/feasibility study

RPO = remedial process optimization

TPA-CN = Tri-Party Agreement-Change Notice

RAWP = remedial action work plan

Status of river protection is evaluated annually based on assessment of the hydraulic effects of operation of the remedial action systems, along with evaluation of changes in the discharge boundary head conditions associated with the Columbia River and the inferred distribution of Cr(VI) in groundwater. Both a quantitative and a qualitative approach are used for this assessment.

Details on the technical approach used for evaluating progress toward river protection are provided in SGW-54209, *Systematic Method for Evaluating the Length of the Hanford Reach of the Columbia River Shoreline that is Protected from Further Discharges of Chromium from the 100 Area Operable Units (OUs)*.

The 100-HR-3 SAP (DOE/RL-2013-30) has been prepared to meet the monitoring needs for the 100-HR-3 interim actions. The SAP provides a detailed description and schedule of activities, including data management and evaluation methods, to meet the data needs identified in the data quality objective (DQO) process completed for 100-HR-3. Data needs are specific to the principal study questions (PSQs) developed during the DQO process (Table 2-5). Details for the PSQs are provided in the SAP.

In addition to the monitoring conducted for CERCLA, the Mission Support Alliance (MSA) project conducts environmental monitoring to measure radionuclide concentrations in various environmental media, including air, surface water, sediment, soil, natural vegetation, agricultural products, fish wildlife, and external radiation levels to assure the public that the dose and risk from Hanford contaminants are well understood. Samples of Columbia River seep water are collected along the Hanford Reach, including the 100-H Area. The 100-H Area seep sampling includes an annual grab sample analyzed for gross alpha, anions, gross beta, metals (filtered and unfiltered), strontium-90, technitium-99, and tritium. The results of the samples are provided in the annual Hanford Site environmental report (e.g., DOE/RL-2014-52, *Hanford Site Environmental Report for Calendar Year 2014*).

Performance monitoring data are used in conjunction with treatment system data to obtain the following information:

- Evaluate concentration trends, monitor geochemical changes, plume boundaries, and plume capture.
- Determine if there are any continuing source or transformation products.
- Optimize the treatment system.

Concentration trends and plume models are used to confirm and predict progress toward performance goals.

Table 2-5. Monitoring Data Quality Objective Principal Study Questions

PSQ 1: Is Cr(VI) discharging to the river at concentrations greater than 10 μg/L?
PSQ 2: Is the remedy effectively reducing the groundwater Cr(VI) plume?
PSQ 3: Are other contaminant plumes that exceed risk based/ARAR levels decreasing as predicted?
PSQ 4: What are the direction and magnitude of groundwater hydraulic gradients in the confined and unconfined aquifer?
PSQ 5a: What data verify that infrequently detected analytes are not contaminants of potential concern? PSQ 5b: What data verify that analytes with detection limits above action levels are not contaminants of potential concern? PSQ 5c: What data verify that there are not continuing sources?

PSQ = principal study question

ARAR = applicable or relevant and appropriate requirement

2.4.3 Remedial Process Optimization

RPO is an ongoing systematic evaluation that includes an examination of various remedial systems elements. System elements evaluated include extraction well performance, extracted water conveyance performance, treatment process performance, treated water conveyance performance, and injection well performance. Remedial activity recommendations that are incorporated into RPO include the following elements:

- Operation of existing groundwater P&T remedies for hydraulic containment and capture of groundwater contaminant plumes and contaminant mass removal
- Identification of sources to prevent ongoing contaminant releases
- Monitoring of groundwater conditions and remedial system operations to provide information to assess remedy performance and progress
- Routine data evaluation and reporting to document remedy progress and provide the basis for recommending changes
- Preparation of annual RPO recommendations based on the evaluation of activities that occurred during the previous fiscal year (FY)

The optimization approach integrates year-over-year efforts into a systematic approach that includes the following elements:

1. **Evaluate and Refine the CSM.** Ineffective or inefficient P&T system operations often result from an incomplete CSM that may not recognize the significance of features such as secondary contaminant sources, time-varying plume geometry, and spatially variable hydrogeologic conditions. Maintaining a CSM ensures that the pumping strategy reflects current understanding while accounting for potential uncertainties or lack of knowledge regarding aquifer properties, contaminant extent, and continuing contributions from secondary sources.

2. **Remedy Component Integration.** Each of the P&T systems is composed of an array of hydraulically connected components consisting of extraction and injection wells, conveyance systems, and treatment systems. Change to one component of the system, such as extraction well pumping or injection rate, has the potential to affect system operations elsewhere. Analysis of one component independent of the other components can lead to sub-optimal operation and inhibit efforts to accelerate remediation. The RPO strategy identifies where key dependencies exist and applies tools to integrate analysis of the connected components.

3. **Baseline and Periodic Optimization Tasks.** Optimization tasks are divided between baseline tasks and annual or periodic tasks. Baseline tasks are generally one-time activities that are used to develop the tools that will be used to conduct the annual/periodic tasks. The baseline tasks include overall review of the system and, upon completion, allow the annual/periodic tasks to focus on a smaller set of data, speeding up the evaluation process.

4. **Data Evaluation and Groundwater Modeling Tools.** Accelerating the cleanup rate is accomplished through smart pumping, which emphasizes dynamic operation of wells based on scheduled and real-time data analysis. For systems with a large number of extraction wells, groundwater flow and contaminant transport modeling is the primary tool for comparing the likely relative efficacy of alternate pumping strategies to accelerate remediation. Model simulations, supported by other data analysis tools, are used to help interpret P&T performance and determine decision points where

strategic pumping or other remedy modifications may be needed. Groundwater modeling tools are periodically updated to reflect the current CSM and changes to P&T system components.

5. **Pre-Attainment Strategy.** Remedial goals for Cr(VI) and co-contaminants will be achieved in different areas of the aquifer at different times. RPO is used to develop and implement a technical approach that defines when and where active extraction, injection, and monitoring can be downsized or terminated as a strategy for P&T systems. This approach also facilitates resource prioritization.

Results of the individual RPO process element analyses are integrated with the remedial system performance monitoring data to identify recommendations for changes to the system configuration and/or operation. The annual P&T report provides a summary of RPO recommendations implemented for the year. These changes provide the opportunity to accelerate achievement of RAOs and reduce incremental and overall project costs. P&T enhancements at the 100-HR-3 OU have resulted from the following past process optimization recommendations:

- Modifying the groundwater treatment process to use an alternate IX resin that increased treatment effectiveness and resin lifetime
- Converting treatment trains from a series to parallel configuration, increasing process throughput
- Repurposing existing wells
- Installing new wells
- Adjusting groundwater extraction and injection rates.

As new well locations are identified, addenda to DOE/RL-2013-35, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan*, will be provided for regulatory review and approval. Each addendum identifies the purpose of the well, construction details, and a sampling and analysis summary.

2.5 Applicable or Relevant and Appropriate Requirements Compliance

The remedial actions described in this RD/RAWP are required to comply with the applicable or relevant and appropriate requirements (ARARs) established in the interim action ROD and interim action ROD amendment and in accordance with the NCP (40 CFR 300). The following ARARs for the action are identified in the interim action ROD:

- Chemical-specific ARARs
  - WAC 173-218, "Underground Injection Control Program," and 40 CFR 144, "Underground Injection Control Program," Subpart B, "General Program Requirements," are applicable to reinjection of treated groundwater.
  - *Clean Water Act of 1977*, "Ambient Water Quality Criteria for Protection of Aquatic Life" (40 CFR 131, "Water Quality Standards") for chromium are relevant and appropriate for establishing cleanup goals that are protective of the Columbia River.
  - WAC 173-201A-240, "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances," for chromium are relevant and appropriate for establishing cleanup goals that are protective of the Columbia River.
- Action-specific ARARs
  - WAC 173-303, "Dangerous Waste Regulations," are applicable for the identification, treatment, storage, and land disposal of wastes determined to be dangerous wastes.

- 40 CFR 268, "Land Disposal Restrictions," are applicable to the land disposal of wastes determined to be hazardous wastes.
- WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and WAC 173-162, "Regulation and Licensing of Well Contractors and Operators," are applicable regulations for the location, design, construction, and abandonment of groundwater extraction, reinjection, and monitoring wells.
- WAC 173-303-640, "Tank Systems": the substantive requirements of this are relevant and appropriate to the construction, operation, maintenance, and closure of any tanks and associated components (e.g., piping) that contain dangerous waste associated with both the water treatment system and the resin stabilization system.

- Location-specific ARARs
  - *Archeological and Historic Preservation Act of 1974* and 36 CFR 65, "National Historic Landmarks Program," are applicable to recover and preserve artifacts in areas where an action may cause irreparable harm, loss, or destruction of significant artifacts.
  - *National Historic Preservation Act of 1966* and 36 CFR 800, "Protection of Historic Properties," are applicable to actions in order to preserve historic properties controlled by a federal agency.
  - "To authorize a study of the Hanford Reach of the Columbia River and for other purposes" (Appendix D – Public Law 100-605) and "To provide for the administration of certain Presidio properties at minimal cost to the Federal taxpayer, and for other purposes (*Omnibus Parks and Public Lands Management Act of 1996*, Public Law 104-333, Section 104) are applicable to planning, designing, and locating activities in a manner that minimizes direct and adverse effects on the values for which the river is under study. The location of any facilities within 1/4 mile of the river will be coordinated with the National Park Service.
  - *Endangered Species Act of 1973* is applicable to protection of endangered or threatened species. Consultation with the U.S. Department of the Interior will occur as needed.
  - *Migratory Bird Treaty Act of 1918* is relevant and appropriate to protect migratory birds in the areas. Consultation with the U.S. Fish and Wildlife Service will occur as needed.
  - *Bald and Golden Eagle Protection Act of 1940* is applicable due to the known roosting of bald eagles in the general vicinity of potential extraction wells. Consultation with the U.S. Department of the Interior will occur as needed.

- Other criteria, advisories, and guidance to be considered
  - Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, are relevant and appropriate to activities within the floodplains and wetlands.
  - WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, delineates primary requirements including regulatory requirements, specific isotopic constituents and contamination levels, and the dangerous/hazardous constituents and concentrations, and the physical/chemical waste characteristics that are acceptable for disposal of wastes at ERDF.

For the interim action ROD amendment, the ARARs set forth in the 1996 interim action ROD were unchanged, with the exception of WAC 173-218 and 40 CFR 144, Subpart B, which are not ARARs for the interim action ROD amendment. An addition to the procedures and practices applicable to the injection of fluids through wells under WAC 173-218 and 40 CFR 144, Subpart B, was added in

Appendix A of DOE/RL-96-84. The ARAR clarification stated: "To facilitate removal of the chromium, small quantities of chemicals (e.g., indicator chemicals associated with the sampling system) might be reinjected with the treated groundwater. Prior to using any new chemical, an evaluation will be made to demonstrate that the chemical will not result in a violation of a DWS or otherwise adversely affect the beneficial use of the groundwater".

2.6 Other Remedial Action Requirements

Table A-2 in Appendix A presents requirements specified in previous RAWPs for implementing the remedial actions.

2.7 Interfaces with Other Projects

Washington Closure Hanford (WCH) is remediating waste sites in the vadose zone overlying the 100-HR-3 OU. Implementation of interim remedial actions for groundwater requires interfacing with WCH to ensure that both soil and groundwater cleanup goals are achieved safely and efficiently to meet TPA (Ecology et al., 1989a) goals, milestones, and regulatory schedules.

MSA is responsible for the Long-Term Stewardship (LTS) Program on the Hanford Site. The LTS Program includes the geographic areas for which cleanup has been completed to interim actions and/or final action RODs and for which contractual responsibility for land management has been transitioned by DOE-RL to MSA. The scope of the LTS Program includes surveillance and maintenance of physical remedies and ICs, CERCLA 5-year reviews, environmental monitoring, and other post-cleanup activities.

This page intentionally left blank.

3 Remedial Design Approach

This chapter describes the engineering, hydrogeologic, and regulatory design for the 100-HR-3 OU P&T systems and ISRM barrier. It includes a general description of the system components and their functions as well as the post-interim ROD RPO activities that support continued remedy improvement.

3.1 Design Basis

The P&T systems are designed to prevent discharge of Cr(VI) to the Columbia River at concentrations that would result in exceedance of the state surface water quality standard of 10 µg/L, as identified in the interim action ROD. The design locates extraction wells immediately upgradient of locations where Cr(VI) was detected in the near river substrate to achieve the RAO for river protection. Extraction wells should be located at a sufficient distance inland from the river to minimize withdrawal of river water. As the CSM has been further developed and Cr(VI) plumes have been better defined, the remedial action has targeted inland locations to prevent discharge of Cr(VI) contaminated groundwater to the Columbia River, limit plume migration, and remove contaminant mass from inland areas of the plumes.

The DR-5 and HR-3 P&T systems were designed to meet RAOs by providing hydraulic containment of Cr(VI) plumes and preventing discharge to the Columbia River. The ISRM barrier was also installed to provide treatment for Cr(VI) contamination in 100-D. Following implementation of the DR-5 and HR-3 P&T systems, an RPO approach was used for systematic evaluation and enhancement of the interim remedial actions in the 100-HR-3 OU. This included developing and evaluating potential applications of new technologies. The remedy was also expanded with addition of the DX and HX P&T systems to meet TPA (Ecology et al., 1989a) remedial action milestones to take actions to achieve river protection by 2012 (Milestone M-016-110-T01) and groundwater cleanup by 2020 (Milestone M-016-110-T02). Actions taken to complete Milestone M-016-110-T01 included removal of source material and expansion of groundwater P&T operations in the 100-D, 100-H, and 100-K Areas, which completed this milestone as documented in 12-AMRP-0172.

3.2 Conceptual Design

The DX and HX P&T systems and ISRM barrier treatment system are fully designed, constructed, and operational. The DX and HX systems were installed as upgrades to the original HR-3 and DR-5 P&T systems. The following subsection summarizes the conceptual design of the original HR-3 and DR-5 P&T systems and the DX and HX systems. The remaining subsections summarize information obtained from follow-on studies and evaluations that were used to develop the conceptual design for the DX and HX systems.

3.2.1 HR-3 P&T System

A pilot scale treatability test (DOE/RL-95-83, *The Pilot-Scale Treatability Test Summary for the 100-HR-3 Operable Unit*) was conducted in the 100-D Area from July 1994 to March 1995. Based on the demonstrated feasibility of this system, installation of the HR-3 P&T system began in 1996, and operations commenced in 1997. The RDR/RAWP (DOE/RL-96-84) includes a summary of the conceptual design documents, final design documents, and implementation documents and describes the installation of five wells in the 100-H Area and four wells in the 100-D Area. Design criteria were based on the following documents:

- BHI-00772, *Design Criteria and Design Basis for the 100-HR-3 and 100-KR-4 Pump-and-Treat Projects*

- BHI-00764, *100-HR-3 and 100-KR-4 Interim Remedial Measures Pump-and-Treat Acquisition and Design Strategy Plan*

Final design was based on BHI-00770, *100-HR-3 and 100-KR-4 Pump-and-Treat Drilling Description of Work*, and construction documents. The HR-3 P&T system continued operations until 2011, when it was replaced by the HX P&T system.

3.2.2 DR-5 Pump and Treat System

The DR-5 P&T system began operating in 2004. Operation of the DR-5 P&T system was initiated to address the Cr(VI) plume that was passing the ISRM barrier to the northeast (DOE/RL-2005-18, *Calendar Year 2004 Annual Summary Report for the 100-HR-3, 100-KR-4, and 100-NR-2 Operable Unit Pump-and-Treat Operations*). The initial system included three extraction wells and one injection well, with a treatment plant located in the 186-D Building. The DR-5 P&T system was placed in standby in 2011 after the DX system came online as an upgraded replacement.

3.2.3 DX and HX Pump and Treat Systems

The conceptual design basis for the DX system is based on SGW-38338, which provides the results of an RPO evaluation started in 2008. Modeling support to calculate appropriate pumping rates for extraction and injection wells is provided in SGW-40044, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum*. The modeling support was used to identify capture frequency for different design scenarios, with the goal of expanding the system to meet the 2012 and 2020 TPA milestones (M-016-110-T04 and M-016-110-T02). The results identified the optimum well field design. Design for expansion of the P&T system from the original DR-5 and HR-3 to the DX and HX systems was based on the following information obtained from RPO studies:

- An updated conceptual model of groundwater flow and Cr(VI) distribution for each of the plumes in 100-D, 100-H, and the Horn
- Updated geologic cross sections
- Well performance tests that provided an evaluation of well construction details and potential yields
- Model development and assignment of parameter values, including types and sources of information used to support model development and application of the model to evaluate remedy expansion alternatives (SGW-40781, *100-HR-3 Remedial Process Optimization Modeling Data Package*)
- Numerical modeling and well performance tests that were used to size the balance of plant components, including pipe diameters and lengths, flow monitoring and control devices, pumps, tank storage, and electrical/mechanical systems
- Evaluation of various IX resins for Cr(VI) removal efficiencies (SGW-46621, *100 Area Groundwater Chromium Resin Management Strategy for Ion Exchange Systems*)

3.2.4 Supplemental Support Tasks

Additional evaluations and testing that were conducted to support the system designs are provided in this section.

3.2.4.1 Evaluation of Ion Exchange Resins

The purpose of the IX resin evaluation was to recommend the IX resin and regeneration process option for the expansion design of the groundwater P&T capacity in the DX facility. Six resins were selected for evaluation, based on demonstrated or reported ability to remove Cr(VI) from water. Resins included those

in use in the existing treatment facilities, single-use resins, and resins that can be regenerated in situ or in a separate regeneration facility.

Results of the resin tests indicated that, in general, performance of two resins (Purolite® A500, a regenerable resin; and ResinTech® SIR-700, a single-use, disposable resin), ranges between a factor of 2 to an order of magnitude more efficient than that of DOWEX™ 21K. Purolite A500 had been in use at DR-5 since 2004, and the operating experience gained from performance of this resin has been confirmed. However, offsite regeneration capabilities would be needed to support the expanded system needs of the DX design. ResinTech SIR-700 is a new resin and was further evaluated to determine the appropriate disposal pathway and system design for using ResinTech SIR-700 in the DX P&T system.

ResinTech SIR-700 showed high capacity in side-by-side resin testing, with a capacity of greater than 5 times that of Purolite A500 under test conditions. The high capacity of SIR-700, which results from its ability to reduce Cr(VI) to Cr(III), compensates for the cost of resin replacement and was recommended for use in the DX system. It is also used in the HX system.

3.2.4.2 Aquifer Testing and Rebound Study

DOE/RL-2006-20, *The Second CERCLA Five-Year Review Report for the Hanford Site*, set a milestone to conduct an investigation of deep Cr(VI) contamination in the sediments in one deep 100-H well extending below the aquitard (i.e., RUM). The Cr(VI) concentration in this well exceeded both the groundwater standard of 48 µg/L (Ecology Publication 94-06, *Model Toxics Control Act Statute and Regulation*) and the federal DWS of 100 µg/L for total chromium. The extent of Cr(VI) contamination in this zone was not clearly understood. Action 12-1 from the review was to "perform additional characterization of the aquifer below the initial aquitard" (DOE/RL-2006-20).

Field characterization and aquifer testing were performed in the 100-H Area of the Hanford Site to address this milestone. The aquifer tests were conducted to gather data in order to answer several fundamental questions regarding the presence of the Cr(VI) in the deep sediments of the RUM unit and to determine the extent and magnitude of deeper contamination. The pumping tests were performed according to SGW-41302, *Description of Work for Aquifer Testing in Support of the 100-H Deep Chromium Investigation*. The study results are presented in SGW-47776.

The following conclusions are from the deep Cr(VI) study at 100-H Area wells 199-H3-2C, 199-H4-12C, and 199-H4-15CS (SGW-47776):

- Drawdown at two unconfined aquifer wells near pumping Well 199-H3-2C was observed. Drawdown was not observed in the unconfined aquifer near the pumping Wells 199-H4-12C and 199-H4-15CS.
- Analysis of the drawdown data indicated that transmissivity of tested zones of the RUM ranges from 38 to 72 m^2/day (412 to 778 ft^2/day), using the Cooper-Jacob straight-line method (Cooper and Jacob, 1946, "A Generalized Graphical Method of Evaluating Formation Constants and Summarizing Well-Field History").
- Recovery response and examination of the borehole log for Well 199-H3-2C suggests that layered RUM sediments accounted for the positive recharge boundary. Groundwater mounding near the 105-H

® Purolite is a registered trademark of Purolite, Bala Cynwyd, Pennsylvania.
® ResinTech is a registered trademark of ResinTech Inc., West Berlin, New Jersey.
™ DOWEX is a trademark of The DOW Chemical Company, Midland, Michigan.

Reactor or at the solar evaporation basins may have provided enough head to allow Cr(VI) to enter permeable seams within the RUM that may be exposed to the unconfined aquifer beneath this area.

- Comparison of historical and recent groundwater levels in Well 199-H4-15 nested piezometers suggests that the steepness of the upward vertical gradient has decreased in recent years.
- Inspection of Cr(VI) concentration versus time showed no clear concentration trends for Cr(VI) in unconfined aquifer monitoring wells subsequent to the temporary shutdown of the HR-3 P&T system. The concentrations in the RUM wells continued to increase between 2009, when the pump testing occurred, until early to mid-2011 when Cr(VI) stabilized. There is, therefore, no support for any significant rebound of Cr(VI) concentrations.
- The most likely explanation for the origin of the Cr(VI) in the RUM at 100-H is from water contaminated with up to 1 mg/L of Cr(VI) that had passed through the reactor for cooling. It was subsequently discharged to the ground in sufficient quantities to form a mound, which provided sufficient hydraulic driving force to push into the upper RUM and mix with existing groundwater in the RUM.

The RPO process is constantly evolving, based on incoming data. For example, based on lower-than-expected production rates of several extraction wells within the Horn area (199-H1-3, 199-H1-4, and 199-H1-6), future modifications to the well network may be required to meet remedial goals. In addition, based on the 100-H deep chromium study, several RUM wells are now being pumped by the HR-3 system and have been added to the HX network. Additional pump tests and RUM wells are proposed to define and capture contamination more accurately in the RUM. New well installations within the 100-HR-3 OU follow procedures in DOE/RL-2013-35.

3.2.4.3 Conceptual Design for DX and HX Well Installations

Numerical modeling was performed to simulate hypothetical groundwater flow conditions and to assess preliminary well locations and pumping rates to meet the RAO for Cr(VI) using the new expanded P&T systems. The well network conceptual design is based on the results of the numerical modeling. The modeling data package (SGW-40781) provides details about the model development and assignment of parameter values, including the types and sources of information used to support model development and application of the model for evaluating the remedy alternatives in the 100-HR-3 OU. The groundwater flow model and capture analysis are provided in SGW-40044.

The results of the modeling analysis supported the installation of 70 new RPO wells to meet the 2012 and 2020 TPA (Ecology et al., 1989a) requirements. These wells complete the well field expansion to fulfill the requirements of the RPO. The RPO wells are located mainly in the Horn area, north of 100-H, to capture the low-concentration, dispersed plume that has migrated northeast from 100-D. These wells were installed under DOE/RL-2009-09, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells*.

3.2.4.4 Treatability Testing

One of the RAOs for the interim action ROD (EPA/ROD/R10-96/134) and interim action ROD amendment (EPA/AMD/R10-00/122) was to provide information that will lead to a final remedy. Treatability tests that were conducted to support this RAO are described in the following subsections.

3.2.4.4.1 Zero-Valent Iron Treatability Test

A study was conducted to evaluate the ability to regenerate the ISRM barrier by injecting nanometer-size iron particles into ISRM wells, which could react with groundwater to reduce Cr(VI) to Cr(III) (DOE/RL-2008-49). The iron particles are composed of zero valent iron (ZVI), which is a much stronger

reductant than the naturally occurring ferrous iron (valence of +2). In August 2008, ZVI was injected into the ISRM barrier, Well 199-D4-26 (Figure 1-10), to test the feasibility of augmenting iron in a portion of the barrier that had been losing its reductive capacity. Results showed that the treatment reduced Cr(VI) to Cr(III) in the aquifer; however, longer term monitoring has shown that concentrations did not remain at low levels in direct response to the treatment, with the exception of in the injection well and immediately downgradient.

Other significant changes to groundwater chemistry in the vicinity of the injections include increased iron and manganese concentrations, increase in pH to near 11, and decreased DO and nitrate concentrations. Results of the test were published in 2009 (DOE/RL-2009-35). The technology was not implemented sitewide based on the high cost of ZVI materials compared to the amount of area treated.

3.2.4.4.2 Biostimulation Treatability Test

Testing of soluble and immiscible substrates to demonstrate application of in situ biostimulation for remediation in the 100-D Area is described in PNNL-18784. The selection of molasses as a soluble substrate was designed to provide information on a substrate that is easy to distribute over a large areal extent, inexpensive, and expected to have moderate longevity. Emulsified vegetable oil was selected to represent an immiscible substrate that can be distributed over a reasonable areal extent at a moderate cost and is expected to have increased longevity.

The conclusions for the molasses biostimulation treatability test identified a successful, though heterogeneous, distribution to a radius of approximately 15 m (50 ft) from the injection well. Microbial activity and ability to reduce targeted species were observed, with low oxygen, nitrate, and chromium concentrations recorded within the test zone over the 2-year monitoring period. Other water quality changes included increased metals and organic constituents, and a decrease in pH and oxidation-reduction potential.

The treatability test for emulsified vegetable oil identified a heterogeneous distribution to a radius of approximately 8 m (25 ft) from the injection well. Microbial activity and the ability to reduce targeted species were observed, with low oxygen, nitrate, and chromium concentrations recorded within the test zone over the 10-month monitoring period. Other water quality changes included increased metals and organic constituents, and a decrease in oxidation-reduction potential. P&T technology was implemented in lieu of the biostimulation based on its known effectiveness and expanded knowledge regarding the concentrations and expansiveness of the Cr(VI) groundwater plume.

3.3 Design Approach

The overall design approach for the 100-HR-3 interim remedy relies on the use of groundwater P&T systems and a PRB to achieve the RAOs. Groundwater monitoring is conducted to assess progress with respect to the RAOs. The remedial design for the groundwater monitoring is provided in a SAP for the 100-HR-3 OU (DOE/RL-2013-30).

Evaluation of the HR-3 and DR-5 P&T systems using the RPO approach resulted in the design, construction, and operation of the DX and HX P&T systems. Data acquisition activities supporting the design of the systems are complete, including selection of the IX resin for treatment. Tests conducted on several resins resulted in the selection of ResinTech SIR 700 as the resin of choice (SGW-46621, *100 Area Groundwater Chromium Resin Management Strategy for Ion Exchange Systems*). SIR 700 is a single use resin operated at reduced pH, with spent resin stabilization and disposal at ERDF.

Numerical modeling was performed to simulate hypothetical groundwater flow conditions and to assess preliminary well locations and pumping rates to meet the RAO for Cr(VI) for expansion to the HX and DX P&T systems. The well network conceptual design is based on the results of the numerical modeling.

The modeling data package (SGW-40781) provides details about the model development and assignment of parameter values, including the types and sources of information used to support model development and application of the model for evaluating the remedy alternatives. SGW-40044 provides the groundwater flow model and capture analysis.

The results of the modeling analysis supported the installation of 70 new RPO wells to meet the 2012 and 2020 TPA (Ecology et al., 1989a) requirements. These wells completed the well field expansion to fulfill the requirements of the RPO. The RPO wells are located mainly in the Horn area, north of 100-H, to capture the low-concentration, dispersed plume that has migrated northeast from 100-D. These wells were installed under DOE/RL-2009-09, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells*.

The 100-HR-3 geographic area is evaluated periodically to identify new well requirements, as well as the re-alignment of existing wells, supporting extraction, injection, and/or ongoing groundwater monitoring (SGW-54542, *Recommendations and Technical Justification for New and Replacement Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-D/H Area*). This evaluation is based on the following three-level priority:

1. River Protection: To maintain protection of the Columbia River from discharges of groundwater exceeding the Cr(VI) RAO of 20 µg/L.
2. Mass Removal: To remove mass effectively from the areas of highest Cr(VI) concentration in groundwater.
3. Plume Delineation: To delineate the extent of Cr(VI) groundwater plumes and other identified co-contaminants.

As the need for new wells is identified, addenda to DOE-RL-2013-35 that provide well specific construction details and proposed monitoring are submitted for regulatory approval. General well construction diagrams for the unconfined and semiconfined to confined aquifer are provided in Figures 3-1 and 3-2, respectively. All wells are constructed in accordance with WAC 173-160. Table 3-1 lists documents provided to support the DX and HX systems.

Table 3-1. Documents Written to Support DX and HX Expansion

DOE/RL-2009-09, Rev. 2, 2010, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells*
DOE/RL-2012-45, Rev. 0, 2012, *Sampling and Analysis Plan for the Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells*
DOE/RL-2013-35, Rev. 0, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan*
DOE/RL-2013-35-ADD1, Rev. 0, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 1: 199-D5-153, 199-D5-154, 199-H4-90, 199-H4-91*
DOE/RL-2013-35-ADD2, Rev. 0, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 2: 199-D3-6, 699-97-60, 699-97-61, 199-H1-8, and 199-H4-92*
DOE/RL-2013-35-ADD3, Rev. 0, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 3: 100-D-100 Waste Site and Underlying Groundwater Remediation*

Table 3-1. Documents Written to Support DX and HX Expansion

DOE/RL-2013-35-ADD4, Rev. 0, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 4: 699-93-48C and 199-D5-159*
DOE/RL-2013-35-ADD5, Rev. 0, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 5: Wells 199-H6-7, 199-H6-8, 199-H5-16, 199-H4-93, and 699-95-45B*
DOE/RL-2013-35-ADD6, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 6: Wells 699-97-47B and 199-H1-46*
ECF-100HR3-12-0025, Rev. 0, 2012, *Evaluation of Potential Hydraulic Capture and Plume Recovery from the Ringold Upper Mud (RUM) in the 100-HR-3 Operable Unit (OU)*
SGW-38338, Rev. 0, 2008, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document*
SGW-40044, Rev. 0, 2009, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum*
SGW-40243, Rev. 4, 2010, *Functional Design Criteria for the 100-DX Pump and Treat System*
SGW-40781, Rev. 0, 2009, *100-HR-3 Remedial Process Optimization Modeling Data Package*
SGW-41534, Rev. 0, 2009, *Description of Work for the Installation of 35 Remedial Process Optimization Wells in the 100-H Area for the 100-HR-3 Operable Unit, Fiscal Year 2009*
SGW-41535, Rev. 0, 2009, *ARRA Description of Work for the Installation of Fourteen Remedial Process Optimization Wells for the 100-D Area of the 100-HR-3 Operable Unit, FY2009*
SGW-43616, Rev. 4, 2011, *Functional Design Criteria for the 100-HX Pump and Treat System*
SGW-44089, Rev. 0, 2010, *ARRA FY2010 Description of Work for the Installation of 18 Scenario 5 Remedial Process Optimization Wells for the 100-D Area, 100-HR-3 Operable Unit*
SGW-44142, Rev. 0, 2009, *ARRA FY2010 Description of Work for the Installation of 15 Scenario 5 Remedial Process Optimization Wells in the 100-H Area for the 100-HR-3 Operable Unit*
SGW-46279, Rev. 2, 2012, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*
SGW-46621, Rev. 0, 2010, *100 Area Groundwater Chromium Resin Management Strategy for Ion Exchange Systems*
SGW-48612, Rev. 0, 2011, *Borehole Summary Report for the Installation of 70 Remedial Process Optimization, Pump-and-Treat Expansion Wells, for the 100-HR-3 Operable Unit*
SGW-49912, Rev. 0, 2011, *Borehole Summary Report for the Installation of 16 Resource Protection Wells in the 100-HR-3 Groundwater Operable Unit in Support of the Integrated 100 Areas RI/FS: 100-D/H Decisional Unit*
SGW-51502, Rev. 0, 2012, *Borehole Summary Report for the Installation of Well C8668 at 100-D-12 in FY2012*
SGW-54542, Rev. 0, 2013, *Recommendations and Technical Justification for New and Replacement Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-D/H Area*
SGW-55604, Rev. 0, 2013, *Description of Work for the Installation of Four Wells (C8787 to C8790) in the 100-HR-3 Groundwater Operable Unit, FY2013*
SGW-55269, Rev. 0, 2013, *Borehole Summary Report for the Installation of 6 Replacement Multi-Purpose Wells and the Decommissioning of 1 Non-WAC Compliant Well in the 100-HR-3 Operable Unit, FY2013*

Table 3-1. Documents Written to Support DX and HX Expansion

SGW-56810, Rev. 1, 2014, *2014 Field Summary/Data Quality Assessment Report for the Installation of 2 Extraction Wells and 2 Monitoring Wells in the 100-HR-3 Groundwater Operable Unit, Fiscal Year 2013*
SGW-57584, Rev. 0, 2014, *Recommendations and Technical Justification for New Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-HR-3: FY14 and FY15*
SGW-58236, Rev. 0, 2014, *Well Maintenance Plan for the 100-HR-3 and 100-KR-4 Groundwater Treatment Facilities*

3.3.1 DX and HX Pump and Treat Systems

The DX and HX P&T systems became fully operational in December 2010 and October 2011, respectively. The DR-5 and HR-3 P&T systems were removed from service in 2011 after the expanded systems began operations. Figure 3-3 shows the well network for the DX and HX P&T systems. Each network includes selected extraction and injection wells from the previous (DR-5 and HR-3) systems, selected wells converted for use as extraction and injection wells, and new extraction and injection wells. The current P&T systems expand the capture zone in the 100-D and 100-H Areas. In addition, for the first time, groundwater is captured from the central Horn. The new systems have improved operating efficiency in capturing and treating additional contaminated groundwater. Figures 3-4 through 3-7 present the flow schematics and photographs for the current DX and HX systems. The wells in the systems and operating conditions, as well as the P&T operational history, are summarized in DOE/RL-2015-05. Designs for the DX and HX P&T systems are detailed in the following functional design criteria (FDC):

- SGW-40243, *Functional Design Criteria for the 100-DX Pump and Treat System*
- SGW-43616, *Functional Design Criteria for the 100-HX Pump and Treat System*

Copies of these two documents are included in Appendix B. The initial design for the DX P&T system included in the FDC (SGW-40243) included three subsystems:

- Treatment facility, centrally located with respect to the location of the extraction and injection wells, to house all of the process treatment equipment as well as the control system for the project
- Injection and extraction wells
- Balance of plant that includes the well pumps, network, and associated transfer buildings with transfer pumps to pump the contaminated well water to the treatment facility (treatment facility will then pump the treated water to the injection wells)

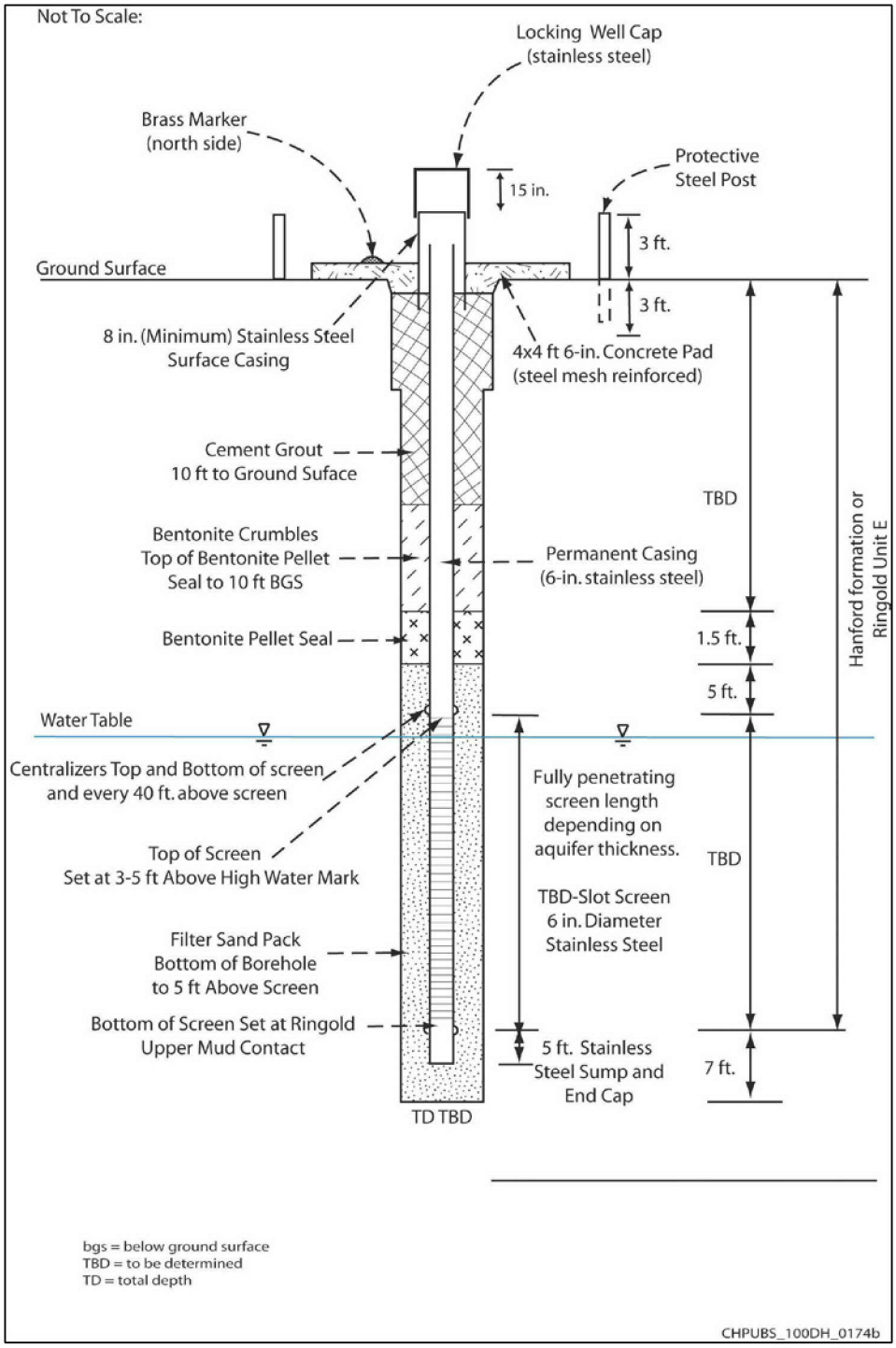


Figure 3-1. General Well Construction Diagram for Monitoring of Unconfined Aquifer and for Extraction/Injection Wells

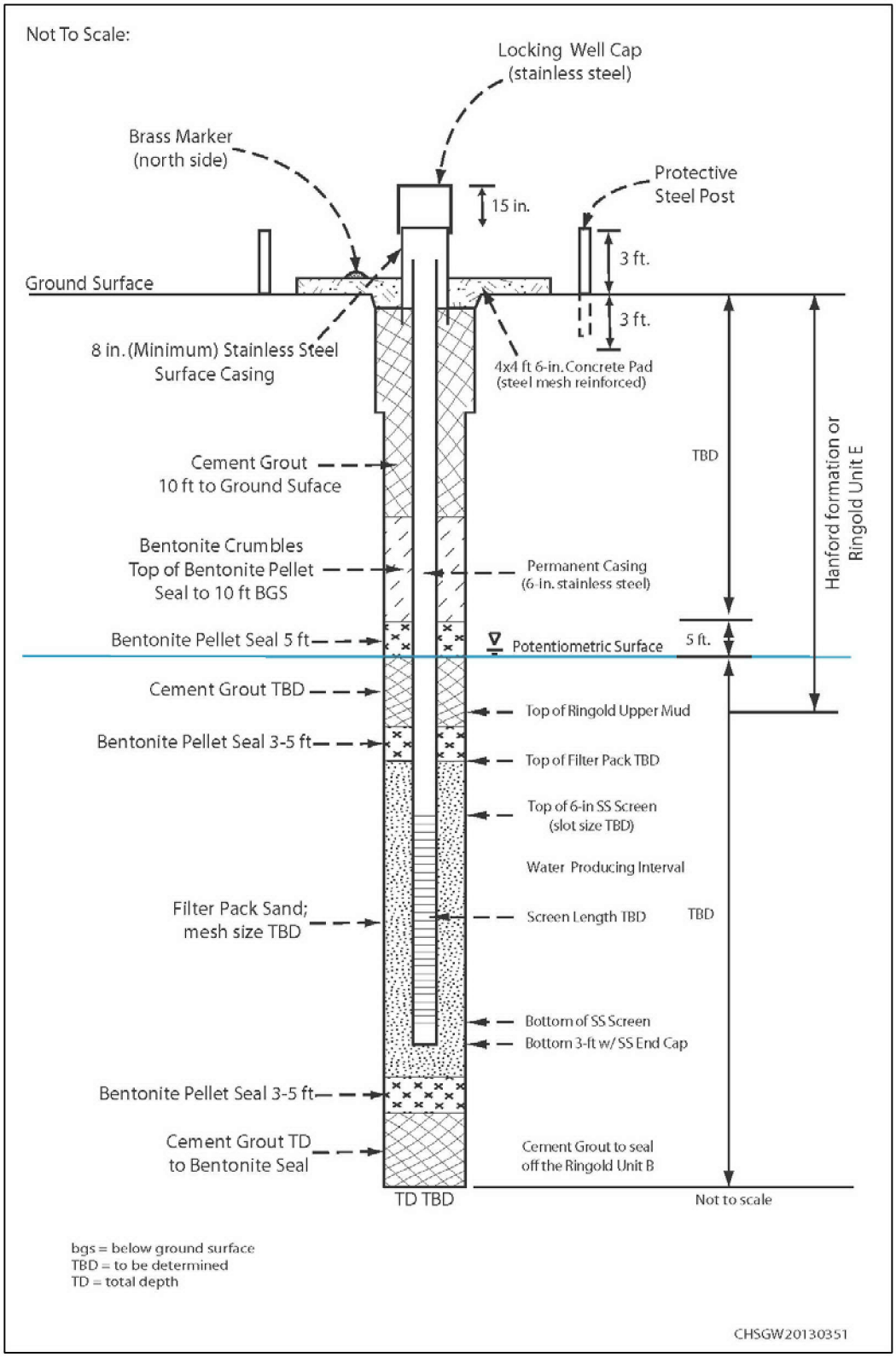


Figure 3-2. General Well Construction Diagram for Monitoring of Semiconfined to Confined Aquifer

Criteria for design, drilling, and installation of the injection and extraction wells was not in the FDC scope beyond stating that each extraction well is designed to provide the nominal flow rates identified. Table A-1 of the FDC provided a list of the 41 extraction and 14 injection wells included in the design. The design of the facility was based on the 600-gpm treatment 100-KX P&T system that was installed in 2008, with modifications as necessary. The treatment system included:

- Influent groundwater collection
- Acid pH adjustment including automated pH adjustment to reduce the groundwater pH
- A minimum of three parallel process feed pumps (and transfer and injection boost pumps) to transfer water to the IX column trains (and influent tanks and injection wells), sufficient to achieve a maximum flow rate of 2,300 L/min (600 gpm) with one pump shutdown
- Six, skid-mounted IX treatment trains with four columns/train; the flow through each train is 100 gpm at full system capacity
- IX columns contain ResinTech SIR-700
- Backwash and resin sluicing system, with resin tote sump load-in/load-out area to remove resins for offsite regeneration
- Compressed air system to supply the tote sump diaphragm pump and for operational use throughout the process building
- Caustic addition and pH monitoring of effluent to prevent treated water from being injected into the groundwater if the pH is too low
- Manual sampling and portable test kits for analysis that are used to verify Cr(VI) concentrations on a scheduled basis
- Treated water storage and adjustable frequency drive controlled injection well booster pumps
- Totes (40 ft^3 each) for resin storage and shipment
- Transfer building(s) to include transfer tank, adjustable frequency drive transfer pumps, filters, piping manifold and associated controls
- Extraction wells to include adjustable frequency drive well pumps, instrumentation, and controls
- Injection wells with level instrumentation

FDC for the HX treatment system (SGW-43616) was based on the DX system, and included the same system component descriptions. The initial system included the 31 extraction wells and 15 injection wells listed in Table A-1 of the FDC (SGW-43616).

The P&T systems continue to change to increase efficiency for river protection and mass removal. The current operational layout and changes to the system are identified in the annual P&T reports.

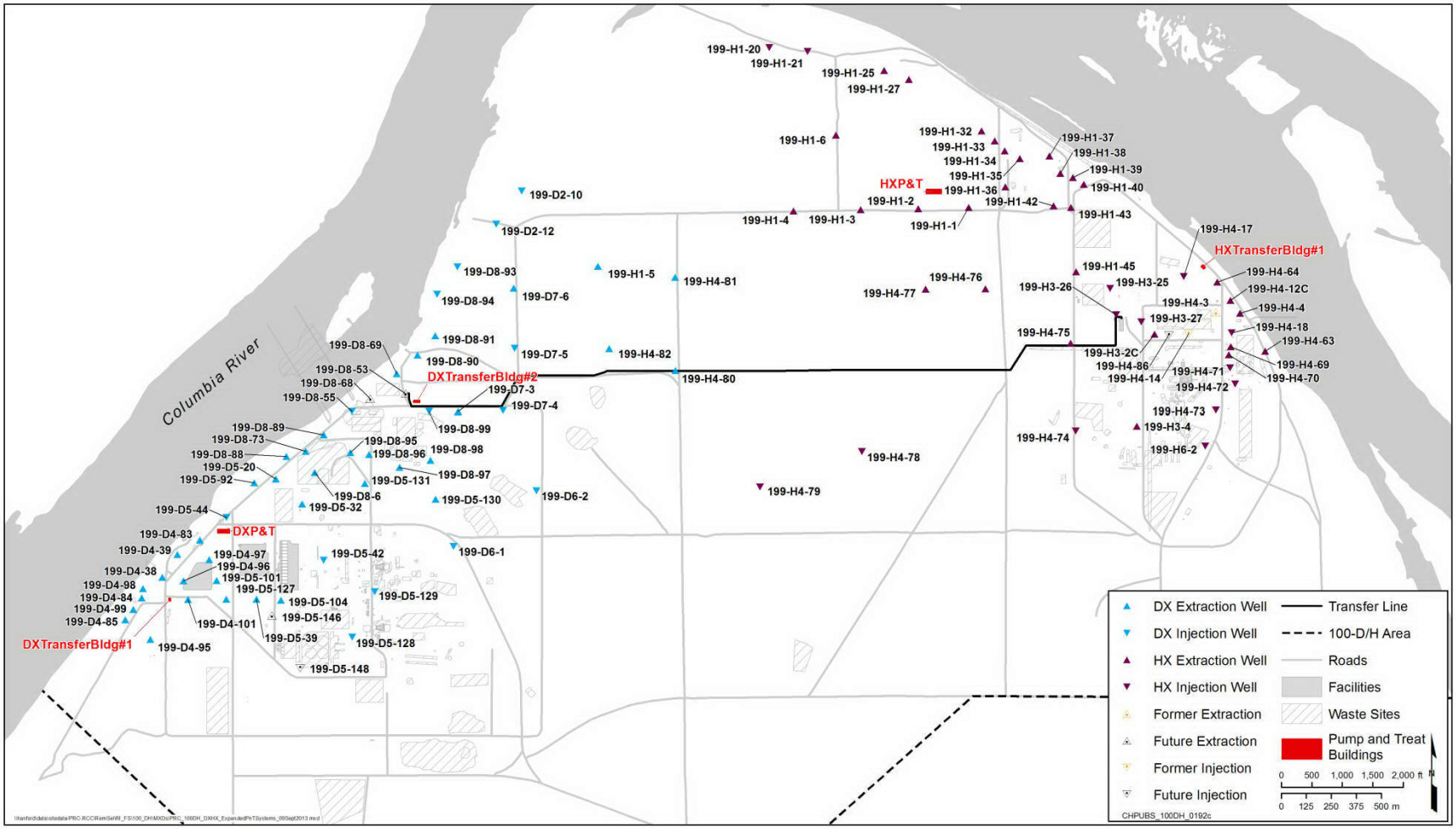


Figure 3-3. Layout of DX and HX Piping and Well Systems as of December 31, 2014

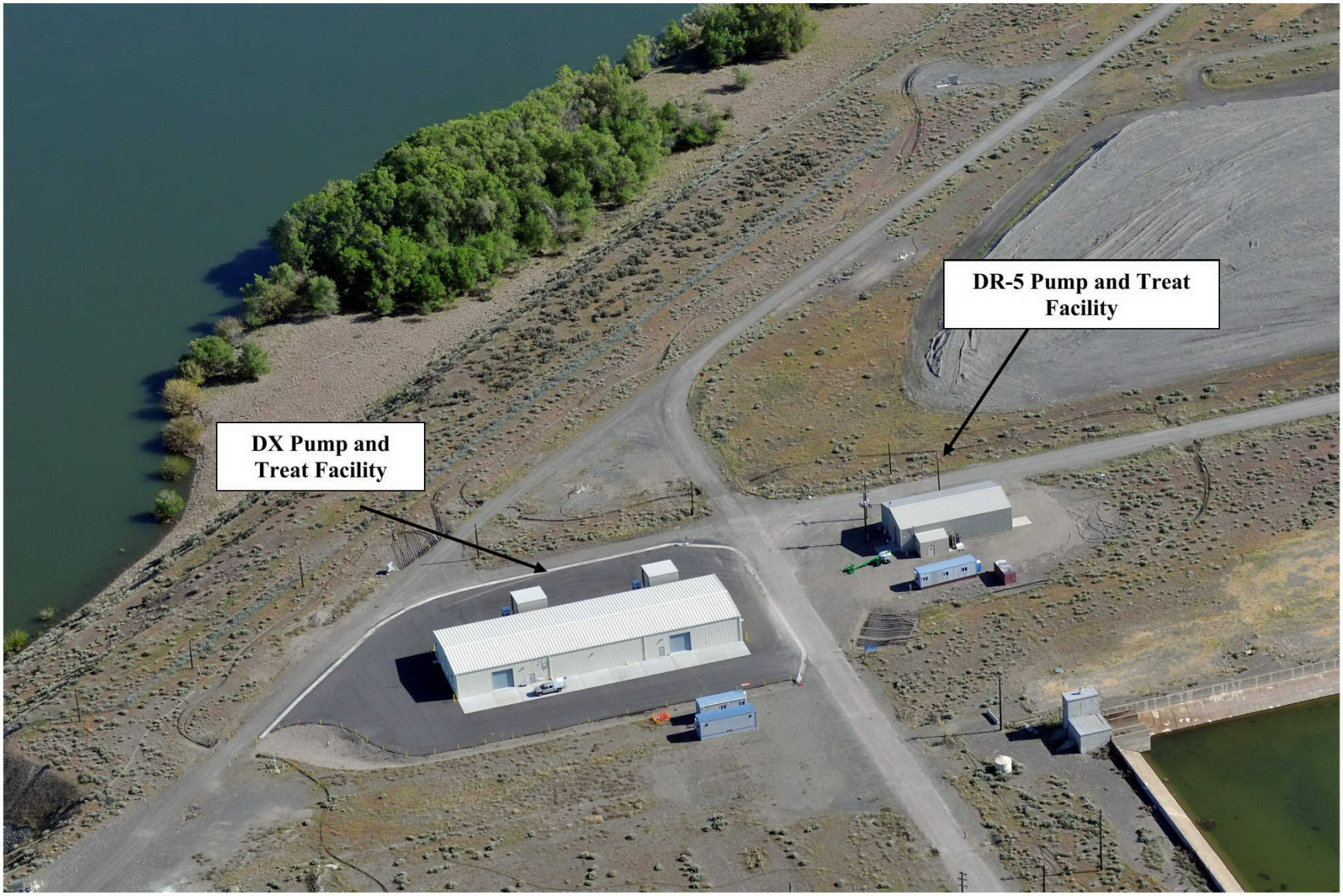


Figure 3-4. Aerial View of DX Pump and Treat Facility

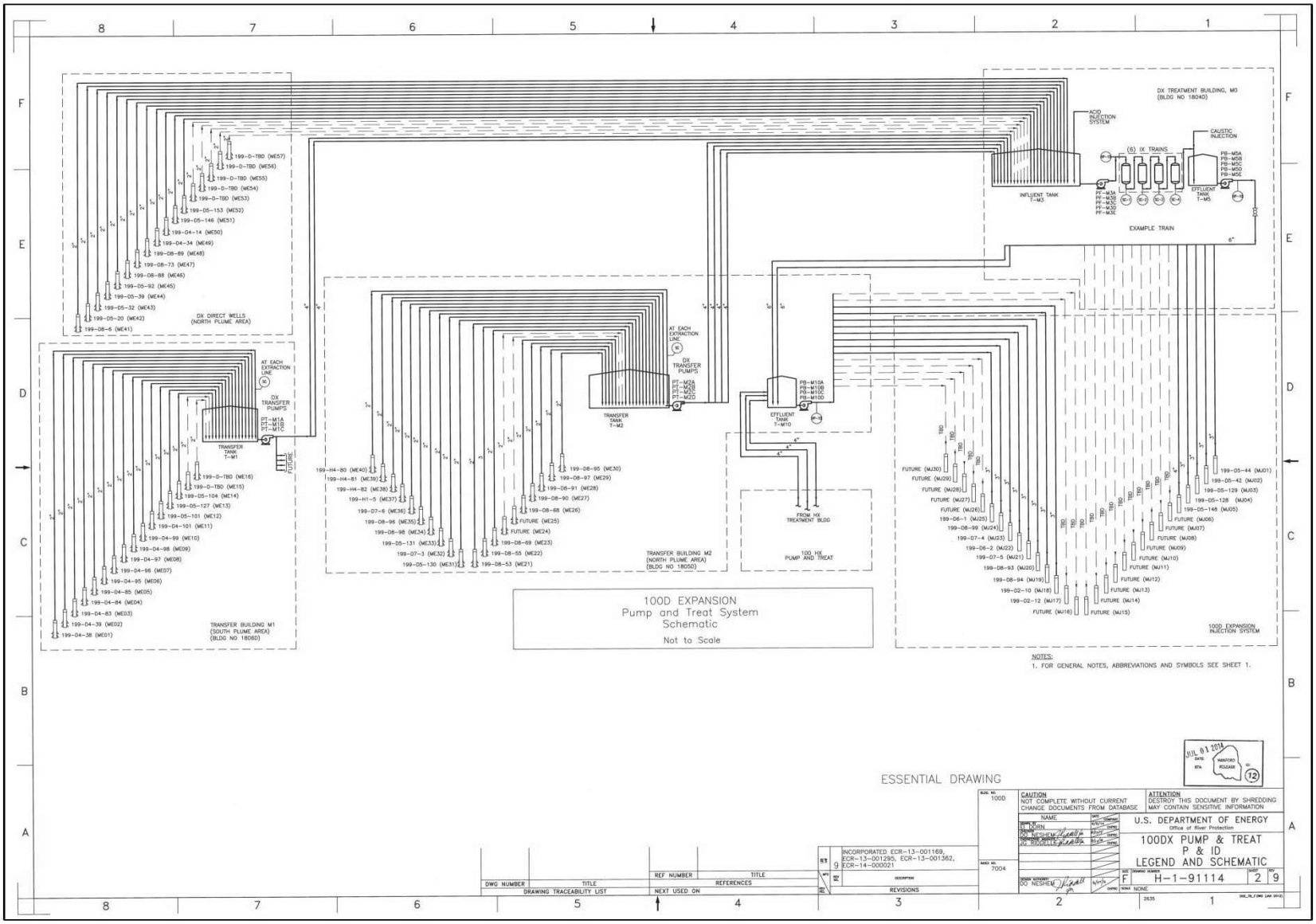


Figure 3-5. DX Pump and Treat System Schematics

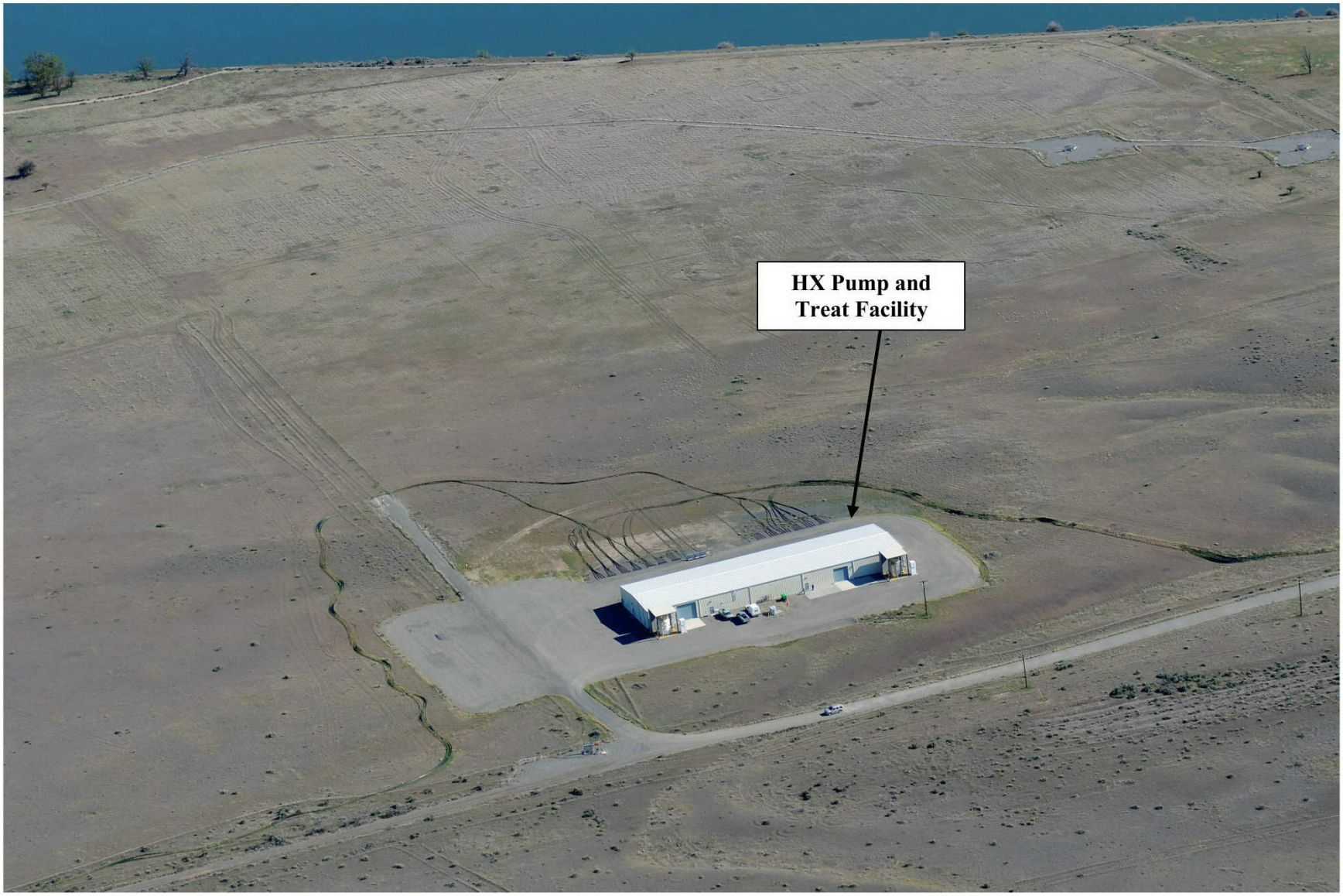


Figure 3-6. Aerial View of HX P&T Facility

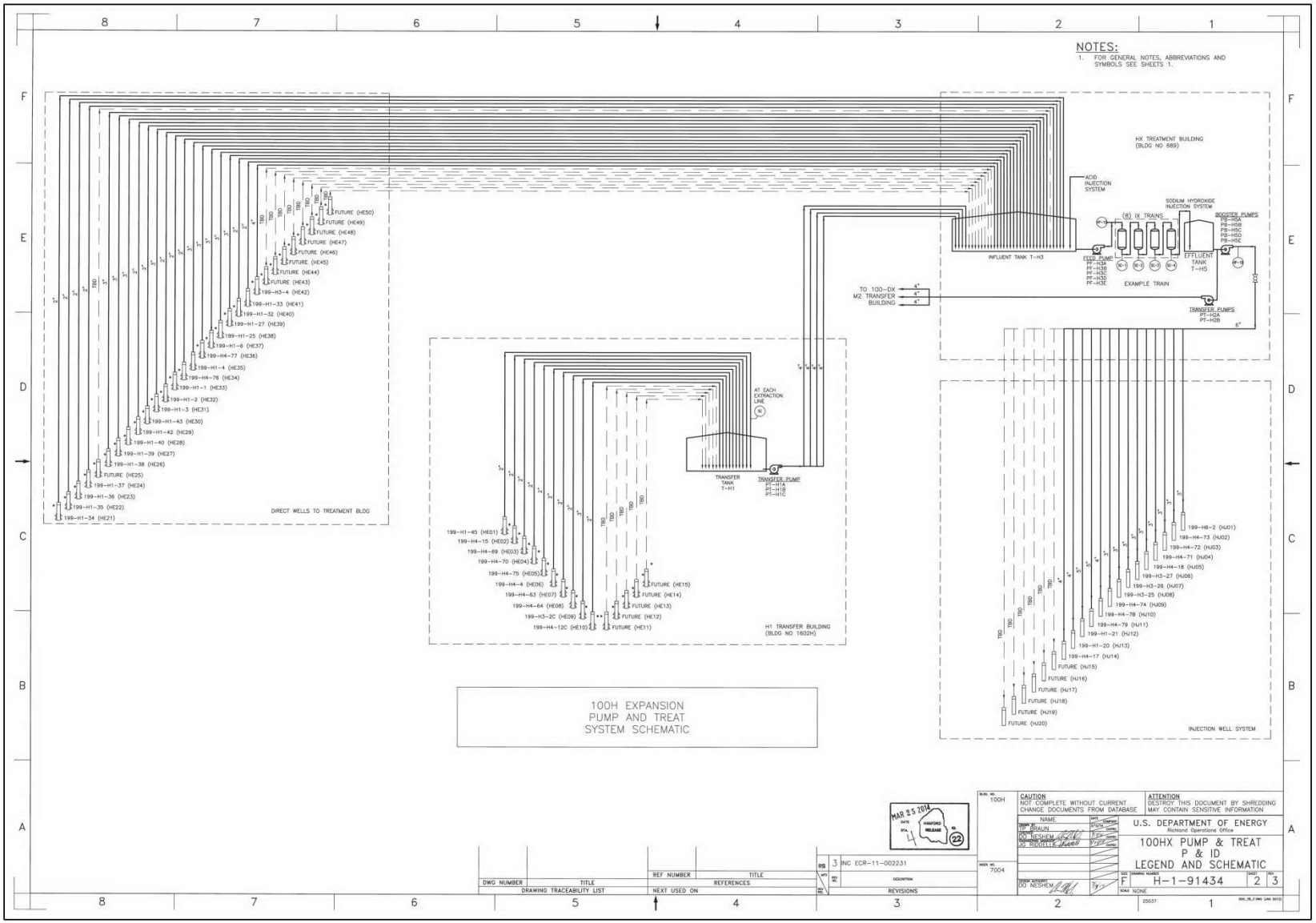


Figure 3-7. HX Pump and Treat System Schematics

DOE/RL-2015-05 documents the calendar year 2014 groundwater contamination extent and progress toward achieving the interim action RAOs. Additional details on the nature and extent of contamination and information collected for selecting a final remedial action are presented in the 100-D/H RI/FS (DOE/RL-2010-95).

In 2014, the 100-HR-3 P&T systems treated approximately 2,352 million L (621 million gal) and removed 201.5 kg (444 lb) of Cr(VI) from the groundwater. Since startup of the DX and HX systems in 2010 and 2011 through the end of 2014, approximately 8,373.7 million L (2,212.1 million gal) of groundwater have been treated, and 1,496.3 kg (3,298.8 lb) of Cr(VI) have been removed. In contrast, operation of the HR-3 and DR-5 systems from 1997 until shutdown in 2011 resulted in the treatment of an estimated 4,554 million L (1,203 million gal) of groundwater and removal of 744 kg (1,640 lb) of Cr(VI). The annual and cumulative volume of groundwater treated and annual and cumulative Cr(VI) removal are shown on Figures 3-8 and 3-9.

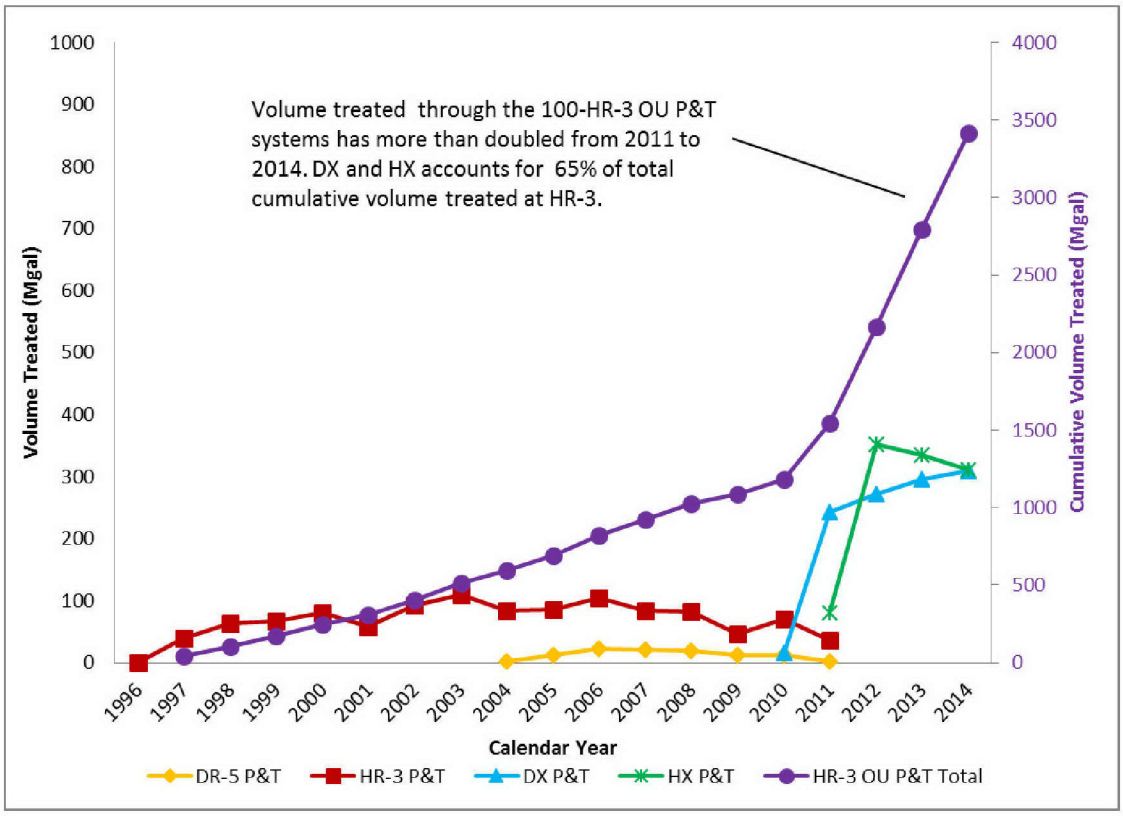


Figure 3-8. Annual and Cumulative Volume Treated at 100-HR-3 Operable Unit Pump and Treat Systems

3.3.2 In Situ Redox Manipulation Permeable Reactive Barrier

Beginning in 2000, a PRB for in situ chemical treatment of Cr(VI) in the southern plume (100-D Area) was installed as an interim remedial action in accordance with the interim ROD amendment. The design basis for the ISRM permeable treatment barrier is described in DOE/RL-99-51. Elements of the barrier design include the well spacing, well construction, barrier alignment, barrier length, barrier width, and longevity. Elements of the treatment system design include the method of ISRM emplacement (i.e., the method to inject the chemical reagent and create the treatment zone) and the description of the ISRM treatment equipment (mobile process trailer, dilution water supply components, and purgewater extraction and storage/disposal components). Figure 1-10 shows the locations of the ISRM well network (treatment and monitoring wells).

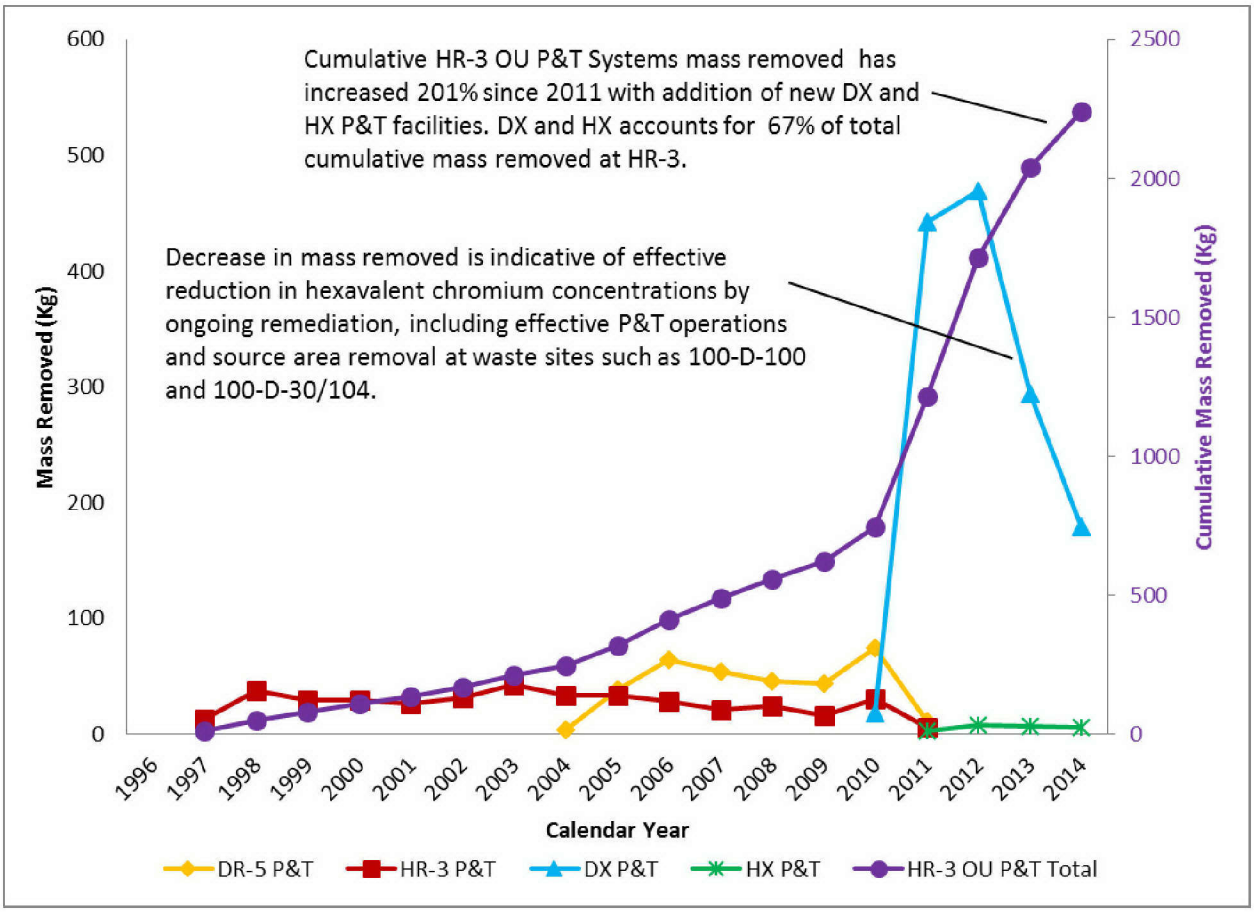


Figure 3-9. Annual and Cumulative Cr(VI) Mass Removed by 100-HR-3 Operable Unit P&T Systems

The PRB uses ISRM technology to create a treatment zone in which ferric iron is reduced to ferrous iron within the aquifer matrix. This is accomplished by injecting sodium dithionite into the aquifer through wells, then withdrawing the unreacted reagent and reaction products (predominately sulfate) through the same wells. The unreacted reagent and reaction products are pumped to the ISRM evaporation pond. The sodium dithionite serves as a reducing agent for iron, producing a reducing-type environment in the aquifer. As the groundwater migrates through the treatment zone, mobile Cr(VI) is reduced to less toxic and less mobile Cr(III), which precipitates from solution. DO and some nitrate are also removed from the groundwater as it passes through the PRB.

The oxidation-reduction treatment zone is approximately 680 m (2,230 ft) long (aligned parallel to the Columbia River) and approximately 100 to 200 m (330 to 660 ft) inland. The barrier consists of 65 wells spaced across the southern Cr(VI) plume. The treatment zone was designed to reduce the concentration of Cr(VI) in groundwater to below 20 µg/L, as measured at seven compliance wells located between the treatment zone and the Columbia River.

The interim ROD amendment acknowledged that injection of chemicals associated with the treatment barrier would result in aquifer degradation, though concentrations were not anticipated to result in exceedances of primary DWSs or adversely affect the beneficial use of groundwater. No exceedances of primary DWSs associated with the chemical injections have been identified. Monitoring of sulfate identified concentrations that exceeded the secondary DWS, though concentrations have declined and were below the standard in 2012 (DOE/RL-2013-22).

Breakthrough of Cr(VI) was identified at the northeast end of the ISRM barrier, indicating the ability of the ISRM to meet RAOs has varied, and the required treatment levels are not consistently achieved. In accordance with the 1999 ROD amendment (EPA/AMD/R10-00/122), Ecology and EPA determined the alternative action to be taken when barrier breakthrough was identified. Ecology and EPA determined that P&T system expansion, to encompass areas downgradient of the barrier where breakthrough was identified, was to be used to provide a protective remedy. A letter of non-significant change to the ROD (11-AMCP-0002), issued in October 2010, clarified that expansion of the existing DR-5 P&T system to the DX system included wells located downgradient of the plume breakthrough that would provide a protective remedy to meet the RAO for river protection.

In addition, the letter of non-significant change to the ROD (11-AMCP-0002) indicated that the barrier would no longer be actively maintained. Current plans for the ISRM barrier are to continue performance monitoring.

3.3.3 Operations and Maintenance Plan

An O&M plan (DOE/RL-2013-49) that describes the DX and HX P&T operations has been prepared for review and approval. The O&M plan includes the following information:

- Operational criteria
- Routine and preventive O&M
- Transient conditions
- Corrective maintenance
- O&M practices and training requirements
- Inspection requirements
- Operational monitoring
- Reporting
- Health, safety, and quality

The O&M plan includes details on the scheduling of maintenance activities to minimize impacts to system performance. Efforts will be made to avoid scheduling preventive maintenance activities during the low river stage season identified in the SAP (DOE/RL-2013-30), as well as during freezing conditions. The O&M plan is a primary document as described in the TPA Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*).

3.4 Managing and Communicating Uncertainties

Groundwater remediation activities are subject to a range of uncertainties that fall into three major categories: incomplete CSM, system O&M that does not achieve quantitative benchmarks, or resource limitations. The following subsections describe how uncertainties in any one of these elements could affect interim action P&T system operations and what strategies are needed to minimize these effects.

3.4.1 Conceptual Site Model

Groundwater remediation at the 100-HR-3 OU involves integration of engineered systems constructed in the subsurface environment. Imperfect knowledge of subsurface conditions represents a large portion of the overall remedial action uncertainty. The following uncertainties may be encountered during P&T activities:

- Groundwater contaminant plume geometry and magnitude are not clearly defined in all areas. Actions that can be used to reduce this area of uncertainty may include installation of additional monitoring wells at selected locations to provide bounding measurements (vertical and horizontal distribution) of

contaminant concentrations and collect additional measurement and observations of local hydrogeologic conditions and stratigraphy.

- Potential continuing contribution to groundwater from secondary sources in the vadose zone, periodically rewetted zone, or from within the aquifer is not well defined in some areas. Actions that can be used to reduce this area of uncertainty include performing additional characterization of the soil column in historical release areas, and installing monitoring wells to measure groundwater quality changes at known or suspected release locations.

3.4.2 Remedial System Performance

The remedial systems may not perform as expected during operations due to variations in component functionality or system design. The following types of performance uncertainty may be experienced:

- Exact performance of extraction and injection wells may vary from design expectations. The following actions can be used to reduce uncertainty:
  - Monitor system element performance and establish corrective action limits for selected metrics.
  - Continue preventive and corrective maintenance on remedial systems.
  - Ensure that remedial systems have adequate levels of excess capacity or redundancy to maintain operations.
- Aquifer hydraulic parameters may vary from average or typical values. The following actions can be used to reduce uncertainty from this element:
  - Collect samples for aquifer hydraulic parameter measurements during drilling and construction of new and replacement wells to enhance understanding of site conditions.
  - Perform aquifer pumping tests at new and replacement wells.
  - Design system components to perform under their intended purpose.
  - Ensure adequate development of new and reconditioned wells.

3.4.3 Resource Allocation

Groundwater remediation activities include complex mechanical systems that are expected to operate over many years to achieve cleanup goals. Specific areas of uncertainties that may affect project performance and potential actions to reduce or mitigate effects of resource uncertainty include:

- Unforeseen project needs are identified during operations:
  - Maintain prioritization of project activities that allow redirection of specific project resources.
- Requested resource is not provided:
  - Provide an adequately defined technical basis for project activities.
  - Maintain prioritization of project activities that allow redirection of specific project resources.
- Selection of final remedies for OUs under interim remedial action is delayed:
  - Maintain robust operation of interim remedial systems where those systems are expected to form the basis of final actions.
- Hanford Site shutdown occurs:

- Implement safe store activities to protect systems from deterioration during nonoperational periods.

Instituting these mitigating strategies should minimize potential affects to P&T operations resulting from resource uncertainty.

This page intentionally left blank.

4 Remedial Action Management and Approach

This chapter describes the work elements and management approach associated with implementing the selected interim actions.

4.1 Project Organization

The project organization includes DOE-RL, Ecology, and the remediation contractor organizations that support the 100-HR-3 OU interim remedial actions. Figure 4-1 provides the current organizational structure.

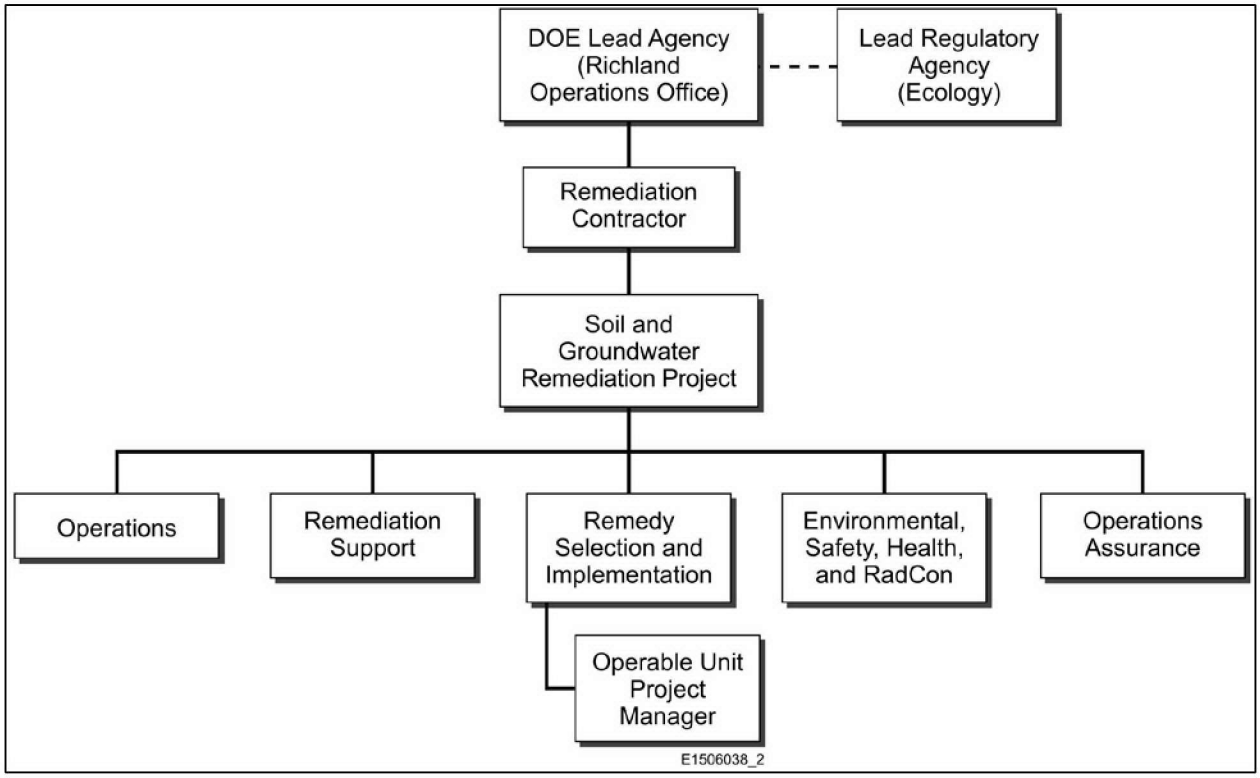


Figure 4-1. 100-HR-3 Interim Action Project Organization

- **Lead Agency (DOE)**—DOE is the lead agency under CERCLA (delegated by Executive Order 12580, *Superfund Implementation*, the primary authority under Section 104, "Response Authorities," and Section 121, "Cleanup Standards") to conduct removal and remedial actions at DOE facilities. DOE is responsible for remedial actions throughout the Hanford Site and, as such, has assigned remedial project managers to each main area and task involved with remediation activities. The lead agency is responsible for managing the assigned activities including scope, budget, schedule, quality, personnel, communication, risk/safety, contracts, and regulatory interface and works under regulatory oversight in accordance with Section 120, "Federal Facilities," of CERCLA, as implemented through the TPA (Ecology et al., 1989a). DOE obtains Congressional funding for these functions.

- **Lead Regulatory Agency (Ecology)**—Ecology is the lead regulatory agency for CERCLA remediation activities at the 100-HR-3 OU, as described in the TPA (Ecology et al., 1989a). The lead regulatory agency is responsible for overseeing activities to verify that applicable regulatory

requirements are met. Lead regulatory agency approval will be required on all TPA (Ecology et al., 1989a) primary documents (e.g., RD/RAWP, RDR, and O&M plan).

- **Remediation Contractor**—CH2M HILL Plateau Remediation Company is the prime contractor responsible for implementing CERCLA remediation activities at the 100-HR-3 OU. The following organizations within CHPRC provide functional and operational support for remediation activities:
  - **Soil and Groundwater Remediation Project**: The Soil and Groundwater Remediation Project (S&GRP) is responsible for management and implementation of remediation activities at the 100-HR-3 OU and coordinates with DOE-RL, Ecology, and Remediation Contractor personnel. The following organizations within S&GRP provide functional and operational support for the remediation activities:
    - **Operations**: The Operations organization is responsible for O&M of the P&T systems. This includes ensuring that appropriate operations support functions (e.g., radiological protection and safety) are available to support operations activities and verifying that O&M procedures have been prepared, approved as necessary, and implemented.
    - **Remediation Support**: The Remediation Support organization provides field and technical support to S&GRP. These field activities include groundwater well and investigative borehole drilling, well and borehole decommissioning, environmental sampling, and groundwater well maintenance. The organization also provides environmental sample planning, sample and data management, sample analytical support, and data quality assessment services.
    - **Remedy Selection and Implementation**: Remedy Selection and Implementation provides direction and oversight for remediation activities and coordinates with DOE-RL, Ecology, and Remediation Contractor personnel. Remedy Selection and Implementation is responsible for coordinating and evaluating remediation data and ensuring compliance with state and federal laws. The group is also responsible for collecting P&T data and tracking trends to show cleanup performance.
    - **Operable Unit Project Manager**: The OU project manager provides direction and oversight and coordinates with DOE, regulatory, and contractor personnel to support remediation activities. The OU project manager is responsible for sampling documents and requirements, field activities, and subcontracted tasks. The OU project manager works closely with the Operations, Remediation Support, Environmental, Safety, Health, and RadCon (ESHR), and Operations Assurance organizations to integrate the disciplines in planning and implementing the work scope.
    - **Environmental, Safety, Health, and RadCon**: The ESHR organization supports S&GRP by providing a safe work environment. The organization is responsible for protection of employees, the public, and the environment and provides assistance in complying with company, DOE, and Occupational Safety and Health Administration (OSHA) standards and requirements. Safe operations are achieved by applying the Integrated Safety Management System (ISMS) and the Voluntary Protection Program (VPP).
    - **Operations Assurance**: The Operations Assurance organization provides support to S&GRP to execute project activities in a manner that improves operational efficiency and performance. Operations Assurance responsibilities include training, procedures, lessons learned, issues management, and emergency preparedness.

4.2 Change Management

The following three types of changes in remedial actions could affect compliance with the requirements in the interim action ROD and/or interim action ROD amendment:

- Nonsignificant or minor change does not affect the remedy identified in the interim action ROD or interim action ROD amendment. An example of a nonsignificant change may include modifications to the remedial action schedule that do not affect an agreed upon milestone. Minor changes should be documented in the appropriate post-decision project file (e.g., through interoffice memoranda or in logbooks) or project manager meeting minutes.
- Significant change is defined as a change that significantly modifies the scope, performance, or component cost for the remedy as presented in the ROD. All significant changes will be addressed in an ESD.
- Fundamental change does not meet the requirements set forth in the interim action ROD or interim action ROD amendment or incorporates remedial activities not defined in the scope of the interim action ROD or interim action ROD amendment. Should this situation arise, the ROD must be amended.

Determining whether a change is significant or fundamental is the responsibility of the lead agency (DOE) and lead regulatory agency (Ecology). The OU project manager is responsible for tracking all changes and obtaining appropriate reviews by staff. The OU project manager will discuss the changes with DOE, followed by discussions with Ecology. Types of changes and processes associated with the change are identified in Table 4-1. Informational notifications will be provided to Ecology if operations are temporarily suspended due to unplanned circumstances such as a power surge or weather extremes.

Table 4-1. Project Modifications and Approval Mechanisms for Change Management

Type of Change	Documentation Process	Description
Nonsignificant Changes	Project File (technical memos or calculations)	Reroute injection or extraction conveyance.
		Modify ion exchange vessel configuration.
		Modify well pumping rates within record of decision specified limits.
		Modify instrumentation and control systems.
	RL Informational Notifications to Regulator	Temporarily suspend operations due to unplanned circumstances (e.g., power surges or weather extremes).
	Tri-Party Agreement-Change Notice or Document Revision	Add or remove extraction/injection well (well realignments).
		Permanently modify treatment system capacity.
		Change ion exchange media type.
		Modify sampling requirements defined in Table 4-2 of DOE/RL-2013-49.
		Discontinue pumping at specific locations in response to plume cleanup/achieving remedial action objectives in specific plume segments.

Table 4-1. Project Modifications and Approval Mechanisms for Change Management

Type of Change	Documentation Process	Description
		Update this remedial design/remedial action work plan.
Significant Changes	Explanation of Significant Differences	Realize cost increase or decrease (>+50% or <-30%).
		Add another contaminant treated with same technology.
		Add new/additional hexavalent chromium contaminant plume areas to the remedy.
Fundamental Changes	Record of Decision Amendment	Remedy change.
		Add constituent treatment (additional technology).

4.3 Operational Approach

Operation of the P&T system involves O&M, engineering, and support functions. Operations activities include operation and control of facility systems, access control, training and qualification of operators, sample collection, emergency response, and continuous improvement through lessons learned. Feedback using tools such as management assessments, independent assessments, quality assurance (QA), and DOE-RL oversight will be in place throughout the lifecycle of the project. The feedback will be used to identify preventive, corrective, and modification maintenance. Engineering evaluations and plant/system optimization will be ongoing activities for continuous improvement of efficiency, reliability, and maintainability. Radiation control, industrial safety and hygiene, and waste management programs for long-term surveillance, oversight, and stewardship of the facility will be updated as conditions change or as new activities warrant.

Operation of the P&T system is expected to be dynamic in order to optimize contaminant recovery and system performance. As such, operations will adjust flow rates from individual wells and treatment components, as necessary based on performance, which may include eliminating wells that have already achieved cleanup levels or identifying alternate extraction/injection wells. Flow rates may also be adjusted to accommodate seasonal variations, such as decreasing extraction rates when water levels drop in order to maintain hydraulic capture without shutting down a well completely. Per the interim action ROD (EPA/ROD/R10-96/134), in the event of a partial or total system shutdown, Ecology may impose additional near-river compliance sampling requirements. Ecology may also authorize short-term intentional shutdowns for the purposes of observing aquifer response or for other purposes, as deemed appropriate. In the event of special conditions, such as an unusual flood event or prolonged downtime of the P&T system, extra monitoring at the direction of EPA or Ecology shall be conducted. The system run time is reported for the DX and HX systems in the annual P&T reports.

An O&M plan (DOE/RL-2013-49) developed for the 100-HR-3 P&T systems includes process monitoring involving extraction/injection wells and facility monitoring. Process and facility monitoring data will be used to assess contaminant mass removal and treatment effectiveness.

While the P&T system is operating, groundwater elevation data are collected from system wells and wells in the AWLN. Water level data are used to monitor the extraction and injection rates, assess plume capture, and assess the need to rebalance flow rates to optimize capture zone boundaries. Water level data are supplemented with information collected in accordance with SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*. The primary objective of

monitoring is to determine groundwater flow rates and directions by collecting annual measurements across the Hanford Site. These sitewide data are used to provide groundwater flow maps for the annual groundwater monitoirng reports.

Table 4-2 summarizes work tasks by activity that are ongoing for the P&T systems, the minimum frequency, and where the information is documented.

4.3.1 Up-Time Requirements

In accordance with the interim action ROD, operating P&T systems will achieve substantial treatment for the interim action. As specified in the interim action ROD, the extraction and treatment system is designed to run on an essentially continuous basis in such a way that routine procedures and mechanical maintenance can be conducted with minimal impact to system operations. The system is designed, so if one or several of the wells are out of service (e.g., due to a mechanical problem or a well pump replacement), the rest of the system can continue operating. The system is also winterized, so severe cold weather does not cause extended shutdown of the system and compromise RAOs. System run time is provided in the annual report.

4.3.2 Effluent Monitoring

The interim action ROD recognizes that ambient water quality standards and state injection standards for contaminants other than Cr(VI) may not be met. Potential co-contaminants identified in the interim action ROD for the 100-HR-3 OU included nitrate, strontium-90, tritium, uranium, and technetium-99. COPCs identified in the 100-D/H RI/FS (DOE/RL-2010-95) may be extracted, along with Cr(VI) contaminated groundwater, and may enter the treatment system but are not targeted for treatment. Monitoring of the effluent is described in DOE/RL-2013-30 and DOE-RL-2013-49. Effluent sampling results will be used to track plume boundaries and monitor radiological conditions. Effluent monitoring is conducted to identify if the effluent for injection meets the discharge criteria. Current remedy performance monitoring of the treatment system effluent indicates that no other contaminants are discharged at concentrations exceeding water quality standards.

4.3.3 Pond Decommissioning for the ISRM System

Decommissioning of the 147-D ISRM Evaporation Pond was added as an activity to DOE/RL-2010-34, *Removal Action Work Plan for River Corridor General Decommissioning Activities*, through TPA-CN-557 on November 12, 2012. The work was performed by WCH in accordance with WCH-572, *Decommissioning Plan for the 147-D In Situ Redox Manipulation (ISRM) Evaporation Pond*. Details of the pond decommissioning, completed on June 16, 2014, are provided in WCH-617, *Decommissioning Report for the 147D In Situ Redox Manipulation (ISRM) Evaporation Pond*, and summarized in the following paragraphs.

Table 4-2. Remedial Action Work Tasks

Work Task	Requirement (Location)	Activity	Minimum Frequency	Where Documented
100-HR-3 Remedial Design/Remedial Action Work Plan (This RD/RAWP)				
Evaluate Progress of Remediation	Conduct performance monitoring and calculate progress of remedy in removal of contaminant mass and reduction in plume dimensions.	Monitor and assess the progress toward completion of the remedial actions using individual well analysis and simple regression analysis. (Section 6.2.2 this RD/RAWP)	Annual – during active remediation	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Evaluate Completion of Active Remediation	Develop and implement the necessary analysis to initiate the rebound study.	Use available analytical tools, including advanced analysis, to determine active remediation can be suspended. Prepare rebound study plan. (Section 6.2.2.3 this RD/RAWP)	Once[a] – when evaluation indicates remediation is complete	Technical Memorandum
Perform Rebound Study/Develop SAP and DQO as Applicable	Conduct rebound study monitoring and evaluation.	Determine whether contaminant concentrations will remain below cleanup levels when the aquifer is no longer under the influence of active remedial processes. (Section 6.2.3.1 this RD/RAWP)	Once[b] – to develop the plan; annual evaluation during the rebound study	Rebound Study Plan and SAP Hanford Site Annual Groundwater Monitoring Report Final Rebound Report
Compliance Monitoring	Conduct evaluation of monitoring data and attainment of RAOs.	When it is determined the wells are not being influenced by active remediation and concentrations will remain below cleanup levels, continue collecting monitoring data to demonstrate attainment of RAOs. (Section 6.2.4 this RD/RAWP)	Triannual monitoring	Hanford Site Annual Groundwater Monitoring Report Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Summarize Completion of Interim Actions	Evaluate and summarize the progress of remedial actions under the interim action RODs	Summarize progress toward meeting the RAOs and cleanup levels under the interim action ROD. (Section 6.3 this RD/RAWP)	Once – transition to final remedial action	Summary in RD/RAWP prepared for final ROD

Table 4-2. Remedial Action Work Tasks

Work Task	Requirement (Location)	Activity	Minimum Frequency	Where Documented
Summarize Completion of Remedial Actions	Final report on completion of remedial actions under the ROD	Prepare final close out report in accordance with guidance. (Section 6.4 this RD/RAWP)	Once	Operable Unit Close Out Report
Evaluate RD/RAWP	Evaluate existing RD/RAWP to determine if updates are appropriate; consider a complete document update after five TPA-CNs.	Changes to the RD/RAWP are handled consistent with the TPA Action Plan (Section 4.2 this RD/RAWP)	After five TPA-CNs	Per Change Control Requirements
Sampling and Analysis Plan for 100-HR-3 Groundwater Operable Unit Monitoring (DOE/RL-2013-30)				
Evaluate Monitoring Results	Evaluate groundwater monitoring results to ensure monitoring objectives are being met.	Monitor remedial action performance to protect Columbia River and evaluate plume geometry and hydraulic capture for remediation of contaminated groundwater (Section 4.3.3, this RD/RAWP)	Annual	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Evaluate Uncertainty Sampling	Calculate “uncertainty” analyte concentrations and compare with action levels.	Identify locations and analytes for “uncertainty” sampling to confirm infrequently detected analytes are not COPCs and confirm analytes with method detection limits above action levels are not COPCs (Section 4.3.3, this RD/RAWP)	Annual	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Evaluate Potential Source Areas	Evaluate contaminant trends to identify if there are continuing vadose sources.	Identify locations and analytes for sampling to confirm they are not continuing sources of COCs/COPCs in groundwater (Section 1.1 of DOE/RL-2013-30)	Annual	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Evaluate Monitoring Plan	Evaluate existing monitoring plan to determine if updates are appropriate; consider a complete document update after five TPA-CNs.	Changes to the sampling document are handled consistent with HASQARD (DOE/RL-96-68) and the TPA Action Plan (Section 2.1.4 of DOE/RL-2013-30)	After five TPA-CNs	Per Change Control Requirements

Table 4-2. Remedial Action Work Tasks

Work Task	Requirement (Location)	Activity	Minimum Frequency	Where Documented
100-HR-3 Operations and Maintenance Plan (DOE/RL-2013-49)				
Remedial Process Optimization	Perform systematic review of remedial system components to identify opportunities for enhancing system performance.	Integrate the results of RPO analyses with system performance monitoring data to identify recommendations for changes to the system configuration and/or operation (Section 2.4.3, this RD/RAWP)	Annual	Recommendations – Annual SGW Document for Upcoming Year Implementation – Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Evaluate Effects of Source Removal/Remediation Schedule	Evaluate source remediation schedule to determine potential monitoring and treatment system impacts.	Identify if source remediation may result in changes needed for well configuration, such as replacing a decommissioned well or reconfiguring piping (Section 2.4.3, this RD/RAWP)	As needed	Technical Memorandum
Maintain Remedial Systems	Perform required preventive and corrective maintenance on remedial systems, including facility structures and annual system winterization.	Perform routine and preventive maintenance of P&T system components in accordance with engineering evaluations and approved procedures (Section 3.2 of DOE/RL-2013-49)	Per maintenance schedule and as needed	Job Control System
Verification of Water Level Monitoring Equipment	Evaluate function and performance of automated water level in system wells; perform repairs and/or calibration as necessary.	Perform routine and preventive maintenance for mechanical components on the remedial system wells (Section 3.2 of DOE/RL-2013-49)	Per maintenance schedule and as needed	Work Packages
System Calibration	Perform routine calibration of remedial system components.	Perform routine maintenance and calibration of P&T system components in accordance with engineering evaluations and approved procedures (Section 3.2 of DOE/RL-2013-49)	Per maintenance schedule and as needed	Job Control System

Table 4-2. Remedial Action Work Tasks

Work Task	Requirement (Location)	Activity	Minimum Frequency	Where Documented
Well Maintenance	Conduct technical evaluation of wells to assess well conditions and performance.	Conduct well maintenance program on extraction, injection, and monitoring wells within the 100-HR-3 OU (Section 3.2 of DOE/RL-2013-49; SGW-58236)	As identified in Figure 1 of SGW-58236	Operating Records Hanford Site Annual Groundwater Monitoring Report
Evaluate Co-contaminants in System Effluent	If two consecutive co-contaminant concentration levels are ≥ 90% MCL, or a single MCL exceedance occurs, then review data and discuss impacts with regulatory agency.	Monitor process water for co-contaminants and track co-contaminant concentrations and plume boundaries (Section 4.3.3, this RD/RAWP)	Quarterly	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Assess System Performance	Evaluate system performance and aquifer impacts.	Collect treatment process water samples in order to monitor system treatment performance and determine the need for IX resin changeout (Section 4.2 of DOE/RL-2013-49)	As needed	Annual Summary Report for the 100-HR-3 and 100-KR-4 P&T Operations, and 100-NR-2 Groundwater Remediation
Update O&M Plan	Evaluate the O&M plan to determine if updates are appropriate; consider document update after five TPA-CNs.	Changes to the O&M plan are handled consistent with the TPA Action Plan (Section 5.3 of DOE/RL-2013-49)	After five TPA-CNs	Per Change Control Requirements

a. If remediation is restarted, this activity may be repeated.

b. There may be multiple areas of the aquifer where separate rebound studies are performed.

COC = contaminant of concern

COPC = contaminant of potential concern

DOE-RL = U.S. Department of Energy, Richland Operations Office

IX = ion exchange

MCL = maximum contaminant level

RPO = remedial process optimization

TPA-CN = Tri-Party Agreement-Change Notice

The ISRM evaporation pond consisted of a 60 mil high-density polyethylene liner on a 10 cm (4 in.) layer of sand. The interior of the pond above the liner was filled with 30 cm (12 in.) of sand bedding. The pond was surrounded by a 0.6 m (2 ft) high berm, which also served as a gas vent for the liner. The ISRM evaporation pond was maintained for use as needed for disposal of extracted ISRM process groundwater during barrier emplacement in FYs 2000, 2001, and 2002. Additional waste streams were also identified as suitable for disposal in the pond, as identified in the interim action waste management plan (DOE/RL-97-01). Following construction of the DR-5 P&T system in 2004, rinsate and filtrate from the DR-5 groundwater treatment system were discharged to the ISRM evaporation pond. In January 2009, all discharges to the pond were stopped. In July 2009, a fixative was applied to the outer one-third to one-half of the pond area (DOE/RL-2009-01, *Fiscal Year 2008 Annual Summary Report for the In Situ Redox Manipulation Operations*).

An action specific applicable or relevant and appropriate requirement (ARAR) for an evaporation pond to be located at 100-D, that was not included in the ROD amendment, was identified in the RDR/RAWP (DOE/RL-99-51). This ARAR required the pond to be designed, constructed, and operated in accordance with WAC 173-304-430, "Minimum Functional Standards for Solid Waste Handling," "Surface Impoundment Standards;" this requirement is included in the 2003 ESD (EPA/ESD/R10-03/606), which identified that at the completion of the project, the evaporation pond would be dismantled. Any remaining purgewater would be trucked to the Purgewater Storage and Treatment Facility (PSTF) or Effluent Treatment Facility (ETF) for disposal. Any remaining sediments or precipitates would be collected as solid wastes and characterized to determine waste disposal requirements. The ESD also noted that sulfate in the precipitate was not an environmental concern because sulfate is neither a carcinogen nor a toxic waste. WAC 173-303 is identified as an ARAR in the RDR/RAWP (DOE/RL-99-51). Accordingly, solid wastes, including the pond liner and accumulated evaporation pond sediments, were evaluated and disposed to ERDF. Waste associated with the ISRM project was designated in accordance with WAC 173-303, using process knowledge, historical analytical data, and/or analyses of samples identified in project documents or SAPs, as appropriate (DOE/RL-97-01). The waste designation was applicable to 40 CFR 268, which is an applicable action specific requirement. Samples of the pond sediment were collected in July 2009, and are reported in MSA, 2009, *Data Package Summary Analytical Laboratory F09-053 In Process Sampling and Analysis of the ISRM Pond Soil Sampling*. WCH collected additional pond sediment samples in December 2013 for radiological analysis to support completion of the waste profile for disposal to ERDF. High activities of naturally occurring potassium-40 were identified, and the pond sediment was managed using radiological controls.

Pond decommissioning activities began on April 8, 2014, with the removal of bird chase wire and ecology blocks, and was completed on June 16, 2014. Decommissioning included removal and disposal of accumulated sediment, the pond structure (sand bedding material, 60 mil high-density polyethylene liner), bird chase wire, and perimeter fence to ERDF. Approximately 0.5 to 1.5 m (1 to 5 ft) of soil below the pond liner was also removed and disposed at ERDF. Approximately 39,000 tons of material was removed and disposed to ERDF. All work was conducted in accordance with requirements for closure of surface impoundments (WAC 173-304-430(2)(g)), which included removing all solid wastes including liners to another permitted facility and returning the site to its original or acceptable topography.

Verification samples were collected from the footprint of the remediated pond following decommissioning. Verification samples were analyzed for COPCs (chromium [total and hexavalent]), chloride, sulfate, sulfide, nitrate, nitrate/nitrite, pH, potassium-40, and metals (antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc). Results for the 12 verification samples were compared to soil cleanup levels in Table 2-1 of DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*. No constituents were detected at concentrations exceeding soil cleanup levels following remediation of

the 147-D ISRM Evaporation Pond. As documented in D4-100D-005, *Facility Status Change Form (for DOE/RL-2010-34 Facilities)*, all removal actions required by the action memo are complete, and no additional actions are anticipated.

4.3.4 Data Use and Interpretation

As described in Section 2.4, operational and monitoring data will be reviewed and evaluated to optimize performance of the system. Performance reports are prepared to evaluate the effectiveness of treatment systems and progress toward achieving the RAOs in the interim action ROD. Elements of the reports include evaluation of contaminant concentration and hydraulic capture efficiency of the well network. The annual groundwater P&T reports (e.g., DOE/RL-2015-05) include summaries of the following:

- Well and aquifer tube locations
- Layout of the current P&T systems
- Cr(VI) mass removal and volume of treated groundwater
- Influent and effluent contaminant concentrations
- System availability (run time)
- Interpolated and simulated capture frequency
- Quantitative and qualitative assessment of shoreline protection

The report also provides an assessment of the effectiveness of system operations. The P&T annual reports compare the estimated extent of hydraulic containment for the 100-HR-3 P&T systems with the estimated extent of chromium contamination in groundwater to estimate the extent of hydraulic containment. An example of the calculations and details of the procedures used are provided in ECF-Hanford-14-0035, *Description of Groundwater Calculations and Assessments for the Calendar Year 2013 (CY2013) 100 Areas Pump-and-Treat Report*.

The annual groundwater monitoring reports, such as DOE/RL-2015-07, include summaries of the following:

- Groundwater contaminant concentrations
- Plume areas
- Water table elevations
- Contaminant trend plots

The web based version of recent annual reports also provides tools for plotting and tracking contaminant plumes, charting contaminant trends in groundwater, and examining geological cross sections. Table 4-2 lists the reporting tasks.

This page intentionally left blank.

5 Environmental Management and Controls

This chapter describes environmental management and controls associated with implementation of the DX and HX P&T systems and the ISRM barrier.

5.1 Air Emissions

The treatment process for removing Cr(VI) uses SIR-700 resin, and there are no process air emissions for this CERCLA response action. There are two emergency generators: one each located at the HX and DX main process buildings. The purpose of the generators is to provide backup power to heat tracing for tanks and piping that hold/transfer the 45 percent sodium hydroxide, as the sodium hydroxide will solidify at approximately 4.4°C (40°F). These generators are for emergency use, in the event of a main power supply failure, and are periodically run for testing and maintenance. Each 25.5 kW generator is powered by a 34 horsepower Tier 4i diesel engine.

Both emergency generators meet 40 CFR 60.4205(b), Subpart IIII (Table 2) emission requirements (emergency use diesel engine powered generator set 19≤ kW<37, manufactured 2008 and later) in g/kW-hr (g/HP-hr):

- NOx + NMHC 7.5 (5.6)
- CO 5.5 (4.1)
- PM 0.30 (0.22)

The engines meet this standard as the manufacturer certifies the engine complies with the Tier 4i standards. For 40 CFR 60.4209(a), "Monitoring Requirement," the engine meets the standards applicable to nonemergency engines and does not require a diesel particulate filter to meet the emissions standards; therefore, no additional monitoring is required. Maintenance will be performed in accordance with manufacturer recommendations on any emission related devices or systems.

5.2 Reporting Requirements for Non-Routine Releases

40 CFR 302, "Designation, Reportable Quantities, and Notification," requires immediate notification to the National Response Center upon discovery of a release of a hazardous substance into the environment in excess of a reportable quantity in a 24 hour period. 40 CFR 355, "Emergency Planning and Notification," requires notification for nonroutine releases of a reportable quantity of any extremely hazardous substance or CERCLA hazardous substance. The Hanford Site has comprehensive policies and procedures in place to report nonroutine releases to the environment. These procedures will be followed at the 100-HR-3 OU.

5.3 Waste Management

Details on the specific requirements for waste identification, characterization, segregation, packaging, labeling, storage, and inspection for waste generation activities associated with the 100-HR-3 OU ISRM and P&T systems are provided in DOE/RL-97-01. The following projected waste streams are included in the waste management plan. In general, soil and other solid wastes are sent to ERDF for disposal. Water from 100-HR-3 OU may be sent to the associated P&T systems for treatment, as appropriate.

- Drill cuttings (both dry soil and saturated slurries)
- Spent resins and filter elements
- Solids from the treatment process

Liquid wastes may include, but are not limited to, the following:

- Purgewater generated during well or aquifer tube installation; development, testing, monitoring, maintenance, decommissioning, and decanting of saturated soil
- Water from slurry pumping and gravity draining P&T resins
- Extracted groundwater containing reaction products and unreacted reagent
- Decontamination fluids
- Process sampling and screening analysis liquids
- Water from UPRs

Miscellaneous solid wastes may include, but are not limited to, the following:

- Filter paper, syringes, wipes, personal protective equipment (PPE), cloth, plastic, equipment, tools, pumps, wire, metal and plastic piping, and materials from cleanup of UPRs
- Decommissioning debris such as concrete, wood, rebar, metal/plastic pipe and screens, wire, liners, bentonite/sand/gravel, equipment, pumps, and tanks
- Spent/excess chemicals/reagent and used oil

5.4 Cultural and Ecological Resources

Protection of cultural resources is addressed in the *Archeological and Historic Preservation Act of 1974*, *National Historic Preservation Act of 1966* and *Native American Graves Protection and Repatriation Act of 1990*. These federal acts mandate the identification and protection of archeological objects and historic data including human remains, funerary objects, sacred objects, and objects of cultural significance. Following identification of areas for construction or surface disturbance (e.g., drilling, surface grubbing, and excavating), a survey is conducted to identify culturally significant items and document those with respect to the areas included in these interim remedial actions. Prior to disturbing the earth (e.g., drilling, surface grubbing, and excavating), DOE-RL will initiate discussion with the affected parties (as prescribed by the *National Historic Preservation Act of 1966*), and an analysis of cultural and ecological resource impacts will be undertaken. This will include an assessment of the resources present and a qualitative comparison to the risk posed by the contaminants present in the OU. A mitigation action plan is prepared to minimize project impacts to cultural and natural resources that are identified during the survey.

Disturbance to natural vegetation and habitat is minimized by using existing roads and drill sites, where practicable. Where disturbance to undisturbed ground is unavoidable (e.g., where water transfer lines must cross a previously undisturbed area), cultural resources and ecological reviews are conducted to identify controls that will limit disturbances. Areas of disturbance may include the following:

- Drill pads and access roads for well sites
- Transfer pump building locations
- Water transfer lines
- Power pole installations

Construction of drill pads and access roads (in some locations) is necessary for drilling equipment and followup sampling rigs. Because occasional maintenance of wells and well pumps will be necessary during the interim remedial actions, these disturbed areas are not restored immediately following

construction. Groundwater conveyance pipes are installed in a manner to minimize disturbance to existing vegetation. Conveyance pipes and associated conduits are laid over existing vegetation, where practicable, to limit trenching. Power poles are installed to supply power for well pumps and transfer pump buildings because overhead power is less costly than on-ground conduit and helps limit disturbance to cultural and ecological resources.

At the completion of the interim remedial actions, the continued need for wells, transfer pump buildings, treatment facilities, conveyance pipes, and power poles will be evaluated. Components that are needed by another project may be transferred to the other project. Components that are no longer needed will be removed, and the site will be restored. While disturbed areas will be restored, restoration will be postponed until source remediation activities have been completed if it is anticipated that an area will be disturbed in the future by source remediation activities. For areas that are disturbed during construction and operation, the land will be revegetated following construction in those areas that are not needed for O&M of the treatment system and where additional disturbance of the land is not expected within the next few years by other site activities.

5.5 Safety and Health Program

Work activities identified under this RD/RAWP are regulated under 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." The CHPRC Company Level Health and Safety Program, which includes all procedures for Occupational Safety and Industrial Hygiene, has been developed and implemented to protect worker health and safety. This Health and Safety Program meets 29 CFR 1910.120 requirements for a Written Safety and Health Program. The health and safety plan (HASP) (SGW-41472, *Soil and Groundwater Remediation Project Site Specific Health and Safety Plan*) is an extension of the overall CHPRC Safety and Health Program. This HASP identifies mitigative controls for general hazards that can be encountered within the project. Mitigative controls for task specific hazards are identified and evaluated in task specific job hazard analyses as part of the work package development process.

5.5.1 Worker Safety Program

ISMS will be incorporated into all work activities. The program includes the following elements:

- Organizational structure that specifies the official chain-of-command and overall responsibilities of supervisors and employees
- Comprehensive work plan developed before work begins at a site to identify operations and objectives and address logistics and resources required to accomplish project goals
- Comprehensive hazard analysis when workers could be exposed to hazardous substances (both chemical and radiological) as well as physical hazards
- Worker training commensurate with individual job duties and work assignments
- Medical surveillance program administered to comply with OSHA requirements (29 CFR 1910.120)
- CHPRC procedure and project/task-specific implementing plans and procedures
- VPP

5.5.2 Health and Safety Plan and Activity Hazards Analysis

Access and work activities are controlled in accordance with approved work packages, as required by established internal work requirements and procedures. SGW-41472 identifies how the project integrates the following required HASP elements into work control process:

- Safety and health hazard analysis identifying hazards and their mitigations
- Employee training assignments
- PPE to be used by employees for tasks and operations
- Medical surveillance requirements
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques
- Site control measures
- Decontamination procedures
- Emergency response plan, including necessary PPE and other equipment
- Confined space entry procedures
- Spill containment measures

As part of work package development, a job hazards analysis is completed to identify and control hazards associated with the work tasks. A pre-job briefing will also be held with involved workers. This briefing includes reviews of the hazards that may be encountered and associated requirements. Visitors will be briefed on site hazards and controls, read and sign the HASP, and must be escorted by a member of the P&T operations organization or designee. Visitors are not allowed into contamination controlled areas or areas where waste systems are open with the potential for exposure.

Emergency contact numbers are 911 or 373-0911, which is the Hanford Site Emergency number from a mobile phone.

5.6 Quality Assurance Program

The overall QA program for the RD/RAWP is implemented in accordance with 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements;" EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*; and SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. QA activities will use a graded approach based on the potential effects on the environment, safety, health, reliability, and continuity of operations.

All SAPs prepared to support the 100-HR-3 OU interim remedial action will contain a QA project plan, which establishes quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory results. The QA program requirements associated with the environmental data collection described in this RD/RAWP are included with the QA project plan (Chapter 2 of DOE/RL-2013-30). QA plans will comply with DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), and DOE O 414.1D, *Quality Assurance*. Other specific items that are addressed by the QA program include QA implementation, responsibilities and authority, document control, QA records, and audits.

5.6.1 Quality Assurance Implementation

All project related activities will establish and implement appropriate QA requirements. Conditions adverse to quality will be identified in nonconformance reports, audit reports, surveillance reports, and corrective action requests. Investigation and corrective actions in response to these adverse conditions will be completed in a timely manner.

5.6.2 Responsibilities and Authority

The contractor must perform quality engineering, design reviews, surveillance, and audits (as necessary) to achieve QA objectives. The contractor also must ensure that various contractors and design agencies establish programs to control design and QA in accordance with applicable requirements.

5.6.3 Document Control

All technical documents (e.g., specifications and drawings) will be controlled in accordance with approved configuration management internal work requirements and processes. The responsible design agency will maintain control of the design documents through acceptance of the documents.

5.6.4 Quality Assurance Records

Each organization that maintains QA records will be required to control the records in accordance with applicable contractor QA requirements.

5.6.5 Audits/Assessments

Internal and external audits may be performed by contractor assessments, regulatory, and quality program organizations to ensure project compliance with the QA program requirements.

5.6.6 Self Assessments

Self assessments may be conducted by project personnel to determine compliance in accordance with the contractor internal work requirements and processes.

This page intentionally left blank.

6 Remedial Action Completion

This chapter describes the strategy for completing site closure and provides information on when remediation should end, completing a rebound study, and demonstrating attainment of cleanup levels in groundwater.

Objectives for groundwater cleanup are summarized in the RAOs discussed in Chapter 2. RAOs are achieved through active remediation by reducing contaminant concentrations in groundwater while maintaining ICs to prevent groundwater use until the cleanup levels are achieved.

The remedial action target concentration is less than 20 µg/L Cr(VI) in groundwater for the P&T system compliance wells and ISRM barrier compliance wells (Chapter 2). Table 6-1 provides the cleanup levels currently anticipated to be included in the final ROD for the 100-HR-3 OU.

Table 6-1. Anticipated Cleanup Levels for 100-HR-3 Groundwater

Contaminant of Concern[a]	Units	Anticipated Cleanup Level[b]	Basis for Cleanup Level
Hexavalent Chromium[c]	µg/L	10/48	WAC 173-201A/WAC 173-340-720
Total Chromium[d]	µg/L	65/100	40 CFR 131/DWS
Nitrate[e]	µg/L	10,000	DWS
Strontium-90	pCi/L	8	DWS
Co-Contaminants[f]	**Units**	**Anticipated Cleanup Level**	**Basis for Cleanup Level**
Technetium-99	pCi/L	900	DWS
Tritium	pCi/L	20,000	DWS
Uranium	µg/L	30	DWS

References: DWS is from 40 CFR 141, "National Primary Drinking Water Regulations."

40 CFR 131, "Water Quality Standards."

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards."

a. Contaminants of concern are identified in DOE/RL-2010-95.

b. Anticipated cleanup level is from Table 6-31, "Summary of Federal and State Water Quality Criteria used as Action Levels for the 100-HR-3 Groundwater OU" (DOE/RL-2010-95).

c. Cleanup levels for hexavalent chromium are 10 µg/L where groundwater discharges to surface water and 48 µg/L in the upland groundwater.

d. Cleanup levels for total chromium are 65 µg/L where groundwater discharges to surface water and 100 µg/L in the upland groundwater.

e. Nitrate may be expressed as nitrate-nitrogen (NO3-N) or nitrate-nitrate (NO3-NO3). The DWS for nitrate is 10,000 µg/L, measured as NO3-N. When nitrate is measured as NO3-NO3, the mathematical equivalent to the DWS is 45,000 µg/L.

f. Co-contaminants are identified in EPA/ROD/R10-96/134 and EPA/AMD/R10-00/122.

DWS = drinking water standard

6.1 Remedial Action Completion Timeline

A representative timeline for successful completion of groundwater remediation is shown in Figure 6-1 (based on EPA 230-R-92-014, *Methods for Evaluating The Attainment Of Cleanup Standards Volume 2: Ground Water*). The steps indicate the progression of the remedial action from start to finish. The following distinct steps are shown in Figure 6-1:

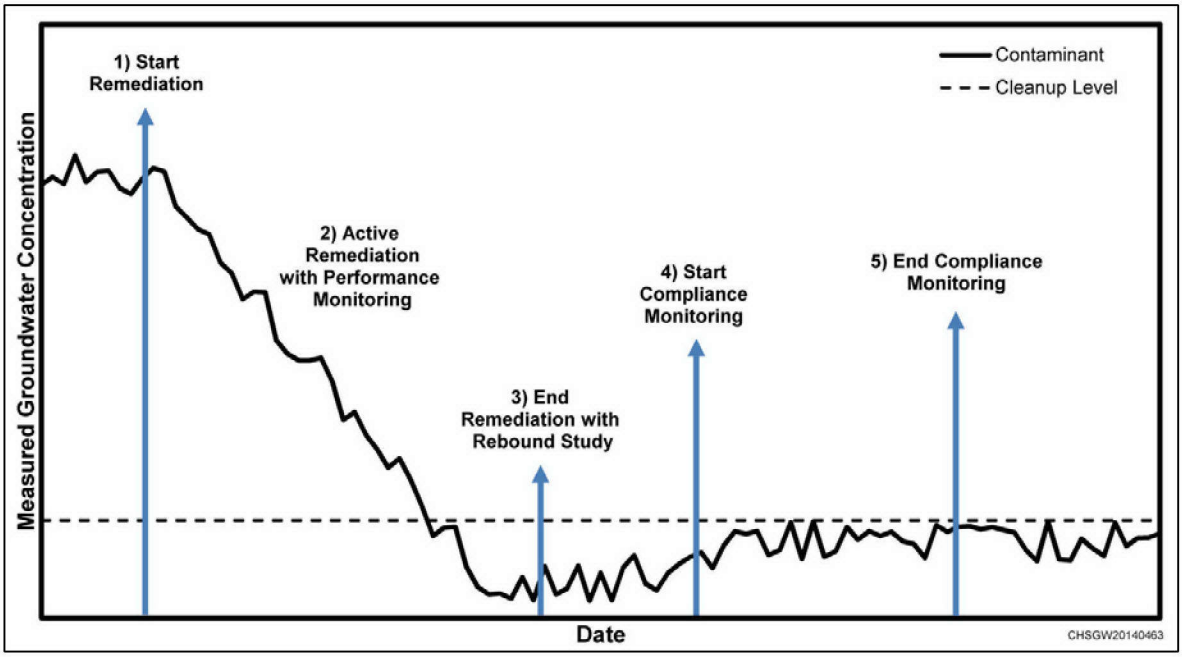
4. Start Remediation – Represents the point in time when active and/or passive remedial actions have been implemented.

5. Active Remediation with Performance Monitoring – Includes the period where contaminant reduction due to remedial practices is monitored and/or optimized to ensure that progress toward cleanup is being made.

6. End Remediation – Point in time when cleanup levels are achieved and active and/or passive remediation can be suspended. It is typically expected that some "rebound" of contaminant concentration will occur after termination of remedial activities and a rebound study is initiated.

7. Start Compliance Monitoring – Point at which data collection to demonstrate compliance begins. This may or may not coincide with the end of step 3, depending on the time required for the hydraulic gradient to return to pre-remedial action conditions.

8. End Compliance Monitoring – Point in the process where analysis of the data indicates whether contaminant concentrations will or will not rise above the cleanup level. Compliance monitoring may indicate that RAOs have not been achieved, and previous activities (i.e., remediation or studies) need to be repeated.



Note: Figure is adapted from EPA 230-R-92-014, *Methods for Evaluating The Attainment Of Cleanup Standards Volume 2: Ground Water*.

Figure 6-1. Steps in Groundwater Remediation

6.2 Groundwater Remediation Steps

The following subsections summarize the steps as they apply to remediation of groundwater in the 100-HR-3 OU.

6.2.1 Step 1 - Start Remediation

The start of remediation for 100-HR-3 groundwater began in 1997. The initial P&T system used nine extraction wells and a withdrawal rate of 225 gpm for the 100-H Area and ten extraction wells and an extraction rate of 100 gpm for the 100-D Area. Groundwater monitoring and investigations resulted in revisions to the known extent of the Cr(VI) plume and identification of the need for additional actions. The ISRM barrier was installed beginning in 2000 as an additional action for the southern portion of the 100 D Area. The DR-5 P&T system began operating in July 2004. The 100-H Area and 100-D Area were selected to have three and five injection wells, respectively.

As the extent of the Cr(VI) plume was revised, two new P&T systems were designed to provide additional hydraulic control and Cr(VI) mass removal to protect the Columbia River. The DX system began operating in December 2010, and the HX system began operating in October 2011. The DX and HX systems are currently in operation and are designed to provide treatment capacities of 2,300 L/min (600 gpm) and 3,000 L/min (800 gpm), respectively.

These expanded systems were installed as upgrades for the HR-3 and DR-5 P&T systems, which were shut down in May 2011 and March 2011, respectively. As breakthrough of the ISRM barrier was identified, a decision was reached to use P&T expansion to address the groundwater contamination in the breakthrough area and no longer actively maintain the barrier (11-AMCP-0002). To manage and refine the DX/HX system, RPO is used. Ongoing RPO includes modifications to the remedy (DX/HX systems) that are made periodically to improve capture, remove mass, and generally improve system performance in meeting the remedy goals.

6.2.2 Step 2 - Active Remediation with Performance Monitoring

During the active remediation and performance monitoring phase at 100-HR-3, progress toward completion of the remedial actions is monitored and assessed. Figure 6-2 is a flowchart of the activities that will be conducted during remediation. The main criteria used in determining the progress of active remediation includes the following:

- Trend of contaminant concentration
- Determination that the contaminant concentration will decrease and remain below cleanup levels
- Anticipated rebound of the contaminant will not exceed the cleanup level for the COC

Monitoring during remediation also includes an evaluation of the potential influence on the aquifer from active remediation. This includes consideration of the potential influence of monitoring results obtained from active injection and extraction wells and the travel times for contaminants.

A variety of analytical tools is available to evaluate performance of the remedial action and determine when it may be appropriate to end remediation. As described in EPA 230-R-92-014, these tools include statistical and geostatistical analysis of water quality and water level data and fate and transport modeling. Some of the tools are discussed in the following subsections.

The decision to stop treatment is based on many sources of information, including the following:

- Expert knowledge of the groundwater system at the site
- Mathematical modeling of how treatment affects groundwater flows and contamination levels

- Results from the monitoring wells from which levels of contamination can be evaluated and extrapolated

All applicable data should be used for each type of analysis. Recommendations and guidance on evaluating groundwater data to determine remedial action performance are provided in OSWER 9283.1-44, *Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well*. Each P&T system will have a sample set composed of wells used to monitor performance. Performance analysis may be performed on groups of wells that identify sub-areas within the OU where concentrations indicate that cleanup has been achieved. The set of wells may be divided by proximity to the river. The systems and areas may likely proceed along the remediation path over varying periods in the 100-HR-3 OU; therefore, remediation may end at one system or area sooner than the others.

6.2.2.1 Remediation Monitoring

OSWER 9283.1-44 provides recommendations on evaluating data from individual monitoring wells to assess the progress of remediation. The sampling frequency and time frame when data are collected should be based on site-specific groundwater flow conditions (such as hydraulic conductivity and gradient), seasonal variations, and other contributing factors. It may be appropriate to reevaluate the groundwater monitoring plan as the monitoring well data evaluation indicates that the remedial action is approaching cleanup levels for all COCs. The remediation monitoring phase at a monitoring well typically is complete when data demonstrate that the groundwater has reached cleanup levels established for all COCs in the ROD. The guidance recommends that a minimum of four data points be used to make this conclusion.

6.2.2.2 Simple Performance Analysis

EPA 230-R-92-014 suggests using regression analysis on the observed concentration data as an aid for determining the progress of active remediation and estimating the time when remediation may be ceased. Regression analysis is a statistical technique for fitting a theoretical curve to a set of sample data. In groundwater monitoring studies, regression techniques can be used to accomplish the following objectives:

- Detect trends in contaminant concentration levels over time.
- Determine variables that influence concentration levels.
- Predict chemical concentrations at future points in time.

The goal of a regression analysis is to estimate the underlying functional relationship (i.e., the model), assess the fit of the model and, if appropriate, use the model to make predictions about future observations. Regression analysis provides a simple tool for quick estimation of performance throughout the life of the remedial activities.

The selected regression model, application of the model, applicable dataset, and calculated results will be documented in a technical memorandum. The selected regression model should be checked to ensure that residuals from the regression are normally distributed and have a constant variance (other regression methods and transformations can be employed to work with situations where these assumptions cannot be supported). A prediction based on the regression analysis, estimated with confidence limits, can be calculated to assess the likelihood that the concentration will rebound. If the results indicate that the concentration will rebound above the cleanup level, active remediation will continue.

6.2.2.3 Advanced Performance Analysis

When the results of the simple regression analysis indicate that the concentration is below the cleanup level and is not expected to rebound, an advanced analysis of the remediation progress will be conducted to verify results of the simple regression analysis. This advanced analysis will include a more robust set of

tools that will consider not only concentrations at individual wells, but also site-specific conditions (e.g., potential dilution from injection wells) that may affect the observed concentration levels.

OSWER 9283.1-44 identifies nonstatistical or visual review that may be appropriate when groundwater data are all nondetect or data are a combination of nondetect and detected COC concentrations less than the cleanup level. For groundwater data that are appropriate for statistical review, a mean test or trend test, using the 95 percent upper confidence limit (UCL) for comparison to the cleanup level, is recommended.

A predictive fate and transport simulation may be used to demonstrate that contaminants are not likely to be located in portions of the aquifer that are unmonitored. Remaining sources of contamination outside the monitoring network could cause a rebound in contaminant concentrations in the future. If the results remain uncertain, more advanced simulations, including sensitivity analyses, may be employed to assess the effect of input parameter change on simulated concentrations.

When available tools indicate that rebound is unlikely, active remediation can be suspended and a rebound study is initiated.

6.2.3 Step 3 - End Remediation

If analyses of the contaminant plumes, discussed in the previous section, yield results indicating that the remedial action has been successful in reducing concentrations below the cleanup level, the site will enter step 3 (end remediation) of the timeline presented. The decision to move to step 3 (end remediation) is critical to the overall success of the remedial action. It can affect the ultimate condition of the aquifer with respect to the concentrations of contaminants. If shutdown occurs too soon, contamination may rebound and rise above cleanup levels, extending the period for cleanup.

Step 3 (end remediation) does not signify site closure or compliance. It signifies the end of active remediation (e.g., a P&T system is turned off). At this point, the remediation system can be placed into cold standby in the event that active remediation must be restarted. The cold standby period allows for a rebound study to be performed.

6.2.3.1 Rebound Study

The purpose of the rebound study is to identify whether contaminant concentrations will remain below cleanup levels when the aquifer is no longer under the influence of active remedial processes. Analysis of physical and chemical properties of the aquifer will be used to determine whether active remediation is influencing data at monitoring wells. Water quality samples will continue to be collected and analyzed in accordance with the 100-HR-3 SAP to identify any increase or rebound in the contaminant concentration. Some rebound of the concentration is anticipated, and observed rebound will be compared to cleanup levels to evaluate if active remediation should recommence. The rebound study approach will be documented. If changes are needed to groundwater monitoring, a TPA-CN or a revision to the monitoring plan will be initiated to document these changes.

When the rebound study shows that the aquifer is not under the influence of active remediation (e.g., extraction and injection wells have ceased operating, and groundwater head levels and gradients return to ambient conditions), the compliance monitoring period (step 4) will commence. If the rebound study shows an increase above cleanup levels, the site will re-enter the active remediation phase (step 2). Figure 6-2 shows the steps for evaluating the progress of remediation.

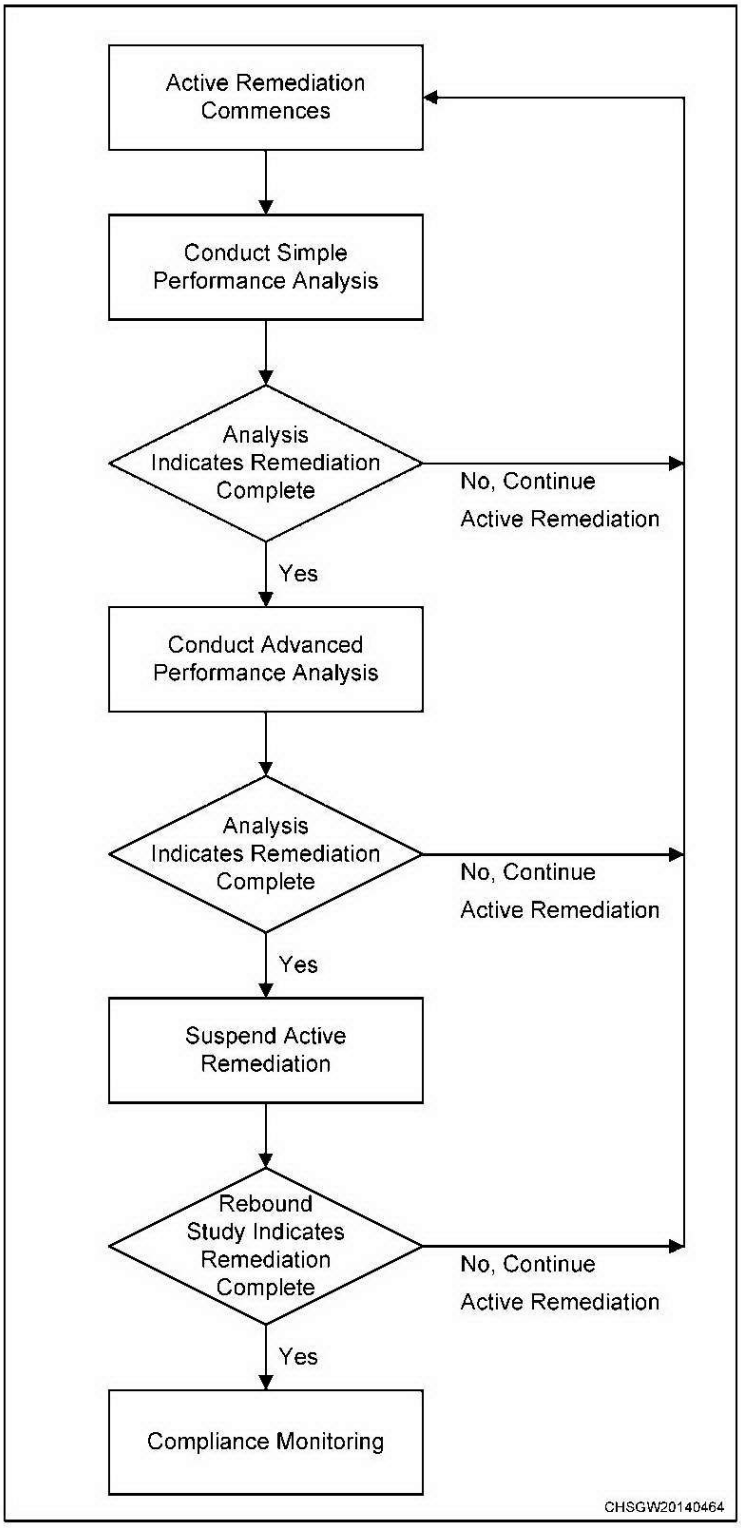


Figure 6-2. Flowchart Showing the Steps to Evaluate the Progress of Remediation

6.2.4 Step 4 - Start Compliance Monitoring

Once the rebound study is complete, indicating that contaminant levels will remain below cleanup levels, compliance monitoring can begin. OSWER 9283.1-44 provides recommendations on evaluating data from individual monitoring wells to assess attainment of remediation. Once it is determined that the well is not being influenced by an active system and there is no indication that rebound may be occurring, it is appropriate to continue collecting data for purposes of evaluating the attainment monitoring phase. In this situation, it also may be appropriate to include data that were used for the rebound study as part of the attainment monitoring evaluation. Use of the rebound study data would be dependent on demonstrating suitability, such as attainment of natural or background conditions.

The attainment monitoring evaluation should be conducted separately for each COC at each well. The attainment monitoring phase at a monitoring well typically is completed when contaminant specific data indicate the following conclusions:

- The contaminant cleanup level for each COC has been met.
- Groundwater will continue to meet the contaminant cleanup level for each COC in the future.

It is recommended that the same data set be used to make both attainment monitoring conclusions discussed previously for each COC and a minimum of eight data points be used in these analyses. It is also recommended that a statistical analysis be used to help calculate the UCL on the mean contaminant concentration from the data.

The data will be expressed and reported as individual measurements for each COC as a 95 percent UCL using the compliance monitoring dataset. Using UCL_{95} to determine whether the site can be declared clean is suggested in both CERCLA and WAC 173-340, "Model Toxics Control Act—Cleanup." Completed remediation can be attained after UCL_{95} for each COC at each well remains below the established cleanup levels for a period of three years. The UCL_{95} calculation will be completed using the recommended methodologies found in EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, and WAC 173-340-720(9)(d)(i), "Groundwater Cleanup Standards."

6.2.5 Step 5 - End Compliance Monitoring

Once steps 2, 3, and 4 are performed and ongoing compliance monitoring demonstrates that cleanup requirements have been achieved, DOE, in consultation with the lead regulatory agency, will determine if final cleanup levels have been met. If additional remediation is needed to achieve compliance due to rebound of a COC in a specific area of the plume, the system may be optimized to focus on the specific area. System operation and monitoring may be halted within areas where target cleanup levels have been demonstrated to meet the cleanup levels.

6.3 Interim Remedy Reporting

A description of the performance of the interim remedial actions is provided in annual summary reports. The annual P&T summary reports include progress toward meeting RAOs and cleanup levels for groundwater. It is anticipated that interim remedial actions for the 100-HR-3 OU will be superseded by a final remedial action when a final ROD is approved for the 100-D/H Area. Annual reporting of remedial action performance is anticipated to continue until completion of all remedial actions for the 100-HR-3 OU. A description of the data use and reporting is provided in Section 4.3. The annual P&T report integrates calendar year data for the 100-HR-3 OU and will be issued by May 30 of the following year.

Abbreviated monthly summaries of general information on system operations are communicated to project management staff and regulatory agency personnel at unit manager meetings. These summaries

generally include descriptions of the system operation and non-routine events. Quarterly summaries of system operations, including volume of groundwater treated and mass of chromium removed, are also provided to regulatory agency personnel. Regulatory agency personnel will be notified if treated water at a concentration greater than regulatory standards is injected into the aquifer.

6.4 Final Closeout Report

Once DOE, in consultation with the lead regulatory agency, has determined that RAOs and final cleanup levels have been met, a final closeout report will be prepared. Table 6-2 provides the recommended outline and contents for a final closeout report (OSWER Directive 9320.2-22, *Close Out Procedures for National Priorities List Sites*), which identifies site completion as the end of all response actions. The site completion designation generally means that the response actions at the site were completed and it is anticipated that no further response is necessary to protect HHE.

Table 6-2. Recommended Outline for Final Closeout Report (from OSWER Directive 9320.2-22)

Section	Contents
I. Introduction	General statement indicating all response actions have been successfully completed.
II. Summary of Site Conditions	Background summary of site location, site description, and NPL listing information. Summary of any removal action activities at the site. Summary of remedies selected and RAOs from decision documents. Dates of remedial action implementation and completion, methods used to implement, report summaries. Details of ICs. Final inspection activities.
III. Monitoring Results	Confirmatory sampling results, which indicate compliance with cleanup levels.
IV. Attainment of Groundwater Restoration Cleanup Levels	Summary of monitoring data and an analysis to indicate cleanup levels specified in the RODs or Action Memoranda are achieved. Actual monitoring data and analysis reports.
V. Summary of Operation and Maintenance Required	Description of ongoing monitoring activities for all media and engineering controls if waste is left onsite. Description of all enforcement and maintenance activities for institutional controls.
VI. Demonstration of Cleanup Activity QA/QC	Document construction QA/QC plan that was implemented. Document that the O&M QA/QC plan was implemented. Document the sampling and analysis protocol that was followed.
VII. Five-year Review	Statement explaining whether a 5-year review is appropriate, and if so, the type of review (statutory or policy) and the schedule for the review. Summary of the last 5-year review completed (protectiveness determination, any identified issues and recommendations). Description of any issues raised in the last 5-year review and activities taken to address issues and implement recommendations.
VIII. Site Completion Criteria	Statement that the implemented remedy achieves the degree of cleanup or protection specified in the ROD(s) for all pathways and exposure.

Table 6-2. Recommended Outline for Final Closeout Report (from OSWER Directive 9320.2-22)

Section	Contents
	Statement that all selected remedial and removal actions RAOs are consistent with agency policy and guidance. Statement that no further response is needed to protect human health and the environment.
IX. Bibliography	Complete citation of relevant reports.

QA/QC = quality assurance/quality control
RAO = remedial action objective
ROD = record of decision

6.5 Decontamination and Decommissioning

This section identifies the plans that will be in place to address decontamination and decommissioning (D&D) of the P&T systems after they are no longer needed. Anticipated future land use after completion of the remedial action will be incorporated in the D&D plan.

Decontamination is a process whereby contaminants that have accumulated on or in equipment, tools, or treatment systems are removed or neutralized, so they no longer present a hazard to HHE. Decontamination efforts associated with 100-HR-3 OU P&T systems have been grouped into two activities: some activities are interim (i.e., involved with day-to-day operations), and others are associated with final shutdown and decommissioning.

Decommissioning is removing a facility that is no longer needed and removing and/or disposing of equipment and materials in a manner that protects worker and public health and the environment. Under the authority delegated by Executive Order 12580, DOE is responsible for evaluating whether conditions at sites under DOE jurisdiction pose a significant threat of release of hazardous substances, as defined by CERCLA. If a significant threat of release is identified, DOE is authorized to conduct removal action, remedial action, and any other response measures consistent with the NCP (40 CFR 300).

According to DOE and EPA, 1995, *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)*, decommissioning activities at facilities located on DOE sites will be conducted as non-time-critical removal actions under CERCLA, unless circumstances at the facility make it inappropriate. DOE will conduct a removal site evaluation, as directed by the NCP (40 CFR 300), to assess site conditions and determine whether a release or substantial threat of release exists at the facility. At any facility for which DOE conducts a removal site evaluation, DOE will consult with the lead regulatory agency and provide, as requested, information necessary to review such evaluation. At any facility where DOE determines that a release or substantial threat of release has not occurred, DOE will consult with the lead regulatory agency and provide any information necessary to evaluate such determination. Further guidance on decommissioning of DOE facilities is provided in DOE G 430.1-4, *Decommissioning Implementation Guide*.

Decontamination of equipment and miscellaneous items and decommissioning of facilities will be conducted in accordance with the work control documents including, as appropriate, requirements of WAC 173-303-070, “Designation of Dangerous Waste,” and 40 CFR 268.45, “Treatment Standards for Hazardous Debris,” as adopted in entirety by WAC 173-303-140, “Land Disposal Restrictions.”

6.5.1 Interim Decontamination

Work control documents for decontaminating equipment and other miscellaneous items will be developed when the material is no longer required. Decontaminating the tanks, containers, and equipment associated with the 100-HR-3 OU P&T systems involves removing and disposing of wastes present in containers, and decontaminating the tanks, containers, and associated ancillary equipment that were in contact with the waste, as necessary.

Requirements for management and disposal of wastes associated with operation and D&D of the P&T systems are discussed in the waste management plan (DOE/RL-97-01). Liquid wastes generated from O&M and decommissioning of the P&T systems and groundwater well-related activities will be processed through the remaining active 100-HR-3 systems (DX or HX), if it is technically feasible. This may include purgewater from wells and aquifer tubes, water from slurry pumping and gravity draining of resins, and contained releases from the P&T systems. To the extent practicable, decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) from tool and equipment cleaning will be contained and managed as purgewater. Introduction of contamination that is not found in the OU is not allowed; only unaltered liquids will be returned to the system.

Fluids that contain additives, such as those used for decontamination or reagents added for field screening or analysis, will be contained and transported to PSTF or ETF if waste acceptance criteria can be met. If the waste acceptance criteria cannot be met, pretreatment may be necessary, or another suitable disposal facility may be identified, as authorized by EPA or in accordance with the methods stated in the interim action ROD (EPA/ROD/R10-96/134).

6.5.2 DR-5 and HR-3 Decontamination and Decommissioning

The DR-5 P&T system was removed from service in April 2011. At that time, the remaining wells were realigned to the DX system and the DR-5 system was rinsed and flushed. The system piping, pumps, and vessels were drained and blown down. All electrical feeds to wells, pumps, and equipment were deactivated and isolated. The system was placed in cold standby in November 2011. The deactivated equipment was disconnected and removed from the facilities for disposal, recycle, or reuse when feasible. This was completed in February 2015. Demolition of the D transfer building (1601-D) was completed in May 2015 as a part of DOE/RL-2010-34. The deactivated P&T building (186-D) is currently being used as a maintenance facility to support the DX and HX P&T systems.

The HR-3 P&T system was removed from service in May 2011. At that time, the remaining wells were shut down and the system was rinsed and flushed. The system piping, pumps, and vessels were drained and blown down. All electrical feeds to wells, pumps, and equipment were deactivated and isolated. The system was placed in cold standby in March 2012. One IX vessel was removed from the facility for reuse. This work was completed in October 2014. The remainder of the equipment will be removed and disposed of during demolition. Demolition of the H transfer building (1601-H) was completed in May 2015 as a part of the River Corridor general decommissioning activities (DOE/RL-2010-34). Demolition of the deactivated P&T building (1713-H) is anticipated by December 2015 as a part of DOE/RL-2000-57, *Removal Action Work Plan for 105-D and 105-H Building Interim Safe Storage Projects and Ancillary Buildings*.

6.5.3 DX and HX Decontamination and Decommissioning

Final D&D of the DX and HX P&T systems will be addressed after DOE, EPA, and Ecology determine that active remediation is complete or the treatment system is no longer required. D&D requirements will be addressed in a D&D plan, which will be developed and submitted prior to the end of the active remediation period. The D&D plan will identify applicable requirements for conducting the actions.

Decontaminating the P&T systems is expected to include the following activities:

- Remove and dispose of liquids from tanks, piping, and process equipment.
- Remove and dispose of IX and other resins, filters, and media.
- Remove and dispose of all waste solids.
- Drain transfer piping and dispose of the liquid.
- Winterize buildings and leave the facility for further use later. Periodic inspections of the buildings will be necessary for long-term care.

Once a determination is made that no further use of the DX and/or HX P&T systems is required, D&D is expected to include the following activities:

- Remove and dispose of conveyance and process piping.
- Salvage equipment and materials that can be used elsewhere on the Hanford Site.
- Demolish buildings, tanks, and structures.
- Perform site restoration.

Extraction and injection wells will be evaluated for use as groundwater monitoring wells (sampling and water levels). Those wells not retained for monitoring purposes will be decommissioned in accordance with WAC 173-160-381, "What Are the Standards for Decommissioning a Well?"

The site will be returned to its pre-operational condition, to the extent feasible, considering cost and intended future use. Waste materials generated as part of D&D activities will be managed and disposed as addressed in the waste management plan (DOE/RL-97-01).

This page intentionally left blank.

7 Cost and Schedule

This chapter provides the current O&M cost and a schedule of anticipated activities.

7.1 Cost Summary

The ESD (EPA et al., 2009) indicated that the costs provided in the interim action ROD for the P&T remedy operating at that time for the 100-HR-3 OU (and 100-KR-4 OU) had increased more than 50 percent above the original estimate. The cost increased at 100-HR-3 because the P&T systems operated longer than the originally projected 5-year period, and a new P&T system was added. Actual costs for the 100-HR-3 OU for the years 1995 through 2008 are listed in the ESD. Additional treatment system capital construction and O&M costs were also estimated in the ESD through FY 2012 to expand the 100-HR-3 OU P&T system.

Costs are presented in DOE/RL-2011-25 and include design, treatment system capital construction, project support, O&M, performance monitoring, and waste management. Table 7-1 provides the annual costs for each of the categories for the 100-HR-3 P&T systems (DX and HX) for calendar years 2009 through 2013. A detailed cost estimate was not developed for this RD/RAWP. Future costs for the remedy are anticipated to be within roughly ±30 percent of the 2013 total.

Table 7-1. 100-HR-3 Operable Unit Interim Remedial Action Actual Costs

Task	2009*	2010	2011	2012	2013
	Costs (Dollars × 1,000)				
Design	3,011.6	2,335.3	1,180.5	70.2	32.5
Treatment System Capital Construction	5,973.9	25,620.5	11,316.2	(5.4)	464.2
Project Support	495.1	1,637.1	2,027.1	124.5	365.4
Operations and Maintenance	--	--	3,300.5	2,753.7	3,914
Performance Monitoring	--	--	9.8	484.6	1,010.6
Waste Management	7.4	9.3	--	1.8	--
Totals	9,488	29,602	17,835	3,430	5,787

* Annual report has been transitioned from a fiscal year reporting period to a calendar year reporting period. The cost breakdown for 2009 is for15 months (October 2008 through December 2009).

7.2 Schedule

Table 7-2 presents remediation goals related to completion of interim actions for the 100-HR-3 OU and transition to final actions. The table includes two TPA milestones. Remediation goals and milestones assume conformance with requirements of the TPA (Ecology et al., 1989a), interim action decisions, and pertinent laws and regulations.

Table 7-2. Remediation Goals and Milestones for the 100-HR-3 Operable Unit

Goal/ Milestone	Due Date	Description
Record of Decision	To be determined	Complete ROD for the 100-HR-3 OU.
Interim Action Closeout	Within 6 months after final ROD	Evaluate and summarize the progress of remedial actions under the interim action RODs.
Update RD/RAWP	Within 6 months after final ROD	Evaluate existing RD/RAWP to determine if updates are needed to achieve RAOs.
Update SAP	Within 6 months after final ROD	Evaluate existing monitoring plan to determine if updates are needed to achieve RAOs.
Evaluate Progress of Remediation	Within 1 year of final ROD	Conduct performance monitoring and evaluate progress of remedy in removal of contaminant mass and reduction in plume dimensions. The due date will be based on an annual reporting activity.
M-016-110-T04	12/31/2016	Implement remedial actions selected in all 100 Area Records of Decision for Groundwater Operable Units so that no contamination above drinking water standards or ambient water quality standards enters the Columbia River unless otherwise specified in a CERCLA decision.
M-016-110-T02	12/31/2020	Take actions necessary to remediate hexavalent chromium groundwater plumes such that hexavalent chromium will meet drinking water standards in each of the 100 Area NPL operable units.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
RAO = remedial action objective
RD/RAWP = remedial design/remedial action work plan
ROD = record of decision
SAP = sampling and analysis plan

8 References

11-AMCP-0002, 2010, "Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Washington July 2010, Memo to File Regarding: Supplemental Actions for the In-Site Reduction/Oxidation Manipulation Barrier Performance for the 100-HR-3 Groundwater Operable Unit Interim Remedy" (letter to J.A. Hedges, Washington State Department of Ecology, and D.A. Faulk, U.S. Environmental Protection Agency from R.A. Holten), U.S. Department of Energy, Richland Operations Office, Richland, Washington, October 26. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1011290677.

11-AMCP-0049, 2010, "Completion of Hanford Federal Facility and Consent Order (Tri-Party Agreement) Milestone M-016-111B Due December 31, 2010" (letter to J.A. Hedges, Washington State Department of Ecology, and D.A. Faulk, U.S. Environmental Protection Agency from R.A. Holten), U.S. Department of Energy, Richland Operations Office, Richland, Washington, December 20. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084139.

12-AMCP-0036, 2011, "Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-016-111C By December 31, 2011" (letter to J.A. Hedges, Washington State Department of Ecology, and D.A. Faulk, U.S. Environmental Protection Agency from J.A. Dowell), U.S. Department of Energy, Richland Operations Office, Richland, Washington, December 20. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1112281636.

12-AMRP-0172, 2012, "Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Target Milestone M-016-110-T01, 'DOE Shall Take Actions Necessary to Contain or Remediate Hexavalent Chromium Groundwater Plumes in Each of the 100 Area National Priority List Operable Units Such That Ambient Water Quality Standards for Hexavalent Chromium are Achieved in the Hyporheic Zone and River Water Column,'" (letter to J.A. Hedges, Washington State Department of Ecology, and D.A. Faulk, U.S. Environmental Protection Agency from J.A. Dowell), U.S. Department of Energy, Richland Operations Office, Richland, Washington, November 14. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091053.

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/xml/CFR-2010-title10-vol4-part830-subpartA.xml.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol5/xml/CFR-2010-title29-vol5-sec1910-120.xml.

36 CFR 65, "National Historic Landmarks Program," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title36-vol1/xml/CFR-2010-title36-vol1-part65.xml.

36 CFR 800, "Protection of Historic Properties," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title36-vol3/xml/CFR-2010-title36-vol3-part800.xml.

40 CFR 60.4205, "Standards of Performance for New Stationary Sources," Subpart IIII, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," "What Emission Standards Must I Meet for Emergency Engines if I Am an Owner or Operator of Stationary CI Internal Combustion Engine," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?node=sp40.7.60.iiii#se40.7.60_14205.

40 CFR 60.4209, "Standards of Performance for New Stationary Sources," Subpart IIII, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," "What Are the Monitoring Requirements I Am an Owner or Operator of a Stationary CI Internal Combustion Engine," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?node=sp40.7.60.iiii#se40.7.60_14209.

40 CFR 131, "Water Quality Standards," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol21/xml/CFR-2010-title40-vol21-part131.xml.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol23/pdf/CFR-2011-title40-vol23-part141.pdf.

40 CFR 144, "Underground Injection Control Program," Subpart B, "General Program Requirements" *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/xml/CFR-2010-title40-vol22-part144-subpartB.xml.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26-part268.xml.

268.45, "Treatment Standards for Hazardous Debris."

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300.xml.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300-appB.xml.

40 CFR 302, "Designation, Reportable Quantities, and Notification," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part302.xml.

40 CFR 355, "Emergency Planning and Notification," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part355.xml.

Archeological and Historic Preservation Act of 1974, 16 USC 469 – 469c-2. Available at: http://www.nps.gov/history/local-law/fhpl_archhistpres.pdf.

Atomic Energy Act of 1954, 42 USC 2011, Pub. L. 83-703, 68 Stat. 919. Available at: http://epw.senate.gov/atomic54.pdf.

Bald and Golden Eagle Protection Act of 1940, 16 USC 668-668d. Available at: http://www.fws.gov/migratorybirds/mbpermits/regulations/BGEPA.PDF.

BHI-00620, 1996, *Description of Work and Sampling and Analysis Plan for Pore Water Sampling at Groundwater-River Interface Adjacent to 100-D/DR, -K, and -H Reactor Areas*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197189082.

BHI-00764, 1996, *100-HR-3 and 100-KR-4 Interim Remedial Measures Pump-and-Treat Acquisition and Design Strategy Plan*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197188944.

BHI-00770, 1996, *100-HR-3 and 100-KR-4 Pump-and-Treat Drilling Description of Work*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197189092.

BHI-00772, 1996, *Design Criteria and Design Basis for the 100-HR-3 and 100-KR-4 Pump-and-Treat Projects*, Rev. 1, Bechtel Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197189690.

BNWL-CC-1352, 1967, *Ground Disposal of Reactor Coolant Effluent*, Battelle Pacific Northwest Laboratories, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0082449H.

CCN 062039, 1998, "Sampling Changes to the 100-HR-3 and 100-KR-4 Operable Units (OU)" (letter to S.M. Alexander, Washington State Department of Ecology, and D.R. Sherwood, U.S. Environmental Protection Agency, from D.M. Wanek), U.S. Department of Energy, Richland Operations Office, Richland, Washington, September 16. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1304030112.

Cooper, H.H. and C.E. Jacob, 1946, "A Generalized Graphical Method of Evaluating Formation Constants and Summarizing Well-Field History," *Trans. Am. Geophys. Union* 27(4):526-534. Available at: http://core.ecu.edu/geology/spruill/spruill/Groundwater%20Notes%20No.%207.pdf.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

Section 104, "Response Authorities."

Section 120, "Federal Facilities."

Section 121, "Cleanup Standards."

D4-100D-005, 2015, *Facility Status Change Form (for DOE/RL-2010-34 Facilities)*, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1503100608.

DOE and EPA, 1995, *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)*, U.S. Department of Energy and U.S. Environmental Protection Agency, Washington, D.C. Available at: http://energy.gov/em/policy-decommissioning-department-energy-facilities-under-comprehensive.

DOE G 430.1-4, 1999, *Decommissioning Implementation Guide*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/0430.1-EGuide-4/view.

DOE O 414.1D Chg 1, 2011, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0414.1-BOrder-d-admchg1.

DOE/RL-90-25, 1995, *105-DR Large Sodium Fire Facility Closure Plan*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D196025308.

DOE/RL-92-71, 1998, *100-D Ponds Closure Plan*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D198088274.

DOE/RL-93-29, 1994, *Limited Field Investigation Report for the 100-DR-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196016850.

DOE/RL-93-43, 1994, *Limited Field Investigation Report for the 100-HR-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196060716.

DOE/RL-93-46, 1995, *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-2 Operable Unit, Hanford Site, Richland, Washington*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196020069.

DOE/RL-93-51, 1994, *Limited Field Investigation Report for the 100-HR-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196071969.

DOE/RL-94-53, 1995, *Limited Field Investigation Report for the 100-HR-2 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196008301.

DOE/RL-94-54, 1994, *Pilot-Scale Treatability Test Plan for the 100-HR-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196071678.

DOE/RL-94-67, 1995, *100-HR-3 Operable Unit Focused Feasibility Study*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196006763.

DOE/RL-94-102, 1995, *Proposed Plan for Interim Remedial Measure at the 100-HR-3 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196007187.

DOE/RL-95-83, 1995, *The Pilot-Scale Treatability Test Summary for the 100-HR-3 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197188558.

DOE/RL-96-17, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0095436.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), Rev. 4, *Volume 1, Administrative Requirements*; *Volume 2, Sampling Technical Requirements*; *Volume 3, Field Analytical Technical Requirements*; and *Volume 4, Laboratory Technical Requirements*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf. http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf. http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf. http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL4-04.pdf.

DOE/RL-96-84, 1996, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196246917.

DOE/RL-96-84, 2003, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*, Rev. 0-A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196246917. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1348764.

DOE/RL-96-90, 1997, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197194770.

DOE/RL-97-01, 2000, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8406862.

DOE/RL-97-01, 2000, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8479562.

DOE/RL-97-01, 2003, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D2495486.

DOE/RL-97-01, 2005, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA01311800.

DOE/RL-97-48, 1997, *183-H Solar Evaporation Basins Postclosure Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197226569.

DOE/RL-99-51, 2000, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8373878.

DOE/RL-2000-57, 2002, *Removal Action Work Plan for 105-D and 105-H Building Interim Safe Storage Projects and Ancillary Buildings*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D9177865.

DOE/RL-2000-59, 2009, *Sampling and Analysis Plan for Aquifer Sampling Tubes*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=D8510131.

DOE/RL-2001-41, 2015, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*, Rev. 8, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081640H.

DOE/RL-2003-63, 2004, *Sampling and Analysis Plan for In Situ Redox Manipulation Project*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D6455099.

DOE/RL-2005-18, 2005, *Calendar Year 2004 Annual Summary Report for the 100-HR-3, 100-KR-4, and 100-NR-2 Operable Unit Pump-and-Treat Operations*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA088495.

DOE/RL-2006-20, 2006, *The Second CERCLA Five-Year Review Report for the Hanford Site*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA04570094.

DOE/RL-2008-42, 2009, *Hydrogeological Summary Report for 600 Area Between 100-D and 100-H for the 100-HR-3 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0911161139.

DOE/RL-2008-46-ADD1, 2010, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 1: 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084374.

DOE/RL-2008-49, 2008, *Treatability Test Plan for Injecting Zero-Valent Iron Into an In Situ Redox Manipulation Well*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0089311.

DOE/RL-2009-01, 2009, *Fiscal Year 2008 Annual Summary Report for the In Situ Redox Manipulation Operations*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0095247.

DOE/RL-2009-09, 2009, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084448.

DOE/RL-2009-35, 2011, *Treatability Test Report on Mending the In Situ Redox Manipulation Barrier Using Nano-Size Zero Valent Iron*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093960.

DOE/RL-2009-40, 2010, *Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084375.

DOE/RL-2010-34, 2012, *Removal Action Work Plan for River Corridor General Decommissioning Activities*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084335.

DOE/RL-2010-95, 2014, *Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0090581.

DOE/RL-2011-25, 2011, *Calendar Year 2010 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations and 100-NR-2 Groundwater Remediation*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093679.

DOE/RL-2011-111, 2012, *Proposed Plan for Remediation of the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0090582.

DOE/RL-2011-118, 2012, *Hanford Site Groundwater Monitoring for 2011*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0091795.

DOE/RL-2012-45, 2012, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0090246.

DOE/RL-2013-13, 2013, *Calendar Year 2012 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087503.

DOE/RL-2013-22, 2013, *Hanford Site Groundwater Monitoring Report for 2012*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087974.

DOE/RL-2013-30, 2014, *Sampling and Analysis Plan for the 100-HR-3 Groundwater Operable Unit*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082922H.

DOE/RL-2013-35, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087915.

DOE/RL-2013-35-ADD1, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan Addendum 1: 199-D5-153, 199-D5-154, 199-H4-90, 199-H4-91*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087914.

DOE/RL-2013-35-ADD2, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan Addendum 2: 199-D3-6, 699-97-60, 699-97-61, 199-H1-8, AND 199-H4-92*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087394.

DOE/RL-2013-35-ADD3, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan Addendum 3: 100-D-100 Waste Site and Underlying Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2013-35-ADD4, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 4: 699-93-48C and 199-D5-159*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083576.

DOE/RL-2013-35-ADD5, 2014, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 5: Wells 199-H6-7, 199-H6-8, 199-H5-16, 199-H4-93, and 699-95-45B*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083575.

DOE/RL-2013-35-ADD6, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan; Addendum 6: Wells 699-97-47B and 199-H1-46*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2013-49, 2014, *100-HR-3 Pump and Treat System Operations and Maintenance Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082920H.

DOE/RL-2014-52, 2015, *Hanford Site Environmental Report for Calendar Year 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. https://msa.hanford.gov/files.cfm/DOE-RL-2014-52.pdf.

DOE/RL-2015-05, 2015, *Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080210H.

DOE/RL-2015-07, 2015, *Hanford Site Groundwater Monitoring Report for 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080600H.

ECF-100HR3-12-0025, 2012, *Evaluation of Potential Hydraulic Capture and Plume Recovery from the Ringold Upper Mud (RUM) in the 100-HR-3 Operable Unit (OU)*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087251.

ECF-Hanford-13-0020, 2014, *Process for Constructing a Three-dimensional Geologic Framework Model of the Hanford Site 100 Area*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-Hanford-14-0035, 2014, *Description of Groundwater Calculations and Assessments for the Calendar Year 2013 (CY2013) 100 Areas Pump-and-Treat Report*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082016H.

ECF-HANFORD-15-0001, 2015, *Description of Groundwater Modeling Calculations and Assessment of the River Protection Objective for the Calendar Year 2014 (CY2014) 100 Areas Pump and Treat Report*, Rev. 0 (in publication), CH2M HILL Plateau Remediation Company, Richland, Washington.

Ecology Publication 94-06, 2007, *Model Toxics Control Act Statute and Regulation* ("Model Toxics Control Act," Chapter 70.105D RCW; "Uniform Environmental Covenants Act," Chapter 64.70 RCW; "MTCA Cleanup Regulation," Chapter 173-340 WAC), revised 2007, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/9406.pdf.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

Ecology, EPA, and DOE, 2012, "Inter-Agency Management Integration Team (IAMIT) Meeting Minutes," Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, January 26. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1202221574.

Endangered Species Act of 1973, Pub. L. 93-205, as amended, 7 USC 136, 16 USC 1531, et seq. Available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esa.pdf.

EPA, Ecology, and DOE, 2002, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D9192299.

EPA, Ecology, and DOE, 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096029.

EPA 230-R-92-014, 1992, *Methods for Evaluating The Attainment Of Cleanup Standards Volume 2: Ground Water*, Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=200091OR.PDF.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/sites/production/files/2015-07/documents/r5-final.pdf.

EPA 530/R-09-007, 2009, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/osw/hazard/correctiveaction/resources/guidance/sitechar/gwstats/unified-guid.pdf.

EPA-540-R-09-001, 2012, *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites*, OSWER 9355.0-89, Office of Solid Waste and Emergency Response, Office of Enforcement and Compliance Assurance, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/sites/production/files/documents/final_pime_guidance_december_2012.pdf.

EPA-540-R-09-002, 2012, *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites*, OSWER 9200.0-77, Office of Solid Waste and Emergency Response, Office of Enforcement and Compliance Assurance, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/sites/production/files/documents/iciap_guidance_final_-_12.04.2012.pdf.

EPA/AMD/R10-00/122, 2000, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1000122.pdf.

EPA/ESD/R10-03/606, 2003, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/e1003606.pdf.

EPA/ROD/R10-96/134, 1996, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=1000536I.txt.

Executive Order 11988, 1977, *Floodplain Management*, Jimmy Carter, May 24. Available at: http://www.epa.gov/owow/wetlands/regs/eo11988.html.

Executive Order 11990, 1977, *Protection of Wetlands*, Jimmy Carter, May 24. Available at: http://www.archives.gov/federal-register/codification/executive-order/11990.html.

Executive Order 12580, 1987, *Superfund Implementation*, Ronald W. Reagan, January 23. Available at: http://www.archives.gov/federal-register/codification/executive-order/12580.html.

Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste, Revision 8c. Available at: http://www.ecy.wa.gov/programs/nwp/permitting/hdwp/rev/8c/.

HNF-5828, 2012, *Hanford Site Water System Master Plan*, Rev. 3, Mission Support Alliance, LLC, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084888.

Migratory Bird Treaty Act of 1918, 16 USC 703-712, Ch. 128, July 13, 1918, 40 Stat. 755, as amended. Available at: http://www.animallaw.info/statutes/stusmba.htm.

MSA, 2009, *Data Package Summary Analytical Laboratory F09-053 In Process Sampling and Analysis of the ISRM Pond Soil Sampling*, Mission Support Alliance, Richland, Washington.

National Historic Preservation Act of 1966, Pub. L. 89-665, as amended, 16 USC 470, et seq. Available at: http://www.achp.gov/docs/nhpa%202008-final.pdf.

Native American Graves Protection and Repatriation Act of 1990, Pub. L. 101-601, as amended, 25 USC 3001, et seq. Available at: http://www.nps.gov/history/local-law/FHPL_NAGPRA.pdf.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

Omnibus Parks and Public Lands Management Act of 1996, Public Law 104-333, 100 Stat. 4093, 16 USC 1. Available at: http://www.gpo.gov/fdsys/pkg/PLAW-104publ333/pdf/PLAW-104publ333.pdf.

OSWER 9283.1-44, 2013, *Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well*, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/GroundwaterAttainmentPolicy-finalsigned-11%2025%202013.pdf.

OSWER Directive 9320.2-22, 2011, *Close Out Procedures for National Priorities List Sites*, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100BCFN.txt.

PNNL-13349, 2000, *100-D Area In Situ Redox Treatability Test for Chromate-Contaminated Groundwater*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13349.pdf.

PNNL-17619, 2008, *Hanford 100-D Area Biostimulation Soluble Substrate Field Test: Interim Data Summary for the Substrate Injection and Process Monitoring Phases of the Field Test*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1110180069.

PNNL-18784, 2009, *Hanford 100-D Area Biostimulation Treatability Test Results*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1002020098.

Public Law 100-605, 1988, *The Hanford Reach Study Act*, 102 Stat. 3043, 100th Congress, U.S. House of Representatives, Washington, D.C. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=DA06639964.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

SGW-38338, 2008, *Remedial Process Optimization for the 100-D Area Technical Memorandum Document*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082359H.

SGW-38815, 2009, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082378H.

SGW-40044, 2009, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0908311238.

SGW-40243, 2010, *Functional Design Criteria for the 100-DX Pump and Treat System*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084885.

SGW-40781, 2009, *100-HR-3 Remedial Process Optimization Modeling Data Package*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0907010823.

SGW-41302, 2009, *Description of Work for Aquifer Testing in Support of the 100-H Deep Chromium Investigation*, Rev. 0, REISSUE, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0909081364.

SGW-41472, 2014, *Soil and Groundwater Remediation Project Site Specific Health and Safety Plan (HASP)*, Rev. 9, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082379H.

SGW-41534, 2009, *Description of Work for the Installation of 35 Remedial Process Optimization Wells in the 100-H Area for the 100-HR-3 Operable Unit, Fiscal Year 2009*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0908311236.

SGW-41535, 2009, *ARRA Description of Work for the Installation of Fourteen Remedial Process Optimization Wells for the 100-D Area of the 100-HR-3 Operable Unit, FY2009*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084884.

SGW-42305, 2009, *Collection and Mapping of Water Levels to Assist in the Evaluation of Groundwater Pump-and-Treat Remedy Performance*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0911170654.

SGW-43616, 2011, *Functional Design Criteria for the 100-HX Pump and Treat System*, Rev. 4, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081275H.

SGW-44089, 2010, *ARRA FY2010 Description of Work for the Installation of 18 Scenario 5 Remedial Process Optimization Wells for the 100-D Area, 100-HR-3 Operable Unit*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1001290782.

SGW-44142, 2009, *ARRA FY2010 Description of Work for the Installation of 15 Scenario 5 Remedial Process Optimization Wells in the 100-H Area for the 100-HR-3 Operable Unit*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084883.

SGW-46279, 2012, *Conceptual Framework and Numerical Implementation of 100 Areas Groundwater Flow and Transport Model*, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087245.

SGW-46621, 2010, *100 Area Groundwater Chromium Resin Management Strategy for Ion Exchange Systems*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081273H.

SGW-47776, 2010, *Aquifer Testing and Rebound Study in Support of the 100-H Deep Chromium Investigation*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://www.osti.gov/scitech/servlets/purl/1038045.

SGW-48612, 2011, *Borehole Summary Report for the Installation of 70 Remedial Process Optimization, Pump-and-Treat Expansion Wells, for the 100-HR-3 Operable Unit*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1301110180.

SGW-49912, 2011, *Borehole Summary Report for the Installation of 16 Resource Protection Wells in the 100-HR-3 Groundwater Operable Unit in Support of the Integrated 100 Areas RI/FS: 100-D/H Decisional Unit*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1301110181.

SGW-51502, 2012, *Borehole Summary Report for the Installation of Well C8668 at 100-D-12 in FY2012*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082448H.

SGW-54209, 2013, *Systematic Method for Evaluating the Length of the Hanford Reach of the Columbia River Shoreline that is Protected from Further Discharges of Chromium from the 100 Area Operable Units (OUs)*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087569.

SGW-54542, 2013, *Recommendations and Technical Justification for New and Replacement Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-D/H Area*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087907.

SGW-55269, 2013, *Borehole Summary Report for the Installation of 6 Replacement Multi-Purpose Wells and the Decommissioning of 1 Non-WAC Compliant Well in the 100-HR-3 Operable Unit, FY2013*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1308010612.

SGW-55604, 2013, *Description of Work for the Installation of Four Wells (C8787 to C8790) in the 100-HR-3 Groundwater Operable Unit, FY2013*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1308090253.

SGW-56810, 2014, *Field Summary/Data Quality Assessment Report for the Installation of 2 Extraction Wells and 2 Monitoring Wells in the 100-HR-3 Groundwater Operable Unit, Fiscal Year 2013*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083574.

SGW-57584, 2014, *Recommendations and Technical Justification for New Wells and Re-alignment of Existing Wells Associated with Interim Remedial Actions at 100-HR-3: FY14 and FY15*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082019H.

SGW-58236, 2014, *Well Maintenance Plan for the 100-HR-3 and 100-KR-4 Groundwater Treatment Facilities*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082017H.

SGW-58416, 2015, *Persistent Source Investigation at 100-D Area*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082018H.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

TPA-CN-187, 2007, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units, DOE/RL-97-01, Rev. 5*, dated August 3, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA05598794.

TPA-CN-187, 2007, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units, DOE/RL-97-01, Rev. 5*, dated October 3, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA05907607.

TPA-CN-203, 2008, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated March 26, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0804110073.

TPA-CN-222, 2008, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated June 4, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0806170130.

TPA-CN-257, 2009, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated June 25, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0095230.

TPA-CN-298, 2009, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units, DOE/RL-96-90, Rev. 0*, dated October 5, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0095225.

TPA-CN-316, 2010, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 7*, dated January 25, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1001290779.

TPA-CN-323, 2010, *Tri-Party Agreement Change Notice Form: Revision to TPA-CN-298 that references Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units, DOE/RL-96-90, Rev. 0, to update Table B-2 incorporating October 2009 results*, dated February 18, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093757.

TPA-CN-330, 2010, *Tri-Party Agreement Change Notice Form: Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units, DOE/RL-96-90, Rev. 0*, dated February 28, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093759.

TPA-CN-354, 2010, *Tri-Party Agreement Change Notice Form: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated May 4, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093760.

TPA-CN-368, 2010, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-40, Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study, Rev. 0*, dated June 30, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1009100198.

TPA-CN-377, 2010, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated August 17. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1008250909.

TPA-CN-402, 2010, *Change Notice for Modifying Approved Documents/Workplans In Accordance with the Tri-Party Agreement Action Plan, Section 9.0, Documentation and Records: Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation/Feasibility Study (DOE/RL-2009-44. Rev. 0)*, dated November 4, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1011290681.

TPA-CN-409, 2011, *Tri-Party Agreement Change Notice Form: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated February 22, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093973.

TPA-CN-460, 2011, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-40 Sampling and Analysis Plan for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units Remedial Investigation Feasibility Study, Rev. 0*, dated May 9, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109060929.

TPA-CN-464, 2011, *Tri-Party Agreement Change Notice Form: Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit, DOE/RL-97-01, Rev. 5*, dated August 23, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1109060930.

TPA-CN-550, 2012, *Tri-Party Agreement Change Notice Form: DOE/RL-97-01, Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Unit, Revision 5*, dated November 6, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1211191619.

TPA-CN-556, 2012, *Tri-Party Agreement Change Notice Form: DOE/RL-2000-59, Sampling and Analysis Plan for Aquifer Sampling Tubes*, dated November 29, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1212190362.

TPA-CN-557, 2012, *Tri-Party Agreement Change Notice Form: Removal Action Work Plan for River Corridor General Decommissioning Activities, (DOE/RL-2010-34, Rev. 1)*, dated November 12, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U.S. Environmental Protection Agency, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1212190361.

TPA-CN-580, 2013, *Tri-Party Agreement Change Notice Form: DOE/RL-97-01, Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units, Rev. 5*, dated July 25, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088175.

TPA-CN-615, 2014, *Tri-Party Agreement Change Notice Form: DOE/RL-97-01, Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units, Rev. 5*, dated April 22, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1405020365.

TPA-CN-623, 2014, *Tri-Party Agreement Change Notice Form: DOE/RL-97-01, Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units, Rev. 5*, dated April 30, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1405150186.

TPA-CN-657, 2015, *Tri-Party Agreement Change Notice Form: DOE/RL-96-84, Rev 0 and Rev 0-A, Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*, dated July 6, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080609H.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

160-381, "What Are the Standards for Decommissioning a Well?"

WAC 173-162, "Regulation and Licensing of Well Contractors and Operators," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-162.

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A.

201A-240, "Toxic Substances."

WAC 173-218, "Underground Injection Control Program," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-218.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

303-070, "Designation of Dangerous Waste."

303-140, "Land Disposal Restriction."

303-640, "Tank Systems."

WAC 173-304-430, "Minimum Functional Standards for Solid Waste Handling," "Surface Impoundment Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/wac/default.aspx?cite=173-304-430.

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

340-720, "Groundwater Cleanup Standards."

WCH-191, 2015, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080195H.

WCH-572, 2013, *Decommissioning Plan for the In Situ Redox Manipulation (ISRM) Evaporation Pond*, Rev. 0, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1309200243.

WCH-617, 2015, *Decommissioning Report for the 147D In Situ Redox Manipulation (ISRM) Evaporation Pond*, Rev. 0, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1503100608.

WHC-SD-EN-TI-132, 1993, *Geologic Setting of the 100-HR-3 Operable Unit, Hanford Site, South-Central Washington*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196126259.

WHC-SD-EN-TI-155, 1993, *Geology of the 100-K Area, Hanford Site, South-Central Washington*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196129512.

WHC-SD-ER-TI-003, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D195066471.

This page intentionally left blank.

Appendix A

Summary of Regulatory Requirements

This page intentionally left blank

Contents

A1 Introduction **A-1**
A2 Methodology **A-1**
A3 Organization **A-2**
A4 References **A-47**

Tables

Table A-1. Summary of Requirements from Interim Action Decision Documents A-3
Table A-2. Summary of Previous Planning Document Requirements A-16

This page intentionally left blank.

Terms

ARAR	applicable or relevant and appropriate requirement
AWLN	automated water level network
AWQC	Aquatic Water Quality Criteria
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
Cr(VI)	hexavalent chromium
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIP	Environmental Investigations Procedure
EPA	U.S. Environmental Protection Agency
ERC	environmental restoration contractor
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FFS	focused feasibility study
FS	feasibility study
FT	fiscal year
GTS	groundwater treatment system
HASP	health and safety plan
HEIS	Hanford Environmental Information System
IC	institutional control
ICP	inductively coupled plasma
ISRM	in situ redox manipulation
IX	ion exchange
LDR	land disposal restriction
O&M	operations and maintenance
OIC	operator interface computer
OU	operable unit
P&T	pump and treat

PLC	programmable logic controller
PSDB	project-specific database
PSTF	Purgewater Storage and Treatment Facility
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RD/RAWP	remedial design/remedial action work plan
RDR/RAWP	remedial design report/remedial action work plan
RI	remedial investigation
ROD	record of decision
SAF	Sample Authorization Form
TCLP	toxicity characteristic leaching procedure

A1 Introduction

This appendix provides a list of requirements for the 100-HR-3 Operable Unit (OU). Table A-1 includes requirements from the following documents:

- EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*
- EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*
- EPA/ESD/R10-03/606, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*
- EPA et al., 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site Benton County, Washington*
- 11-AMCP-0002, "Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Washington, July 2010, Memo to File Regarding: Supplemental Actions for the In-Site Reduction/Oxidation Manipulation Barrier Performance for the 100-HR-3 Groundwater Operable Unit Interim Remedy"

Table A-2 summarizes requirements from the following documents:

- DOE/RL-96-84, Rev. 0, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
- DOE/RL-96-84, Rev. 0-A, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*
- DOE/RL-96-90, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*
- DOE/RL-99-51, Rev. 1, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*

Tables A-1 and A-2 describe the methodology for meeting each requirement and references the section where the requirement and/or implementation methodology is discussed in this RD/RAWP.

A2 Methodology

In creating Tables A-1 and A-2, each source document was reviewed for obligatory statements or language (i.e., word searches were conducted for sentences containing words such as will and shall). Any sentence describing a requirement was copied verbatim from the source document into the corresponding table. Any changes made to text from the source document were made for sake of clarity.

A3 Organization

The requirements in Table A-1 are numbered sequentially. The requirements were sorted by document section. Table A-2 requirements are also numbered sequentially. The requirements were first grouped to general categories, based on whether the item was related to a remedial action objective (RAO) (category A), reporting requirement (category B), or an aspect of design, construction, and performance (category C). The design, construction, and performance requirements were further categorized to C (general); Ca (sampling and analysis); Cd (construction design); Cp (performance); Cr (resources); and Cw (waste). In some cases, the requirement was judged to fall into more than one category. Not all requirements "fit" cleanly into one of the categories, and the assignment to a category may be judged arbitrarily.

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
1	This interim remedial action addresses chromium in the groundwater (by preventing human exposure to contaminated groundwater and preventing chromium exceedances of AWQC in the Columbia River substrate) and is only part of a final remedial action that will satisfy other ARAR requirements when completed.	EPA/ROD/R10-96/134, 1996 (XI, 11.2)	Current practice: ICs are in place, and systems are designed to meet the state surface water quality standard of 10 µg/L at the groundwater/surface water interface	Sections 2.1.5 and 3.1
2	The selected remedy will comply with the federal and state ARARs (for complete list of ARARs see Section 11.2 in the ROD).	EPA/ROD/R10-96/134, 1996 (XI, 11.2)	ARARs identified	Section 2.5
3	The pump-and-treat will reduce the concentration of chromium to Ambient Water Quality Standards within the river bottom substrate.	EPA/ROD/R10-96/134, 1996 (XI, 11.1)	Current practice: systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface	Section 3.1
4	Site institutional controls will continue during the interim remedial action period. These controls limit human access to the groundwater and thereby limit human exposure to acceptable risk levels.	EPA/ROD/R10-96/134, 1996 (XI, 11.1)	Current practice ICs are in place	Section 2.1.5
5	Implementation of this remedial action will not pose unacceptable short-term risks toward site workers that cannot be mitigated through acceptable remediation practices.	EPA/ROD/R10-96/134, 1996 (XI, 11.1)	Current practice; health and safety	Section 5.5
6	Cultural and Natural Resource Reviews will be conducted before siting each well, pipeline, or treatment facility to determine the potential impacts associated with specific actions.	EPA/ROD/R10-96/134, 1996 (IX, 9.2)	Current practice	Section 5.4
7	Mitigation measures will include actions to minimize dust, use of protective equipment to minimize worker exposures, seasonal scheduling of site work to minimize disturbance to wildlife, archeological monitoring and/or data recovery, as appropriate, and revegetation of the site following interim action.	EPA/ROD/R10-96/134, 1996 (IX, 9.2)	Worker health and safety; cultural and ecological resource protection	Sections 5.5, 5.4
8	As required by CERCLA, this remedy will be reviewed at least as often as every 5 years.	EPA/ROD/R10-96/134, 1996 (VIII, 8.1)	Current practice	Section 2.7
9	In addition to continued access restrictions, the present network of groundwater monitoring wells will be maintained, and samples will be collected to monitor chromium concentrations in groundwater. Monitoring will also aid in determining when these controls are no longer necessary.	EPA/ROD/R10-96/134, 1996 (VIII, 8.1)	ICs, performance monitoring	Sections 2.1.5, 2.4
10	The qualitative risk assessment is not intended to replace or be a substitute for the baseline risk assessment that will be conducted in association with determining the final action for these operable units.	EPA/ROD/R10-96/134, 1996 (VI, 6.1)	Baseline risk assessment in the RI/FS (DOE/RL-2010-95)	Section 1
11	During March of 1995 porewater samples were collected in the river substrate adjacent to the 100-H Area. Results indicated that chromium is present in the river substrate at levels of concern. Similar data are being collected at other reactor areas. Additionally, sampling points are being successfully installed along the shoreline to evaluate the river-groundwater interface. These new data will support the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP).	EPA/ROD/R10-96/134, 1996 (V, 5.4)	System design and optimization	Section 3.1
12	The interim action is expected to provide adequate protection of human health via institutional controls, and the interim remedial action itself will not pose any unacceptable risk to human health.	EPA/ROD/R10-96/134, 1996 (VI, 6.1.1)	Current practice; ICs are in place	Section 2.1.5
13	Water Quality Standards for Waters of the State of Washington (WAC 173-201A-040) for hexavalent chromium are relevant and appropriate for establishing cleanup goals that are protective of the Columbia River. The chronic ambient water quality standard has been revised as of November 1997 from 11 µg/L to 10 µg/L.	EPA/AMD/R10-00/122, 1999 (V & VII)	ARARS are identified.	Section 2.5

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
14	Based on a preliminary dilution factor of 1:1 between the compliance wells and the river, a remediation goal of 22 µg/L was established (i.e., a 22 µg/L hexavalent chromium concentration in near-river compliance monitoring wells is considered to be equivalent to 11 µg/L at the location of the aquatic receptors).	EPA/AMD/R10-00/122, 1999 (III)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
15	Ecological risk will be addressed by the amended interim action by reducing concentrations of chromium to ambient water quality standards within the river-bottom substrate.	EPA/AMD/R10-00/122, 1999 (VII)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
16	Site institutional controls will continue during the interim remedial action period to limit human access to the groundwater.	EPA/AMD/R10-00/122, 1999 (pg iii)	Current practice. ICs are in place.	Section 2.1.5
17	Institutional controls for protection of human health required by the 1996 ROD are unchanged.	EPA/AMD/R10-00/122, 1999 (V)	Current practice. ICs are in place.	Section 2.1.5
18	Site institutional controls will continue during the interim remedial action period that will limit human access to the groundwater.	EPA/AMD/R10-00/122, 1999 (VII)	Current practice. ICs are in place.	Section 2.1.5
19	Other innovative treatment technologies [in addition to the ISRM technology] will continue to be evaluated for final cleanup of this operable unit. The use of the ISRM technology will not affect ongoing operations of the 100-D and 100-H Area pump and treat system.	EPA/AMD/R10-00/122, 1999 (IV)	Additional technologies evaluated.	Section 3.2
20	This is an interim remedial action to protect the Columbia River by preventing toxic levels of hexavalent chromium in groundwater from reaching the river. This interim remedial action is not intended to be a final cleanup action for the aquifer.	EPA/AMD/R10-00/122, 1999 (pg 4)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
21	ISRM implementation and performance monitoring will be described in the RDR/RAWP, including contingencies.	EPA/AMD/R10-00/122, 1999 (IV)	Performance monitoring continues	Section 2.4
22	Because this remedy may result in hazardous substances remaining onsite above levels that allow for unlimited use, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within 5 years after the commencement of the remedial action. This is an Interim Action ROD; therefore, review of this site and this remedy will be ongoing as the tri-Parties continue to develop final remedial measures for the 100 Area National Priorities List site.	EPA/AMD/R10-00/122, 1999 (Pg iii)	Current practice	Section 2.7
23	During implementation of the ISRM technology, an annual report will be prepared by DOE for submittal to EPA and Ecology. The report will document the effectiveness of the technology in remediating the chromium plume. The contents of the annual report will be outlined in the RDR/RAWP.	EPA/AMD/R10-00/122, 1999 (V)	Interim action monitoring	Section 6.3
24	A compliance monitoring plan will be developed and implemented to assess barrier performance.	EPA/AMD/R10-00/122, 1999 (VII)	Completed, DOE/RL-2003-63, monitoring continues	Section 2.4
25	Based on the positive results from this [treatability test implemented at the site to evaluate the feasibility of using the ISRM technology to treat the hexavalent chromium plume] and additional benefits associated with this technology, a full scale use of the ISRM technology will be deployed to intercept the chromium 'hot spot' plume.	EPA/AMD/R10-00/122, 1999 (II)	ISRM implementation complete	Section 2.1.4
26	The 100-H Area injection wells return treated groundwater to the aquifer. The treatment goal is to reduce effluent chromium concentrations to the maximum extent practicable; however, treated groundwater above 50 µg/L chromium will not be discharged in the injection wells.	EPA/AMD/R10-00/122, 1999 (III)	System design	Section 3.1

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
27	A brief exceedance of the secondary water standard for sulfate is anticipated as a result of chemical injection; however, groundwater is expected to meet the sulfate standard following withdrawal of the chemicals, which occurs within a few days of injection.	EPA/AMD/R10-00/122, 1999 (IV)	ISRM implementation completed	Section 2.1
28	During this process [using ISRM technology], dissolved oxygen levels are also reduced. Treatability studies at the site indicate that the groundwater is reoxygenated to 75% to 95% of the original levels before discharging to the Columbia River. Recuperation of oxygen levels is further enhanced by dynamic mixing in the river bottom.	EPA/AMD/R10-00/122, 1999 (IV)	ISRM implementation complete, monitoring continues.	Sections 2.1.4 and 2.4
29	Hexavalent chromium-contaminated groundwater flowing through the treatment zone will be treated to the less-toxic trivalent form.	EPA/AMD/R10-00/122, 1999 (IV)	ISRM implementation completed	Section 2.1.4
30	This ROD Amendment alters the selected remedy action specified in the Interim Remedial Action ROD for the 100-HR-3 Operable Unit by deploying a new innovative technology (In Situ Redox Manipulation [ISRM]) for remediation of this recently characterized hexavalent chromium plume in the 100-D Area. The technology involves creating a permeable groundwater treatment barrier that reduces the mobility and toxicity of chromium in groundwater. A compliance monitoring plan will be developed in the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) to assess barrier performance. If barrier breakthrough is identified, Ecology and EPA will determine alternative action to be taken. Groundwater remediation by pump and treat will continue at the two other areas of the 100-HR-3 Operable Unit, as described in the 1996 Interim Remedial Action ROD.	EPA/AMD/R10-00/122, 1999 (Pg iii)	ISRM implementation complete	Section 2.1.4
31	Although the ISRM technology involves injecting chemicals into the groundwater, these chemicals will not result in exceeding the primary drinking water standards, nor will they adversely affect the beneficial uses of the groundwater.	EPA/AMD/R10-00/122, 1999 (Pg iv)	ISRM implementation complete, monitoring results in annual reports.	Section 2.4
32	A series of injection wells will be used to form the permeable barrier and thereby intercept the chromium-contaminated groundwater. The RDR/RAWP will contain specific design details for the barrier.	EPA/AMD/R10-00/122, 1999 (V)	Completed	Section 2.1.4
33	All hazardous substances, pollutants, or contaminants removed offsite, pursuant to the ROD, for treatment, storage, or disposal shall be treated, stored, or disposed of at a facility in compliance, as determined by EPA in Section 121(d)(3) of CERCLA and 40 CFR 300.440. Regional offices will provide information on the acceptability of a facility under Section 121(d)(3) of CERCLA and 40 CFR 300.440.	EPA/AMD/R10-00/122, 1999 (V)	Current practice	Section 5.3
34	An increase in the groundwater pump-and-treat facility capacity and groundwater extraction rate through expansion of the pump-and-treat system is required and the future cost increase is identified in this ESD.	EPA/ESD, 2009 (Pg 7)	Expansion completed.	Sections 3.2 and 3.3
35	Based on recent treatability and numerical modeling studies, the initial injection well spacing is anticipated to be approximately 10.5 to 12.5 m apart. Hydrogeologic and chemical field parameters shall be monitored during installation of the treatment barrier to optimize emplacement process and barrier design.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete	Section 2.1.4
36	Compliance monitoring wells will monitor chromium and dissolved oxygen concentrations between the injection wells and the Columbia river to determine the effectiveness of the treatment zone.	EPA/AMD/R10-00/122, 1999 (V)	Performance monitoring	Section 2.4
37	Current studies indicate that the treatment barrier will remain effective for approximately 20 years. After that time, the treatment barrier would become less effective in remediating the contaminated groundwater. Performance monitoring will be performed to track	EPA/AMD/R10-00/122, 1999 (V)	ISRM barrier no longer actively maintained	Section 2.1.4

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
	chemical trends in the compliance wells to evaluate the effectiveness of the barrier. Chemicals could be reinjected to reestablish the barrier.			
38	If barrier breakthrough is identified, Ecology and EPA will determine alternative action to be taken.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation completed; Breakthrough occurred and addressed by 11-AMCP-0002, 2010	Section 2.1.4
39	Injection wells shall form a continuous treatment zone. The location, spacing, and overlap will be established in the RDR/RAWP.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete	Section 2.1.4
40	Performance monitoring wells will measure other field parameters including sulfate, dissolved oxygen, pH, temperature, and specific conductance.	EPA/AMD/R10-00/122, 1999 (V)	Performance monitoring	Section 2.4
41	Subsequent withdrawn volumes [of purgewater generated during post-treatment extraction] will be disposed to the ground. The withdrawn water will be analyzed for sulfate to confirm that it meets discharge criteria before discharging it to the ground.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation completed	Section 2.1.5
42	The barrier will approximately parallel the Columbia river but may also contain other orientations depending on the distribution of the chromium contaminant plume.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation completed	Section 2.1.5
43	The first pore volume of purgewater generated during post-treatment extraction shall be disposed at the ModuTanks (Resource Conservation and Recovery Act [RCRA] interim status unit) and/or at the Effluent Treatment Facility (RCRA final status unit), both of which are located in the 200 Areas. Management of waste at these facilities will comply with all applicable RCRA requirements, including permit requirements.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete	Section 2.1.4
44	The installation of the treatment barrier shall be initiated within 15 months after signing the ROD Amendment and fully implemented by the end of fiscal year 2002, based on current knowledge of the plume and implementability of the treatment technology. Design and schedule will be implemented in accordance with the RDR/RAWP.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete	Section 2.1.4
45	The RDR/RAWP for the 100-HR-3 will identify the specific changes to the capture system for the 100-HR-3 plume.	EPA/ESD, 2009 (Pg 6)	System design	Section 3.1
46	The siting, design, and sampling of the compliance monitoring wells shall be adequate to define the boundaries of the plume, the effectiveness of the treatment zone, and shall be capable of assessing if barrier 'breakthrough' occurs. This requires wells located both between the treatment barrier and the Columbia River and wells beyond the end of the treatment barrier to ensure compliance with the RAOs.	EPA/AMD/R10-00/122, 1999 (V)	Performance monitoring	Section 2.4
47	The treatment barrier will be designed in accordance with the RDR/RAWP to attain the remedial action objectives identified in this ROD Amendment for this plume.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete	Section 2.1.4
48	The treatment zone shall treat the chromium plume to 20 µg/L or less at each compliance well to achieve 10 µg/L at the river using the preliminary dilution factor of 1:1.	EPA/AMD/R10-00/122, 1999 (V)	System design	Section 3.1
49	The Underground Injection Control regulations in WAC 173-218 and 40 CFR 144, Subpart B prohibit the use of an injection well that may result in a violation of any primary drinking water standard or that may otherwise adversely affect beneficial use of groundwater. The solution being injected does not contain any constituents with a primary drinking water standard, and beneficial use of the groundwater will not be affected. However, the groundwater will exceed the sulfate secondary drinking water standard for a brief period of time following injection. WAC 173-218 prohibits certain discharges to groundwater; however, this regulation specifically excludes cleanup actions undertaken pursuant to CERCLA.	EPA/AMD/R10-00/122, 1999 (V)	ISRM implementation complete, performance monitoring.	Sections 2.1.4, 2.4, 2.5

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
50	A definitive cost estimate for the preferred alternative will be prepared as part of the remedial design.	EPA/AMD/R10-00/122, 1999 (VI)	Completed	Not applicable
51	The first remedial action objective for the 100-HR-3 and 100-KR-4 Operable Units is to prevent the discharge of hexavalent chromium to the Columbia River substrate at concentrations exceeding those that are considered protective of aquatic life in the River and river bed sediments. Prioritization of areas to be addressed by the remedial action will be based on suitable salmon habitat. The aquatic receptor exposure point of concern is within the river substrate at depths up to 18 inches (46 centimeters), where embryonic salmon and fry could be present during parts of the year.	EPA/ROD/R10-96/134, 1996 (VII)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
52	A second remedial action objective for these operable units is to continue to protect the public such that there is no exposure to contaminants above health based levels. This objective can be achieved by preventing exposure to contaminated groundwater or reduction of contaminants to health based levels as a result of actions taken to protect ecological receptors.	EPA/ROD/R10-96/134, 1996 (VII)	Current practice. ICs are in place and systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Sections 2.1.5 and 3.1
53	Institutional controls are required to prevent human exposure to groundwater. The DOE is responsible for establishing and maintaining land use and access restrictions until MCLs and risk-based criteria are met or the final remedy is selected. Institutional controls include placing written notification of the remedial action in the facility land use master plan.	EPA/ROD/R10-96/134, 1996 (X)	Current practice. ICs are in place.	Section 2.1.5
54	The interim action is expected to provide adequate protection of human health and ecological receptors in the Columbia River and will continue until implementation of the final remedy for the 100-HR-3 and 100-KR-4 groundwater operable units, or until such time that the DOE demonstrates to Ecology and the EPA that no further interim action is required.	EPA/ROD/R10-96/134, 1996 (IV)	Current practice. ICs are in place and systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Sections 2.1.5, 6
55	Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.	EPA/ROD/R10-96/134, 1996 (Pg ii)	Current practice. Five-year reviews conducted.	Section 2.7
56	Draft A of the RDR/RAWP is due to EPA and Ecology 120 calendar days after the ROD is signed.	EPA/ROD/R10-96/134, 1996 (X)	Completed through DOE/RL-96-84	Not applicable
57	The 100-HR-3 Operable Unit was initially designated as a Resource Conservation and Recovery Act (RCRA) Past Practice unit. The Tri-Parties have decided to redesignate this operable unit as a CERCLA Past Practice unit in order to facilitate the disposal of contaminated materials at the CERCLA Environmental Restoration Disposal Facility (ERDF). Ecology will remain the lead regulatory agency for 100-HR-3 following redesignation.	EPA/ROD/R10-96/134, 1996 (X)	Current practice	Section 1
58	The details of the groundwater quality monitoring program will be described in the RDR/RAWP.	EPA/ROD/R10-96/134, 1996 (X)	Current practice. Monitoring identified.	Section 2.4
59	Two RCRA treatment, storage, and disposal (TSD) units, 100-D Pond and the 183-H Solar Evaporation Basins, are located within the boundaries of the 100 HR-3 Operable Unit. The 183-H basins are anticipated to be remediated and closed under RCRA, and the 100-D Pond is currently an inactive unit. The implementation of the remedial actions under this Interim Action ROD are believed likely to impact the current RCRA groundwater sampling program around both of these facilities. For any RCRA unit whose monitoring compliance program is impacted, Ecology may approve modifications to the	EPA/ROD/R10-96/134, 1996 (X)	Current practice, 183-H RCRA monitoring conducted under a different sampling and analysis plan (PNNL-11573, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*). The 100-D Ponds are a clean closed unit.	Not applicable

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
	monitoring program as appropriate. Potential alternative compliance actions include monitoring other existing wells (including remediation wells) for appropriate RCRA constituents during the period when the groundwater is affected by the remedial action.			
60	The 100-DR-2, 100-HR-2, 100-KR-1 and 100-KR-2 Operable Units will be the subject of future response actions.	EPA/ROD/R10-96/134, 1996 (IV)	Final actions for the OUs are discussed.	Section 1
61	This interim action is expected to become part of the final remedial action for the 100-HR-3 and 100-KR-4 Operable Units.	EPA/ROD/R10-96/134, 1996 (IV)	Basis for remedial action	Section 2
62	To intercept the chromium plumes, groundwater will be pumped from approximately 30 wells located along and inland from the river shoreline. The water will then be treated using an ion exchange treatment technology to remove chromium. The treated effluent will then be returned to the aquifer using injection wells located upgradient of the existing chromium plumes.	EPA/ROD/R10-96/134, 1996 (Pg i)	System design	Section 3.2
63	Because this is an interim action Record of Decision (ROD), review of these operable units and the remedy will be on going as the Tri-Parties continue to develop and implement final remedial alternatives for the operable units and the 100 Area National Priority List (NPL) site.	EPA/ROD/R10-96/134, 1996 (Pg ii)	Data evaluation, interpretation, and reporting.	Sections 4.3.4, 6.3
64	Additional information will be obtained during the interim action prior to the development and implementation of a final action. Effectiveness of the interim action will be evaluated based on site-specific data. This evaluation should include treatment cost, efficiency, evaluation of other technologies, hydraulic impacts, and effectiveness of contaminant removal from the aquifer.	EPA/ROD/R10-96/134, 1996 (VII)	Data evaluation, interpretation, and reporting.	Section 4.3.4, 6.3
65	Monitoring will be performed to assess the effectiveness of the remedial action in meeting the Ambient Water Quality Standard. The relevant standard is the State of Washington's chronic Ambient Water Quality Standard for Protection of Freshwater Aquatic Life for hexavalent chromium of 11 parts per billion (WAC 173-201A-040).	EPA/ROD/R10-96/134, 1996 (VII)	Performance monitoring	Section 2.4
66	Remedial actions should improve water quality in the aquifer by removing contaminants, reducing mobility or toxicity.	EPA/ROD/R10-96/134, 1996 (VII)	Performance monitoring, system design	Sections 2.4, 3.1
67	The treatment of groundwater contaminants in situ was evaluated and dropped from the 100 Area Feasibility Study, Phases 1 and 2, as an appropriate alternative for the 100-HR-3 and 100-KR-4 Operable Units because insufficient information was available on in situ treatment methods. However, more recently DOE has conducted tests of reduction/oxidation in situ treatment technology and will consider this technology for implementation of future remedial actions at the 100-HR-3 and 100-KR-4 Operable Units.	EPA/ROD/R10-96/134, 1996 (VIII)	ISRM implementation complete. Additional treatability studies included ZVI and Bioremediation.	Section 2.1.4, 2.2
68	A network of piezometers (or comparable technique) will be installed and monitored such that the capture zone around the extraction wells can be estimated.	EPA/ROD/R10-96/134, 1996 (X)	Data evaluation and interpretation.	Section 4.3.4
69	After treatment, water will be reinjected into the upper aquifer, using injection wells located upgradient of the existing chromium plume in the 100-HR-3 and 100-KR-4 Operable Units respectively.	EPA/ROD/R10-96/134, 1996 (X), EPA/ESD, 2009 (Pg 2)	Revised to current practice allowing cross gradient injection.	Section 3.1
70	Based on preliminary modeling accomplished for the operable unit Focused Feasibility Studies, the number of wells needed to accomplish [groundwater reinjection] was estimated to be:100-H Area: Three injection wells. During the remedial design process, more precise estimates are expected to be developed based on the collection and incorporation of well and site-specific data.	EPA/ROD/R10-96/134, 1996 (X)	Original design completed. Remedial process optimization is reviewed and updated annually.	Section 3.2

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
71	Based on preliminary modeling accomplished for the operable unit Focused Feasibility Studies, the number of wells needed to accomplish [groundwater reinjection] was estimated to be: 100-D Area : Five injection wells. During the remedial design process, more precise estimates are expected to be developed based on the collection and incorporation of well and site-specific data.	EPA/ROD/R10-96/134, 1996 (X)	Original design completed. Remedial process optimization is reviewed and updated annually.	Section 3.2
72	Chromium compliance monitoring will be conducted at multiple depth intervals. Baseline sampling will be conducted prior to the start of the interim action.	EPA/ROD/R10-96/134, 1996 (X)	Completed vertical profile sampling within the unconfined aquifer. Completed baseline sampling from water bearing units at different depths and monitoring of deeper aquifers continues (see DOE/RL-2013-30, Table 3-3)	Section 2.4, 3.3
73	Compliance monitoring will include analysis of result in a timely manner to support modification to the treatment system in order to meet the remedial action objectives. Significant system modifications as identified in the RDR/RAWP are subject to EPA and Ecology approval.	EPA/ROD/R10-96/134, 1996 (X)	Performance monitoring, change management.	Sections 2.4, 4.2
74	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: Construction is expected to comply with appropriate worker safety requirements.	EPA/ROD/R10-96/134, 1996 (X)	Construction completed per work plans, current health and safety practices identified.	Section 5.5
75	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: In coordination with wildlife and other resource management agencies, activities should avoid or minimize disruption to local wildlife and other natural resources to the extent practicable.	EPA/ROD/R10-96/134, 1996 (X)	Construction completed, cultural and ecological resource protection ongoing.	Section 5.4
76	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: Design should provide for flexibility following startup to accommodate changes in plume characteristics, or different understandings of actual or perceived responses of the aquifer/plume to the pump-and-treat system. When the actual response of the aquifer is known, the pump and treat systems may be altered as needed, and approved by EPA and Ecology to meet the remedial action objectives.	EPA/ROD/R10-96/134, 1996 (X)	Systems designed for flexibility.	Section 3.3
77	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: For areas that are disturbed during construction and operation, it is expected that the land will be revegetated following construction in those areas that are not needed for, operation and maintenance of the treatment system and where the land is also not expected to be re-disturbed within the next few years by other site activities. Following completion of the interim action, it is expected that rectification of the habitat affected by this activity will be conducted and coordinated with activities in the source operable units (100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1, and 100-KR-2).	EPA/ROD/R10-96/134, 1996 (X)	Cultural and ecological resource protection.	Section 5.4
78	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: To the extent practicable, facilities are expected to be designed and located in a manner that minimizes interference with and interference by remedial actions for the source waste sites.	EPA/ROD/R10-96/134, 1996 (X)	Interfaces with other projects.	Section 2.7
79	Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements: Sites with cultural resource significance should be avoided during	EPA/ROD/R10-96/134, 1996 (X)	Cultural and ecological resource protection.	Section 5.4

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
	remedial activities if avoidance is possible. Where avoidance is not possible, a data recovery/mitigation plan must be prepared in consultation with the affected resource trustee and carried out for each site impacted by remedial activities.			
80	Contaminated soil overlying these operable units is or will be addressed in separate remedial actions.	EPA/ROD/R10-96/134, 1996 (X)	Current practice.	Section 1.5
81	EPA and Ecology may also authorize short-term intentional shutdowns for the purposes of observing aquifer response or for other purposes as deemed appropriate.	EPA/ROD/R10-96/134, 1996 (X)	Operational approach.	Section 4.3
82	Extraction wells shall be located such that the plume is captured to meet the remedial action objectives.	EPA/ROD/R10-96/134, 1996 (X)	Current practice.	Section 3.1
83	Extraction wells should be located at a sufficient distance inland from the river to minimize withdrawal of river water.	EPA/ROD/R10-96/134, 1996 (X)	Current practice, system design.	Section 3.1
84	Groundwater sampling will be conducted when dilution by river water at the compliance monitoring points is minimal.	EPA/ROD/R10-96/134, 1996 (X)	Performance monitoring.	Section 2.4.2
85	Groundwater will be extracted from wells primarily located along the river in each of the three reactor areas.	EPA/ROD/R10-96/134, 1996 (X)	System modified from initial design. Only two reactor areas applicable within 100-HR-3 OU.	Section 3.2
86	If during the design or conduct of the remedial action it is determined that regeneration of resins is appropriate, that option may be implemented with any waste disposed as described for resins in this paragraph [Section X: Selected Remedy: Resin Disposal, ROD for 100-HR-3 and 100-KR-4)	EPA/ROD/R10-96/134, 1996 (X)	Resin type changed, resin disposal part of waste management. Resin regeneration is not applicable to SIR-700 resin.	Section 5.3
87	In the event of a partial or total system shutdown EPA or Ecology may impose additional near-river compliance sampling requirements.	EPA/ROD/R10-96/134, 1996 (X)	Operational approach.	Section 4.3
88	In the event of special conditions such as an unusual flood event or prolonged downtime of the pump-and-treat system, extra monitoring, at the direction of EPA or Ecology shall be conducted.	EPA/ROD/R10-96/134, 1996 (X)	Operational approach.	Section 4.3
89	In the event that some materials cannot be disposed to ERDF or other on-site facilities, and require disposal at an off-site facility, such a facility must be in compliance with EPA's Offsite Rule (40 CFR 300.440) concerning off-site disposal of wastes.	EPA/ROD/R10-96/134, 1996 (X)	Waste management.	Section 5.3
90	Resins will be stabilized prior to disposal such that: the Chromium concentration in leachate generated using the Toxicity Characteristic Leachate Procedure (TCLP) is less than 5.0 mg/l and ERDF waste acceptance criteria are met for disposal at ERDF.	EPA/ROD/R10-96/134, 1996 (X)	Waste management.	Section 5.3
91	Sampling will be conducted monthly for at least three months following start-up of the extraction system. Subsequently, there may be substantial reductions in frequency, number of stations, and depths sampled, if demonstrated to be appropriate, and approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Completed for initial systems, sampling frequency modified through change management.	Section 4.2
92	Since it is impractical to routinely monitor the river substrate, groundwater will be monitored at near-river on-shore locations above the common high rivermark. Monitoring shall be conducted at sufficient locations to evaluate the performance of the remedial action.	EPA/ROD/R10-96/134, 1996 (X)	Performance monitoring.	Section 2.4
93	Soil will be disposed to ERDF, as well slurries following dewatering in accordance with ERDF waste acceptance criteria. Water may be processed via the ion exchange treatment system installed for groundwater under this ROD.	EPA/ROD/R10-96/134, 1996 (X)	Waste management.	Section 5.3

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
94	System components will be located such that they will not increase deleterious effects of flooding.	EPA/ROD/R10-96/134, 1996 (X)	Cultural and ecological resources.	Section 5.4
95	The analyte list will be defined during remedial design; it shall include: - Hexavalent chromium (or total chromium assumed to be hexavalent). The method detection limit and quantitation limit of the selected test method shall be sufficiently low to allow comparison with the remedial action goals. - Conductivity or comparable measurements adequate to indicate ratio of river-derived versus groundwater-derived water. - On an infrequent basis, likely co-contaminants will be monitored as part of on-going Tri-Party Agreement activities to assess protectiveness of human health and the environment.	EPA/ROD/R10-96/134, 1996 (X)	Operational and performance monitoring, which reference the O&M Plan (DOE/RL-2013-49) and Sampling and Analysis Plan (DOE/RL-2013-30).	Section 2.4
96	The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in the RDR/RAWP and prepared using the WAC 173-340-720(8) and approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Data use and interpretation, groundwater remediation steps.	Sections 4.3.4, 6.2
97	The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in a compliance monitoring plan as part of the RDR/RAWP and prepared in accordance with WAC 173-340-720(8) and/or as approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Groundwater remediation steps.	Section 6.2
98	The extraction and treatment system shall be designed to run on an essentially continuous basis such that routine procedures such as resin changes and mechanical maintenance can be conducted with minimal impact to system operations.	EPA/ROD/R10-96/134, 1996 (X)	Up time requirements.	Section 4.3.1
99	The following extraction well design was estimated as sufficient to capture the chromium plume to meet the chromium remedial action objectives: 100-H Area: Nine extraction wells spaced approximately 160 m(515 ft) apart with a composite withdrawal rate of 225 gpm. During remedial design, estimates will be improved based on the incorporation of the results of ongoing river pore water sampling and shoreline drive point sampling, recent groundwater sampling data, and other pertinent data collected since the completion of the focused feasibility study.	EPA/ROD/R10-96/134, 1996 (X)	System design.	Section 3.1
100	The following extraction well design was estimated as sufficient to capture the chromium plume to meet the chromium remedial action objectives: 100-D Area : Ten extraction wells spaced approximately 160 m(515 ft) apart with a composite withdrawal rate of 100 gpm. During remedial design, estimates will be improved based on the incorporation of the results of ongoing river pore water sampling and shoreline drive point sampling, recent groundwater sampling data, and other pertinent data collected since the completion of the focused feasibility study.	EPA/ROD/R10-96/134, 1996 (X)	System design.	Section 3.1
101	The groundwater extraction system shall be designed in accordance with the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) as approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Completed.	Section 3.1
102	The groundwater treatment and reinjection system shall be designed in accordance with the RDR/RAWP as approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Completed.	Section 3.1
103	The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 µg/L chromium will not be discharged. The average chromium concentrations in the effluent are expected to	EPA/ROD/R10-96/134, 1996 (X)	System design.	Section 3.1

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
	be below this standard. This will be performed using ion exchange resins such as a weak base anionic resin with a high selectivity toward chromate anions (hexavalent chromium).			
104	The interim action is expected to provide adequate protection of human health and ecological receptors in the Columbia River until implementation of the final remedy for the 100-HR-3 and 100-KR-4 groundwater operable units, or until such time that the DOE demonstrates to Ecology and the EPA that no further interim action is required.	EPA/ROD/R10-96/134, 1996 (X)	System design.	Section 3.1
105	The interim action will be implemented such that to the extent practicable disturbance to wetlands will be avoided and system components except monitoring points will be located away from wetlands.	EPA/ROD/R10-96/134, 1996 (X)	Cultural and ecological resources.	Section 5.4
106	The provisions of this paragraph [Section X: Selected Remedy: Up-time requirements, paragraph 2] do not apply at the conclusion of the interim action.	EPA/ROD/R10-96/134, 1996 (X)	Operational requirements.	Section 4.3
107	The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate because: (A) sampling indicated that hexavalent chromium is below the compliance value, and site data indicate it will remain below the compliance value; or (B) based on an evaluation of the following criteria. The effectiveness of the treatment technology does not justify further operation. An alternative treatment technique, such as in situ chemical reduction or other improved treatment technique, is evaluated and proves to be more effective, and/or less costly, and is consistent with the remedial action objectives.	EPA/ROD/R10-96/134, 1996 (X)	Remedial action completion.	Section 6
108	The RDR/RAWP will establish a schedule including Tri-Party Agreement milestones for this interim remedial action. This Work Plan including the schedule is subject to EPA and Ecology approval.	EPA/ROD/R10-96/134, 1996 (X)	RDR/RAWPs completed, milestones identified.	Section 2.1.1
109	The siting and design of the compliance monitoring system shall be in accordance with the RDR/RAWP as approved by EPA and Ecology.	EPA/ROD/R10-96/134, 1996 (X)	Performance monitoring.	Section 2.4
110	The system shall be designed such that if one or several of the wells are down (such as due to a mechanical problem, or a well pump needs to be replaced), the rest of the system can continue operating.	EPA/ROD/R10-96/134, 1996 (X)	Operational approach.	Section 4.3
111	The system should be winterized such that winter weather or preparation for winter weather does not cause extended shut-down of the system and compromise the remedial action objectives.	EPA/ROD/R10-96/134, 1996 (X)	Up time requirements.	Section 4.3.1
112	The third pump-and-treat system in the third reactor area shall be operating as per the RDR/RAWP within 18 months of this ROD.	EPA/ROD/R10-96/134, 1996 (X)	Completed.	Section 3.2
113	To account for dilution within the aquifer between the monitoring location on-shore and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 1:1 has been selected based on the available data (i.e., 22 µg/L hexavalent chromium in on-shore near-river well points is considered equivalent to 11 µg/L hexavalent chromium in the river substrate).	EPA/ROD/R10-96/134, 1996 (X)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
114	Two pump-and-treat systems designed in accordance with this ROD in two of the three reactor areas are to be operating as per the RDR/RAWP within 15 months of this ROD.	EPA/ROD/R10-96/134, 1996 (X)	Completed.	Section 3.2

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
115	Waste generated during the remedial action, principally exhausted resins, will be disposed of at the Environmental Restoration Disposal Facility (ERDF) or at other on-site facilities as appropriate.	EPA/ROD/R10-96/134, 1996 (X)	Waste management	Section 5.3
116	The DOE will prohibit any activities that would interfere with the remedial activity without EPA and Ecology concurrence. In addition, measures necessary to ensure the continuation of these restrictions will be taken in the event of any transfer or lease of the property before a final remedy is selected. A copy of the notification will be given to any prospective purchaser/transferee before any transfer or lease. The DOE will provide EPA and Ecology with written verification that these restrictions have been put in place.	EPA/ROD/R10-96/134, 1996 (X)	ICs	Section 2.1.5
117	Since mixing of groundwater and river water occurs between the on-shore near river monitoring locations and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 1:1 was selected in the 1996 ROD, based on the available data.	EPA/ESD, 2009 (Pg 3 & 4)	Updated by current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface	Section 3.13
118	Institutional controls are required to prevent human exposure to groundwater, and are identified in the "Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions."	EPA/ESD, 2009 (Pg 4)	Current practice. ICs are in place.	Section 2.1.5
119	During remediation under the existing interim RODs a large amount of additional site data is being collected and will be used in making the final remedial action decision for these areas.	EPA/ESD, 2009 (Pg 4)	Additional data provided in annual reports, RI/FS (DOE/RL-2010-95)	Sections 2.2, 6.3
120	The final decisions will address co-contaminants not targeted by the current groundwater interim remedial action.	EPA/ESD, 2009 (Pg 4)	Discussion of Cr(VI) cleanup and potential cleanup levels for co-contaminants are identified	Section 6
121	Final RODs for the 100 Area Operable Units are expected to be issued in 2012, and will define final actions for groundwater remedial actions, including any additional or alternative actions that may be needed.	EPA/ESD, 2009 (Pg 5)	Completion or replacement of the interim action with a final remedy and RD/RAWP discussed.	Section 1
122	This ESD will become part of the Administrative Record for the 100-HR-3 and 100-KR-4 operable unit Interim Action ROD in accordance with Section 300.825(a)(2) of the NCP.	EPA/ESD, 2009 (Pg 2)	ESD is in the administrative record.	Section 2.1.1, 8
123	The design, schedule and plans for implementing the 100 HR-3 and 100 KR-4 remedy, as revised by this ESD, will be described in an amended RDR/RAWP to be approved by the lead regulatory agency, and will include specific locations of the wells.	EPA/ESD, 2009 (Pg 9)	System design in current RD/RAWP	Section 3
124	The RDR/RAWP identified an additional action specific ARAR for the evaporation pond that was not included in the ROD Amendment. This ARAR, 'Surface Impoundment Standards' (WAC 173-304-430) is applicable to the design, construction, and operation of the evaporation pond that will be used to contain the water withdrawn from ISRM barrier emplacement well activities.	EPA/ESD, 2003 (p. 4 & 5)	No longer applies, pond decommissioned.	Section 4.3.3
125	The original cost and schedule was based on the construction of 40 wells and a barrier length of 610 m (2,000 ft), which gives an inferred well spacing of 15 m (50 ft). The changes in the design that resulted in increased costs are: an increase in barrier length (from 610 m [2,000 ft] to 680 m [2,230 ft]), a decrease in well spacing of the system (from 15 m [50 ft] to 10.7 m [35 ft]), and the design and construction of a local evaporation pond for the disposal of extracted groundwater.	EPA/ESD, 2003 (p. 4)	ISRM implementation complete.	Section 2.1.4
126	[At the completion of the project], any remaining purgewater will be trucked to the Purgewater Storage and Treatment Facility or the Effluent Treatment Facility for disposal.	EPA/ESD, 2003 (p. 5)	ISRM implementation completed.	Section 2.1.4

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
127	[At the completion of the project], any remaining sediments or precipitants will be collected as solid wastes and characterized to determine waste disposal requirements. The sulfate in the precipitate is not an environmental concern because sulfate is neither a carcinogen nor a toxic waste.	EPA/ESD, 2003 (p. 5)	ISRM pond decommissioned.	Section 4.3.3
128	At the completion of the project, the evaporation pond and drip field will be dismantled.	EPA/ESD, 2003 (p. 5)	ISRM pond decommissioned.	Section 4.3.3
129	The 'Dangerous Waste Regulations' (WAC 173-303) are identified as an ARAR in the RDR/RAWP. Accordingly, the solid wastes, including the drip field, pond liner, and accumulated evaporation pond sediments, will be evaluated to determine whether they are a characteristic dangerous waste, and disposed as appropriate to the Environmental Restoration Disposal Facility (ERDF) or other approved Hanford Site landfill [At the completion of the project].	EPA/ESD, 2003 (p. 5)	ISRM pond decommissioned.	Section 4.3.3
130	The ROD Amendment was issued in October 1999 using the Proposed Plan capital estimate of approximately $3,920,000. The capital estimate for ISRM increased to approximately $8,729,000 to account for the changes noted previously.	EPA/ESD, 2003 (p. 5)	ISRM implementation completed.	Section 2.1.4
131	Current effluent chromium concentrations re-injected into the aquifer are typically below the Aquatic Water Quality Criteria (AWQC) of 10 µg/L and treatment is expected to be maintained at or below this concentration.	EPA/ESD, 2009 (2)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
132	As required by the ROD, monitoring of groundwater near the river will be conducted at a sufficient number of locations to determine system performance in meeting ROD requirements.	EPA/ESD, 2009 (p. 8)	Performance monitoring.	Section 2.4
133	Future Costs – FY 2009 to FY 2012: Projected cost for the next four years, until the anticipated final ROD for the 100-D and 100-H Areas is in place, is $60,298,000.	EPA/ESD, 2009 (p. 8)	Cost summary.	Section 7.1
134	This ESD allows for reinjection of treated groundwater in locations other than upgradient of the extraction wells to help contain the hexavalent chromium plumes and prevent the plumes from expanding. The groundwater treatment and re-injection system shall be designed in accordance with the Remedial Design Report/Remedial Action Work Plan as approved by the lead regulatory agency. The treatment system still must reduce the effluent chromium concentrations to the maximum extent practicable.	EPA/ESD, 2009 (p. 8)	System design.	Section 3.1
135	Groundwater monitoring is conducted at on-shore near-river locations within the groundwater operable units to ensure protection of aquatic receptors in the river and to monitor remediation progress in groundwater.	EPA/ESD, 2009 (Pg 3)	RAOs.	Section 2.2
136	Treated groundwater exceeding 50 micrograms per liter chromium cannot be discharged to the aquifer.	EPA/ESD, 2009 (Pg 3)	System design.	Section 3.1
137	While 50 micrograms per liter chromium and below was selected for the reinjection threshold to groundwater upgradient of the plumes, a 20 micrograms per liter threshold at on-shore near-river monitoring locations was selected to achieve the Aquatic Water Quality Criteria (AWQC) of 10 micrograms per liter.	EPA/ESD, 2009 (Pg 3)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
138	Projected cost for the pump-and-treat operations is being increased and the cost will be more than 50% of the estimate in the ROD.	EPA/ESD, 2009 (Pg 4)	Cost summary.	Section 7.1

Table A-1. Summary of Requirements from Interim Action Decision Documents

Number	Requirement	Decision Document/Section[a]	How Met	RD/RAWP Location
139	The original 1996 ROD cost estimate was for a 5-year operations and maintenance period. The systems have been operating for more than twice that long, and are currently estimated to operate at least through 2012.	EPA/ESD, 2009 (Pg 4)	Cost summary.	Section 7.1
140	In addition to the longer operation time, the increased size of the plumes requires expansion of the pump-and-treat systems.	EPA/ESD, 2009 (Pg 5)	System design.	Section 3.2
141	The pump-and-treat systems at 100-HR-3 and 100-KR-4 have operated past the 5 year operational estimate identified in the 1996 ROD, and will continue to run for at least three more years.	EPA/ESD, 2009 (Pg 5)	System design.	Section 3.1
142	Injection wells that are not located upgradient of the extraction wells must reduce the effluent chromium concentrations to the maximum extent practicable, and not to exceed 20 µg/L (i.e. two times the AWQC of 10 µg/L). As indicated in the ROD, a dilution factor of 1:1 is expected before the injected treated groundwater would reach the aquatic receptor point of concern within the river substrate, ensuring that the AWQC of 10 µg/L in the river substrate will be met.	EPA/ESD, 2009 (Pg 8)	Current practice. Systems are designed to meet the State surface water quality standard of 10 µg/L at the groundwater/surface water interface.	Section 3.1
143	After treatment, water will be reinjected into the upper aquifer in a manner that will help contain the hexavalent chromium plumes and prevent the plumes from expanding in the 100-HR-3 and 100-KR-4 Operable Units, respectively.	EPA/ESD, 2009 (Pg 9)	System design.	Section 3.1
144	The groundwater treatment systems will reduce chromium concentrations to the maximum extent practicable. However, groundwater above 50 µg/L chromium will not be discharged and groundwater above 20 µg/L chromium will not be discharged to injection wells that are not located upgradient of the extraction wells. The average chromium concentrations in the treated effluent are expected to be at or below 20 µg/L.	EPA/ESD, 2009 (Pg 9)	System design.	Section 3.1
145	Treatment will be performed using ion exchange resins.	EPA/ESD, 2009 (Pg. 9)	System design.	Section 3.1
146	Ecology and EPA have determined that pump and treat system expansion (i.e., pumping wells downgradient of the barrier) will be used to address the ISRM breakthrough and provide a protective interim remedy.	11-AMCP-0002, 2010	System design.	Section 3
147	The pump and treat expansion and performance monitoring modifications will be addressed through a revision to the Remedial Design/Remedial Action (RD/RA) Work Plan and Interim Action Monitoring Plan (IAMP).	11-AMCP-0002, 2010	System design, performance monitoring.	Sections 3 and 2.4
148	The portions of the ISRM barrier that are operable will continue to be monitored per the current and future RD/RA Work Plan and IAMP.	11-AMCP-0002, 2010	Performance monitoring.	Section 2.4

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
1	A	ICs, which prevent groundwater from being used as drinking water, will be used to protect human health.	DOE/RL-96-90, Rev. 0 (1.3)	Active	Section 2.1.5
2	A	Specific information on how each RAO will be met and where the information is discussed in this document is provided in Table ES-1. The interim action ROD also describes other requirements that were factored into the design, construction, and operation of the P&T systems. There requirements are also summarized in Table ES-1.	DOE/RL-96-84, Rev. 0-A (Pg ii)	Active	Appendix A
3	A	This interim action will achieve three RAOs identified in the interim action ROD: (1) protection of aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River, (2) protection of human health by preventing exposure to contaminants in the groundwater, and (3) provide information that will lead to the final remedy.	DOE/RL-96-84, Rev. 0 (1.2)	Active	Section 2.2
4	A,C	Maintain ICs that prevent access to areas where groundwater containing contaminants above health-based levels occurs.	DOE/RL-96-84, Rev. 0 (5.1.2)	Active	Section 2.1.5
5	A,C	Maintain signs along the river shoreline within the OU boundaries indicating a restricted access area.	DOE/RL-96-84, Rev. 0 (5.1.2)	Active	Section 2.1.5
6	A,C	Modify, if necessary, the existing groundwater use notification to identify areas in 100-HR-3 and 100-KR-4 where chromium and co-contaminant concentrations exceed protective levels. The notification would consist of maps and narrative descriptions of areas where groundwater use is restricted.	DOE/RL-96-84, Rev. 0 (5.1.2)	Active	Section 2.1.5
7	A,C	The primary pathway for human exposure to groundwater containing chromium and other co-contaminants is seeps along the riverbank. Control of this pathway will be achieved by implementing the following actions for the duration of the interim action, or until such time that the pathway is eliminated or contaminant concentrations decline below health-based levels: • Maintain ICs that prevent access to areas where groundwater contains contaminants exceeding health-based levels. • Maintain locks on barrier wells, compliance wells, and monitoring wells. • Perform well surveillance during scheduled sampling events. • Maintain signs along the river shoreline within the OU boundaries indicating a restricted access area. • Modify, if necessary, the existing groundwater use notification to identify areas in the 100-D Area where chromium and co-contaminants exceed protective levels. The notification would consist of maps and narrative descriptions of areas where groundwater use is restricted. • Install and maintain a fence to prevent inadvertent entry into the evaporation pond.	DOE/RL-99-51, Rev. 1 (5.1.2)	Active	Section 2.1.5
8	A,Cp,Ca	Monitoring the remedial action will be necessary to demonstrate its effectiveness and collect information necessary to satisfy RAOs and performance criteria specified in the interim action ROD.	DOE/RL-96-84, Rev. 0 (1.4)	Active	Section 2.4.2
9	B	A HASP will be prepared prior to operations that will identify requirements for safe operation of the treatment system.	DOE/RL-96-84, Rev. 0 (4.4.1)	Active	Health and safety requirements for the DX and HX systems are in Section 5.5.
10	B	A preventive maintenance plan will be generated and implemented to detect and prevent potential interruptions of scheduled monitoring activities.	DOE/RL-99-51, Rev. 1 (6.1)	Complete	Requirement not carried forward, ISRM implementation complete.
11	B	A readiness evaluation plan will be developed in FY 1997. The plan will identify activities and documents (collectively referred to as readiness evaluation items) that will be completed to support system operations.	DOE/RL-96-84, Rev. 0 (4.2)	Complete	Requirement not carried forward. The readiness evaluation was completed.
12	B	A site-specific HASP will be prepared and implemented for well drilling and construction activities. The HASP will address the health and safety considerations for construction, construction oversight personnel, and visitors.	DOE/RL-96-84, Rev. 0 (4.1.5)	Active	Section 5.5
13	B	A startup procedure will be developed prior to startup. The startup procedure will address acceptance testing, calibration of instruments, testing of system components, and testing and startup of the overall system.	DOE/RL-96-84, Rev. 0 (4.3)	Complete	Requirement not carried forward. The system startup was completed
14	B	Abbreviated monthly summaries will be used to communicate general information to project management staff and regulatory agency personnel. A typical data summary would provide monthly and cumulative information on number of operation days, liters of groundwater and kilograms of chromium removed, and average and maximum influent and effluent chromium concentrations, kilograms of resin used, and water level trends in injection well(s).	DOE/RL-96-84, Rev. 0-A (pg. 5-10) DOE/RL-96-84, Rev. 0 (5.5)	Active	Section 6.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
15	B	Additional information on the management and testing of spent resin prior to disposal is presented in Chapter 5.0 of this document and will be presented in an Operations Waste Management Plan.	DOE/RL-96-84, Rev. 0 (3.4.4)	Active	Section 5.3
16	B	An ISRM site-specific HASP will be prepared and implemented to address the health and safety considerations for O&M personnel and visitors. In addition, every subcontractor performing work in association with ISRM deployment and monitoring will be required to prepare and submit a HASP that will be approved by Bechtel Hanford, Inc. prior to initiating work activities.	DOE/RL-99-51, Rev. 1 (7.0)	Complete	Requirement not carried forward, ISRM implementation complete.
17	B	An operations waste management plan will be developed to manage waste produced during system operations. The waste management plan will specify waste characterization requirements for various waste types, waste storage requirements, and waste disposal requirements. This waste management plan will be finalized before the start of operations.	DOE/RL-96-84, Rev. 0 (4.4.1)	Active	Waste management requirements are in Section 5.3
18	B	Annual performance evaluation reports represent an important vehicle for conducting comprehensive evaluations of system operations data. The annual performance evaluations will integrate calendar year data collected from other 100-HR-3 and 100-KR-4 programs and will be issued no later than May 30 of the following year. Performance areas, alternate pumping strategies, treatment system modifications, or alternate sampling parameters and frequencies.	DOE/RL-96-84, Rev. 0-A (pg. 5-10)	Active	Section 6.3
19	B	As noted in Section 3.1.3, a performance monitoring plan will be developed to identify and integrate interim action monitoring activities. This performance monitoring plan will identify operational monitoring requirements applicable to system operations. The performance monitoring plan will be developed prior to system operations and will require regulatory approval.	DOE/RL-96-84, Rev. 0 (4.4.1)	Active	Section 2.4.2
20	B	At a minimum, records will be maintained and managed as specified by BHI-MA-02, *ERC Project Procedures*. Personnel assigned to conduct equipment surveillance and routine inspections will be responsible for preparing, reviewing, and maintaining required records. Recordkeeping will be in accordance with procedures such as those currently used at the P&T facilities. Each record will be signed by the person conducting the surveillance activity and preparing the record. Recordkeeping databases will be developed during implementation of the interim action and will consist of paper and computer-generated data. Periodic recordkeeping audits will be conducted by ERC personnel.	DOE/RL-99-51, Rev. 1 (3.5)	Complete	Requirement not carried forward - ISRM implementation complete.
21	B	Construction HASP: this plan will provide information on field oversight health and safety protocols used during construction.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Health and safety requirements identified in Section 5.5
22	B	Construction quality assurance plan: this plan will be a compilation of DOE and ERC field inspection and quality assurance protocols for use during construction and functional testing of the balance of plant and GTS skid.	DOE/RL-96-84, Rev. 0 (3.1.3)	Complete	Not applicable – HR-3 and DR-5 construction completed. Systems no longer functional.
23	B	Data relevant to the 100-HR-3 and 100-KR-4 P&T systems will be collected and stored in a Microsoft Access® PSDB.	DOE/RL-96-90, Rev. 0 (6.0)	Active	Section 2.4.1
24	B	Field screening results and information pertinent to the analysis will be documented in field logbooks, which will be part of the administrative record. Preliminary data will be available to project personnel as soon as possible following the analyses. Same-day or next-day release of preliminary data is anticipated.	DOE/RL-99-51, Rev. 1 (4.6)	Complete	Requirement not carried forward - ISRM implementation complete.
25	B	Historical data will include flow rate to (or from) all wells and through each treatment skid. Pump operation will also be logged.	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Active	Section 2.4.1
26	B	Implementation documents, to be prepared before or during interim action construction, will address activities necessary to support construction, startup, and operation of the P&T system.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 3 identifies the implementing documents for all the treatment systems.
27	B	Information on the resin selection process will be provided to the regulatory agencies as it is developed.	DOE/RL-96-84, Rev. 0 (3.3.1.5)	Active	Section 2.2
28	B	Mitigation Action Plan. This document will provide mitigation strategies to be used to prevent or reduce impacts to cultural ecological resources present at the present at the 100-HR-3 and 100-KR-4 P&T sites and provide guidance on revegetation after the projects are completed.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 5.4
29	B	Monitoring plans beyond 5 years will include reassessments of how long the barrier is expected to treat Cr(VI) successfully.	DOE/RL-99-51, Rev. 1 (5.2.5)	Active	Sections 2.1.4, 2.4

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
30	B	Operating records will be kept to document specific information listed in DOE/RL-99-51, Section 6.5.	DOE/RL-99-51, Rev. 1 (6.5)	Complete	Requirement not carried forward (records specific to ISRM), ISRM implementation complete.
31	B	Operation of the treatment system will be controlled by an operating procedure that will be developed as the system design progresses. The operating procedure will be finalized before the start of full-scale operations and will include preventive maintenance and instrument calibration requirements.	DOE/RL-96-84, Rev. 0 (4.4.3)	Active	Section 3.3 identifies the design approach and includes O&M for current P&T systems.
32	B	O&M plan, to be prepared during the construction phase, will be a compilation of as-built drawings, equipment specifications, owner manuals, training requirements, and DOE/ERC procedures for performance of specific activities related to operation and maintenance of the P&T system.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 3.3.3
33	B	Performance Monitoring Plan. This plan will integrate monitoring activities designed to meet the interim action ROD requirements with those necessary to safely operate the P&T system and ensure optimum operation. The performance monitoring plan will provide a detailed description and schedule of monitoring activities including data management and evaluation methods. This document will serve as a work plan for project management staff and as a sampling and analysis plan for field support staff.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 2.4
34	B	Prior to changing the resin type, supporting information will be provided to the regulatory agencies to demonstrate the basis for the change.	DOE/RL-96-84, Rev. 0 (3.4.4.5)	Active	Section 4.2
35	B	P&T system operators will maintain a handwritten daily log designed to assist in tracking and evaluating the performance of the system in accordance with the operational and maintenance manual. Selected data stored in the OIC will be retrieved electronically and downloaded. The following parameters will be recorded on an as needed basis: 1. Number and designation of IX columns in service at 100-HR-3 and 100-KR-4 water treatment facilities 2. Column resin installation and change-out dates 3. Total daily throughput by module 4. Number and operating status of 100-H, 100-D, and 100-K Area extraction wells 5. Extraction well pumping rate 6. Flow rate and operating status for each injection well 7. Samples taken and location of sampling 8. Injection well water levels 9. Extraction well water levels 10. River level	DOE/RL-96-90, Rev. 0 (7.1)	Active	Section 2.4.1
36	B	Quarterly data reports, presented in a memorandum format, will be used to present the results from quarterly sampling activities. These reports will include tabular summaries and graphical depictions of compliance well and performance well analytical results and trends along with quality assurance data. A brief narrative summary will also be included with recommendations for modifying the performance monitoring, if warranted. These guidelines will be transmitted to the regulators.	DOE/RL-99-51, Rev. 1 (9.0)	Active	Not applicable for ISRM specific data. Section 6.3 describes remedial action reporting.
37	B	Quarterly monitoring reports, presented in a memorandum format, will be used to present the results from quarterly sampling activities. These reports would include tabular summaries and graphical depictions of compliance and extraction well analysis results and trends, semiannual co-contaminant analysis data, graphical depictions of groundwater elevation trends and flow patterns, and a quality assurance summary. A brief narrative summary would also be included with recommendations for modifying operation if warranted.	DOE/RL-96-84, Rev. 0 (5.5) DOE/RL-96-84, Rev. 0-A (pg. 5-10)	Active	Section 6.3
38	B	Raw data will be preserved in electronic format on computer disks. Data will be compiled and reported annually in the performance evaluation report.	DOE/RL-99-51, Rev. 1 (5.3.2)	Active	Section 4
39	B	Records will be maintained to document, at a minimum, system performance, compliance with regulatory requirements, and significant incidents that occur during operation (e.g., during the injection/withdrawal events).	DOE/RL-99-51, Rev. 1 (6.5)	Complete	Requirement not carried forward, ISRM implementation complete.
40	B	Regulatory records, including waste management and health and safety records, will be maintained to document regulatory compliance.	DOE/RL-99-51, Rev. 1 (6.5)	Complete	Requirement not carried forward, ISRM implementation complete.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
41	B	Relevant elements of the conceptual models and monitoring requirements will also be presented in a performance monitoring plan for the interim action.	DOE/RL-96-84, Rev. 0 (2.1)	Active	Section 1.4 – CSM, Section 2.4 monitoring
42	B	Sampling and analysis procedures for implementing compliance monitoring, in addition to activities required to support the performance and operations monitoring programs, will be presented in the 100-HR-3 and 100-KR-4 interim action performance monitoring plan to be prepared during the implementation phase.	DOE/RL-96-84, Rev. 0 (5.0)	Active	Section 2.4
43	B	Site inspections (e.g., area inspections, wellhead inspections) will be performed on a semi-annual basis and the results documented in the ISRM logbook. Although groundwater remediation using ISRM will accomplish this performance criterion for chromium in the course of protecting aquatic receptors, this performance criterion is accomplished independently of the ISRM treatment.	DOE/RL-99-51, Rev. 1 (5.1.2)	Active	Section 2.4.2. Performance monitoring for ISRM implementation complete.
44	B	System operating records will be maintained to document operating history and to correlate with system performance evaluations.	DOE/RL-99-51, Rev. 1 (6.5)	Complete	Requirement not carried forward, ISRM implementation complete.
45	B	System operations will be controlled through use of O&M manuals. O&M manuals will provide operating and maintenance procedures, as well as specify maintenance and calibration schedules. O&M manuals will be prepared prior to the start of operations.	DOE/RL-96-84, Rev. 0 (4.4.1)	Active	Section 3.3.3 describes the O&M plan.
46	B	The performance monitoring plan will address the following monitoring programs: compliance monitoring program. This program describes the location, methods, and frequency of monitoring required to meet the objectives described in the interim action ROD and to demonstrate successful completion of the interim action or conditions warranting its termination. The compliance monitoring program approach is described in Chapter 5.0 of this document.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 2.4
47	B	The performance monitoring plan will address the following monitoring programs: performance monitoring program. This program describes the locations, methods, and frequency of monitoring conducted to (1) determine the effects of the interim action on groundwater flow and plume distribution, (2) support RI/FS data needs for selection of the final remedy, (3) optimize system performance, and (4) support or describe data sharing with other regulatory programs.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 2.4
48	B	The performance monitoring plan will address the following monitoring programs: operational monitoring Program. This program will describe monitoring necessary to support (1) documentation of safe operation and system function, (2) maintenance schedules, and (3) project cost controls.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 2.4
49	B	The interim action monitoring program will include the following distinct monitoring elements: compliance monitoring. The objectives for compliance monitoring are to perform the appropriate sampling, analysis, and data evaluation necessary to meet the requirements of the interim action ROD.	DOE/RL-96-84, Rev. 0 (5.0)	Active	Section 2.4.2
50	B	The interim action monitoring program will include the following distinct monitoring elements: performance monitoring. The objectives for performance monitoring are to obtain water level and water quality data necessary to optimize performance of the groundwater extraction system, document aquifer and chromium plume response to pumping and injection, and obtain supplemental data to support final remedy selection.	DOE/RL-96-84, Rev. 0 (5.0)	Active	Section 2.4.2
51	B	The interim action monitoring program will include the following distinct monitoring elements: operations monitoring. The objectives for operations monitoring are to conduct the appropriate level of sampling, analysis, and equipment inspection necessary to ensure safe operation and function of the groundwater extraction, injection, and treatment systems.	DOE/RL-96-84, Rev. 0 (5.0)	Active	Section 2.4.1
52	B	The preventive maintenance plan will consist of, but will not be limited to, the following items: • Periodic inspection of the barrier, monitoring, and compliance wells and associated equipment to replace worn pump and piping components • Periodic inspection of evaporation pond and drip field • Calibration schedules for system instrumentation • Periodic inspection of structures for wildlife control • Periodic inspection of IC measures implemented to address the RAO to protect human health	DOE/RL-99-51, Rev. 1 (6.1)	Complete	Requirement not carried forward, ISRM implementation complete.
53	B	Waste Management Plan. This plan will describe waste management requirements for system operations.	DOE/RL-96-84, Rev. 0 (3.1.3)	Active	Section 5.3
54	B,Cp	Abbreviated monthly summaries will be used to communicate general information to project management staff, DOE-RL, and regulators. A typical data summary would provide monthly and cumulative performance of the P&T system days of operations, liters of groundwater processed and kilograms of chromium removed, the average and maximum influent and effluent chromium concentrations, amount of resin used, and water level trends in injection,	DOE/RL-96-90, Rev. 0 (7.2)	Active	Section 6.3 identifies the current reporting

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
		extraction, compliance, and selected performance monitoring wells. In addition to the monthly report information, cost information, new well installations, and other substantial changes in the system will be documented semiannually. Cost information will be documented to help support final remedy selection. Costs for this P&T system will be tracked throughout the life cycle of this project.			
55	B,Cp	An annual performance evaluation report will integrate data collected from the performance monitoring program and will be submitted to the regulators and to onsite contractors, as needed. Performance evaluation results will be used to evaluate the performance of the barrier towards meeting the remedial action goals of the ROD Amendment.	DOE/RL-99-51, Rev. 1 (9.0)	Active	Section 2.4.2
56	C	A more detailed schedule that will control construction activities will be developed as the project progresses. The construction schedule will be updated on a weekly basis and will become part of the project files after completion of construction activities.	DOE/RL-96-84, Rev. 0 (4.1)	Complete	Not applicable- construction activities complete for HR-3, DR-5, DX, and HX
57	C	Additional site inspections and maintenance activities will be required during construction emplacement activities. These include those activities to maintain well sampling and injection/withdrawal equipment, injection/extraction water distribution systems, evaporation pond, and the drip-irrigation system.	DOE/RL-99-51, Rev. 1 (6.0)	Complete	Requirement not carried forward, ISRM implementation complete.
58	C	All field personnel will have completed the 40-Hour Hazardous Waste Site Worker Training Program and will perform all work in accordance with the following: DOE-EH-0256T, *Radiological Control Manual*; BHI-SH-02, *Safety and Health Procedures*, Vol. 1 through 4; BHI-EE-02, *Environmental Requirements*.	DOE/RL-96-90, Rev. 0 (5.0)	Active	Section 5.5
59	C	All field personnel working to this sampling and analysis plan will complete training as specified in the site-specific radiation work permits, site specific HASPs, or other governing safety and health documents. Before beginning field work, all field personnel will receive briefings on radiation work permits and site specific HASPs. Field personnel will also be required to abide by all requirements contained in the above documents as well as BHI Safety and Health Procedures manuals, Volumes 1 through 4.	DOE/RL-96-90, Rev. 0 (5.0)	Active	Section 5.5
60	C	All remedial design and remedial action activities associated with the 100-HR-3 and 100-KR-4 interim action will occur onsite, as that term is defined in 40 CFR 300.	DOE/RL-96-84, Rev. 0 (3.2)	Active	Section 1
61	C	All unplanned liquid releases will be handled in accordance with ISRM procedures and the site specific HASP, which are currently being developed.	DOE/RL-99-51, Rev. 1 (3.0)	Complete	Requirement not carried forward - ISRM implementation complete.
62	C	An operations schedule will be developed during construction. The construction schedule will be updated weekly and will become part of the project files after completion of construction activities. The interim action will be implemented over the next several years. The schedule for interim action design, construction, and startup is provided in Figure 6-1. A more detailed schedule that will control construction activities will be developed as the project progresses.	DOE/RL-96-84, Rev. 0 (6.0)	Complete	Requirement not carried forward, construction completed and systems are operational.
63	C	Because the barrier wells will be installed over a period of a few years, monitoring will be phased over the period of barrier implementation.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward - ISRM implementation complete. Section 2.4 describes current monitoring.
64	C	Compressed air will not be used for any phase of resin loading.	DOE/RL-96-84, Rev. 0 (3.4.4.2, 3.4.4.4)	Complete	Requirement not carried forward. Not applicable to current resin change out procedures.
65	C	Construction activities will be performed according to the schedule presented in Chapter 6 of this document (DOE/RL-96-84). Balance of plant construction will follow the schedule presented in Chapter 6 of this document.	DOE/RL-96-84, Rev. 0 (4.1) DOE/RL-96-84, Rev. 0 (4.1.2)	Complete	Not applicable – construction activities complete for HR-3, DR-5, DX, and HX

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
66	C	Construction of IX units will be controlled through a procurement contract to be issued to the IX manufacturer. The procurement contract will include a schedule for delivery of IX units that will support the overall construction schedule for the 100-HR-3 and 100-KR-4 OUs.	DOE/RL-96-84, Rev. 0 (4.1.3)	Complete	The construction activities have been completed.
67	C	Construction of IX units will occur at the vendor facility. IX units will be delivered to the treatment facility as completed products. IX units will be equipped with appropriate flanges and electrical and control connections to allow connections to the balance of plant described in Section 4.1.2 (DOE/RL-96-84).	DOE/RL-96-84, Rev. 0 (4.1.3)	Complete	The construction activities have been completed.
68	C	Construction of P&T systems will be performed by a subcontractor with oversight provided by the Environmental Restoration Contractor design and construction management team.	DOE/RL-96-84, Rev. 0 (Pg viii)	Complete	Requirement not carried forward. The construction activities have been completed.
69	C	Decommissioning and dismantling of the evaporation pond is projected to occur in FY 2003, after the installation of the complete length of the ISRM barrier.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward. ISRM pond decommissioning and dismantling is complete Section 4.3.3
70	C	ERC site personnel will be responsible for management, operation, and maintenance of the equipment associated with the interim action using the ISRM barrier. Operational and maintenance efforts are expected to be minimal because ISRM has no requirements for ongoing operations or waste management. Maintenance would include site inspections, preventive maintenance, well maintenance, and waste management.	DOE/RL-99-51, Rev. 1 (6.0)	Active	Sections 3.3, 3.3.3
71	C	Every subcontractor performing work associated with the interim action will be required to prepare and submit a subcontractor HASP. Subcontractor health and safety plans will be reviewed for compliance with Hanford Site requirements and approved by ERC representatives before the subcontractor begins work.	DOE/RL-96-84, Rev. 0 (4.1.5)	Active	Section 5.5
72	C	If a problem is found in one treatment system during startup activities, an evaluation will be conducted to determine if the problem is a concern for the other system as well. If only one system is impacted by a problem identified during startup, startup activities at the other system will continue toward full operation.	DOE/RL-96-84, Rev. 0 (4.3)	Complete	Requirement not carried forward. System startups have been completed
73	C	Implementation of the remedial action will be performed with the assistance of one or more prequalified subcontractors.	DOE/RL-96-84, Rev. 0 (1.4)	Active	Section 4.1
74	C	Injection wells will be tested by injecting potable water at rates high enough to confirm the well's potential as an injection well.	DOE/RL-96-84, Rev. 0 (4.1.1)	Complete	Requirement not carried forward. Water treated through the existing system is used for injection well performance evaluation.
75	C	Internal project hold points will be established to review and evaluate data collected during each project phase. The data will be analyzed to determine if any changes in the design and schedule are necessary to complete the objectives of this remediation program. The regulators will be contacted and consulted if it becomes apparent that major changes are required.	DOE/RL-99-51, Rev. 1 (2.2.4)	Complete	Requirement not carried forward - ISRM implementation complete.
76	C	It is anticipated that startup of the extraction system will involve a phased approach. One extraction well will be started and additional wells started in 1 to 3 day increments until all extraction wells in a given area are operational. This ramping up period will allow the wells and transfer piping to be observed and trouble-shooting to be performed as needed.	DOE/RL-96-84, Rev. 0 (4.3)	Complete	Requirement not carried forward. The System startups have been completed
77	C	New injection, extraction, and compliance wells will be tested prior to connection to the transfer piping to confirm the well's potential.	DOE/RL-96-84, Rev. 0 (4.1.1)	Active	Section 2.4.3, new well installation referenced to DOE/RL-2013-35
78	C	Once construction activities are completed, the P&T system will undergo a comprehensive functional test and readiness evaluation prior to a phased startup.	DOE/RL-96-84, Rev. 0 (Pg viii) DOE/RL-96-84, Rev. 0-A (Pg ii)	Complete	Requirement not carried forward. The treatment

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
					system startups have been completed.
79	C	Readiness evaluation items will be identified as either pre-startup or post-startup. Pre-startup items must be completed before startup of the system. Post-startup items can be completed after startup.	DOE/RL-96-84, Rev. 0 (4.1.5)	Complete	Requirement not carried forward – the treatment system startups have been completed.
80	C	The [readiness evaluation] plan will identify persons responsible for various readiness evaluation items and will include, as attachments, a schedule and checklist for the readiness evaluation.	DOE/RL-96-84, Rev. 0 (4.1.5)	Complete	Requirement not carried forward – the readiness evaluations have been completed
81	C	The concurrence of the regulatory agencies will be sought when resins are initially identified for use.	DOE/RL-96-84, Rev. 0 (Pg vii)	Active	No documentation of concurrence found for initial resin identification. Section 4.2, Table 4-1 identifies approvals for change in IX media.
82	C	The entire barrier will be constructed in phases. Phase II will be to extend the barrier approximately 240 m (787 ft) to complete the remaining northeast end of the barrier and to extend the barrier to the southwest.	DOE/RL-99-51, Rev. 1 (2.2.4)	Complete	Requirement not carried forward - ISRM implementation complete.
83	C	The entire barrier will be constructed in phases. Phase III is the construction of the remaining barrier, approximately 240 m (787 ft) along the southwest end. The final barrier length will be sufficient to meet compliance levels as determined in the interim ROD Amendment (EPA 1999b) in consultation with the regulators.	DOE/RL-99-51, Rev. 1 (2.2.4)	Complete	Requirement not carried forward - ISRM implementation complete.
84	C	The entire barrier will be constructed in phases. Based on current planning objectives, Phase I will be to complete the barrier in the high-concentration area, approximately over 1,000 µg/L, with an additional length of approximately 150 m (492 ft) added to the existing treatability test barrier.	DOE/RL-99-51, Rev. 1 (2.2.4)	Complete	Requirement not carried forward - ISRM implementation complete.
85	C	The readiness evaluation will be conducted per Engineering Department Project Instruction 432-01, "Readiness Evaluation" (BHI-DE-OI).	DOE/RL-96-84, Rev. 0 (4.1.5)	Complete	Requirement not carried forward. The readiness evaluation has been completed
86	C	The treatment system operators will be responsible for manually recording key system operating parameters such as wells in use, flow rates, and which modules are in service, on an as-needed basis. This information will be used to verify readings on the OIC, which will store operational data.	DOE/RL-96-90, Rev. 0 (2.3.1.2)	Active	Section 2.4.1.
87	C	To ensure the successful completion of the injection stage, the tanker truck containing the dithionite solution shall be chilled, filled with an argon blanket in the headspace, and delivered to the injection site within 24 hours of dissolving/mixing. Specifically, the dithionite solution is chilled between 3 and 6°C (38 to 42°F) prior to injection because it degrades rapidly if warmer than 25°C (77°F). The tanker headspace is filled with argon gas to minimize contact with the atmospheric oxygen. The water mixed with the sodium dithionite solution during the injection stage is obtained from the groundwater or local water supply. Although the water is not required to be ultrapure, it must be maintained at a temperature such that the dithionite/water mixture temperature does not exceed approximately 25°C (77°F).	DOE/RL-99-51, Rev. 1 (2.3.1.1)	Complete	Requirement not carried forward - ISRM implementation complete.
88	C	WAC 173-162 requires certification of drilling contractors and operators.	DOE/RL-96-84, Rev. 0 (A1.2)	Active	Section 2.5
89	C,B	ICs will be inspected on a semi-annual basis and the results documented in the facility operating record.	DOE/RL-96-84, Rev. 0 (5.1.2)	Active	Section 2.1.5. The Sitewide ICs inspections are performed on an annual basis.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
90	Ca	A KABIS sampling device was permanently installed in Well 199-D8-70. This device allows samples to be collected at selected depths. These data will be used to assess changes in the vertical distribution of Cr(VI) within the aquifer.	DOE/RL-96-90, Rev. 0	Complete	Requirement not carried forward, vertical profiling completed.
91	Ca	A network of piezometers (or comparable techniques) will be installed and monitored such that the capture zone around the extraction wells can be estimated.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 4.3.4
92	Ca	After 5 years: Aquifer tubes (7 wells) sampled for Cr+6 Filtered, Field Parameters, Dissolved Oxygen, & Sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Active	Section 2.4
93	Ca	After 5 years: Barrier wells (10 wells) sampled for Cr+6 Filtered, Field Parameters, & Dissolved Oxygen.	DOE/RL-99-51, Rev. 1 (5.2)	Active	Section 2.4
94	Ca	After 5 years: Monitoring Wells (13 wells) sampled for Cr+6 Filtered, Field Parameters, Dissolved Oxygen, & Sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Active	Section 2.4
95	Ca	All sampling activities must conform to the following standards: • BHI-SH-01, "ERC Safety and Health Program" • BHI-SH-02, "Safety and Health Procedures," Vol. 1 through 4 • BHI-EE-01, "Environmental Investigations Procedures" • BHI-EE-05, "Field Screening Procedures" • BHI-QA-03, "ERC Quality Assurance Program Plans" • Site-specific HASP/activity hazard analysis	DOE/RL-99-51, Rev. 1 (4.0)	Complete	Requirement not carried forward - ISRM implementation complete. These programs and procedures for the ISRM will be superseded by the current RD/RAWP and associated documents.
96	Ca	Analysis for co-contaminants will be performed using EPA approved methods by a certified laboratory. Quality assurance will include 10% field duplicate samples and one matrix spike/matrix spike duplicate per sample batch. Given the intended data use, laboratory splits are not necessary.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4.1
97	Ca	Analysis of samples collected from the GTS will be performed using the modified Hach© Method. Field analyses represent the most effective method for obtaining timely information on GTS operation. Laboratory confirmation of field analysis results will be performed on a graduated frequency basis. During startup, this frequency may occur weekly, increasing to a monthly interval and quarterly thereafter as confidence in system performance improves. Additional information on the sampling approach will be presented in the performance monitoring plan.	DOE/RL-96-84, Rev. 0 (5.3.1)	Active	Section 2.4 discusses current monitoring.
98	Ca	Aquifer tubes (5 to 10 tubes) sampled for Cr+6 filtered, field parameters, dissolved oxygen, & sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
99	Ca	Aquifer tubes (7 wells) sampled for ICP metals filtered & anions.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
100	Ca	At the end of the 3 month startup period, the sampling frequency (for compliance monitoring wells and extraction wells) will be reduced to a quarterly basis until such time that an alternate frequency is warranted.	DOE/RL-96-84, Rev. 0 (5.2.3)	Active	Section 2.4 discusses current monitoring.
101	Ca	Barrier wells (10 wells) sampled for ICP metals filtered & anions.	DOE/RL-99-51, Rev. 1 (5.2)	Active	Section 2.4 discusses current monitoring.
102	Ca	Baseline sampling will be conducted prior to start of the interim action.	DOE/RL-96-84, Rev. 0 (5.2)	Complete	Requirement not carried forward, as the interim action has started. Requirements for installation of new wells and the baseline sampling are in Section 2.4.3 and DOE/RL-2013-35.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
103	Ca	Because it is impractical to routinely monitor chromium concentrations at aquatic receptor exposure points, onshore monitoring of groundwater near the river and data evaluation will be used to assess the effectiveness of the interim action at achieving this objective.	DOE/RL-96-84, Rev. 0 (5.1.1)	Active	Section 2.4.2
104	Ca	Co-contaminants, nitrate, strontium-90, technetium-99, tritium, and uranium for the 100-H Area and strontium-90 and tritium for the 100-D Area will be monitored annually during the operational phase.	DOE/RL-96-90, Rev. 0 (2.1)	Active	Section 2.4
105	Ca	During the first 3 months of operation (startup period), the compliance monitoring wells and extraction wells will be tested monthly for chromium to provide timely information on initial interim action performance.	DOE/RL-96-84, Rev. 0 (5.2.3)	Complete	Requirement not carried forward, startup period complete. Section 2.4 discusses current monitoring.
106	Ca	During the prestartup period, compliance wells in the 100-D and 100-K Areas will be sampled at multiple depths to assess the vertical distribution of chromium in the aquifer. Samples will be collected using an inflatable packer, or equivalent device, to isolate discrete intervals from which the sample will be withdrawn. In the 100-D Area, samples will be collected from the top and base of the aquifer. In the 100-K Area, samples will be collected at I.5-m (5-ft) intervals spanning the aquifer thickness to document chromium concentrations at all depths prior to remediation. The sampling will be conducted concurrently with the prestartup baseline sampling. Test results will be used to assess the integrity of the sampling method and to determine if vertical sampling should be incorporated into the interim action monitoring program.	DOE/RL-96-84, Rev. 0 (5.2.4)	Complete	Requirement not carried forward, system prestartup completed.
107	Ca	During the startup period, GTS effluent sampling and analysis will be conducted weekly. The weekly data will be used for comparison with the 50-µg/L discharge limit and a treatment level to be developed during the startup and operation periods. The treatment level will represent a balance between the level that is technically feasible, is cost effective, and optimizes resin use.	DOE/RL-96-84, Rev. 0 (5.3.1)	Complete	Requirement not carried forward, system startup period completed.
108	Ca	Field measurement will be used to monitor Cr(VI), temperature, pH and specific conductance at the performance wells. The collection will be a one-time event during the prestartup phase and semiannually during the operational phase. Semiannual events will be planned to occur during periods of low river stage. Wells will be sampled by following ERC groundwater sampling; procedures. Cr(VI) will be measured in the field using a modified version of the Hach method. Analysis for co-contaminants will be performed by a state certified laboratory using EPA approved methods.	DOE/RL-96-90, Rev. 0	Active	Section 2.4
109	Ca	Field screening analysis will be conducted in accordance with BHI-QA-03, *ERC Quality Assurance Program Plans*. All field screening data will comply, at a minimum, with the requirements of field screening quality control level QA-1 as specified in BHI-QA -03, Procedure 5.1, "Field Sampling QA Program Plan." Also, sample collection will be done in accordance with BHI-QA -03, Procedure 5.2, "QA Program Plan Field Screening Procedures." Data quality requirements for onsite and offsite are described in the project-specific SAF.	DOE/RL-99-51, Rev. 1 (4.7)	Complete	Requirement not carried forward. ISRM field screening complete. Updated requirements in 100-HR-3 SAP
110	Ca	Filtered groundwater will be tested for contaminants when the wells first reach the water table. Samples will be analyzed for Cr(VI), nitrate, and sulfate by Hach kit to verify contamination levels.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Section 2.4.3; DOE/RL-2013-35
111	Ca	Filtered groundwater will be tested for contaminants when the wells first reach the water table. Samples will be analyzed for Cr(VI) and nitrate to verify contamination levels.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Section 2.4.3; DOE/RL-2013-35
112	Ca	For the first 2 years: Aquifer tubes (7 wells) sampled for Cr+6 filtered, field parameters, dissolved oxygen, & sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
113	Ca	For the first 2 years: Barrier wells (10 wells) sampled for Cr+6 filtered, field parameters, & dissolved oxygen.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
114	Ca	For the first 2 years: Monitoring wells (13 wells) sampled for Cr+6 filtered, field parameters, dissolved oxygen, & sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
115	Ca	For years 3 to 5: Aquifer tubes (7 wells) sampled for Cr+6 filtered, field parameters, dissolved oxygen, & sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
116	Ca	For years 3 to 5: Barrier wells (10 wells) sampled for Cr+6 filtered, field parameters, & dissolved oxygen.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
117	Ca	For years 3 to 5: Monitoring wells (13 wells) sampled for Cr+6 filtered, field parameters, dissolved oxygen, & sulfate.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
118	Ca	Groundwater elevations will be measured in selected wells adjacent to and inland from the river. A decreased hydraulic gradient between the aquifer and the river, or groundwater flow from the river toward the extraction wells, will be a positive indication of interim action effectiveness.	DOE/RL-96-84, Rev. 0 (5.1.1)	Active	Section 4.3.4
119	Ca	Groundwater sampling will be conducted when dilution by river water at the compliance points is minimal.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 2.4
120	Ca	Groundwater level measurements will be taken at groundwater monitoring wells to define the groundwater gradient and flow direction. Selected upgradient, barrier, and downgradient wells will be monitored. Water level measurements are taken manually during sample collection.	DOE/RL-99-51, Rev. 1 (5.3)	Active	Section 2.4
121	Ca	Cr(VI) concentrations will be measured in the field using a modified version of the Hach method. Initially, quality assurance will be provided through 10% field duplicate and spike samples and 10% sample splits with an EPA/Ecology-certified laboratory. Upon satisfactory review of the results by the regulatory agencies, these requirements may be reduced to 5% field duplicates and spikes and 5% laboratory splits, or less as agreed to by the Tri-Parties. If subsequent data evaluations indicate that a 5% quality assurance sample frequency is inadequate, the quality assurance sample frequency may be increased to 10% if requested by DOE or the regulatory agencies.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4
122	Ca	Cr(VI) concentrations will be measured in the field using a modified version of the Hach method. The ERC has successfully developed a three-point calibration procedure that provides a detection limit of 5 µg/L.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4
123	Ca	Cr(VI) concentrations will be measured in the field using a modified version of the Hach method in accordance with BHI-EE-05, Procedure 1.17.	DOE/RL-99-51, Rev. 1 (5.2.3), DOE/RL-96-90, Rev. 0 (2.1)	Active	Procedure not carried forward – updated procedure referenced for Hach testing, Section 2.4
124	Ca	Cr(VI), temperature, pH, and specific conductance will be monitored by field measurement at the performance wells. Collections will be quarterly during the pre-startup phase and monthly during the startup and operational phases. Cr(VI) will be measured in the field using a modified Hach method.	DOE/RL-96-90, Rev. 0 (2.1)	Active	Section 2.4
125	Ca	In addition to wells, approximately 5 to 10 existing river porewater sampling tubes and/or aquifer sampling tubes will be monitored annually for the 100 Area and Hanford Townsite shoreline sampling program (Lee and Raidl, 2000).	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4
126	Ca	Initially, quality assurance for Cr(VI) analyses will be provided through 10% field duplicate and field blank samples and 10% field splits to an offsite laboratory. Laboratory quality assurance will include one matrix spike/matrix spike duplicate per sample batch. Upon satisfactory review of the results by the regulatory agencies, these requirements may be reduced to 5% field duplicates and field blanks and 5% field splits, or less as agreed to by DOE and the regulatory agencies. If subsequent data evaluations indicate that a 5% quality assurance sample frequency is inadequate, the quality assurance sample frequency may be increased to 10% if requested by DOE or the regulatory agencies.	DOE/RL-99-51, Rev. 1 (5.2.4)	Complete	Requirement not carried forward, initial quality assurance analyses completed; current monitoring in Section 2.4
127	Ca	Initially, quality assurance will be provided through 10 percent field duplicate and spike samples and 10 percent sample splits analyzed by an EPA/Ecology-certified laboratory.	DOE/RL-96-90, Rev. 0 (4.0)	Active	Section 2.4 describes current monitoring requirements

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
128	Ca	Liquid samples collected for confirmatory analysis at an offsite laboratory will be handled in accordance with BHI-EE-01, Procedure 4.1, "Groundwater Sampling," and in accordance with the project-specific SAF requirements. Liquid process samples may be tested for, but not limited to, dissolved oxygen, conductivity, pH, and temperature for evaluating process operations and efficiencies.	DOE/RL-99-51, Rev. 1 (4.5)	Complete	Requirement not carried forward. Monitoring procedures updated (Section 2.4)
129	Ca	Manual water level measurements will also be recorded quarterly in a different set of wells.	DOE/RL-99-51, Rev. 1 (5.3)	Active	Section 2.4
130	Ca	Moist soil samples (i.e., soil generated from the aquifer) will be periodically tested for Cr(VI) and nitrate.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Section 2.4.3; DOE/RL-2013-35
131	Ca	Monitoring for co-contaminants will be performed over the course of the interim action to obtain information for final remedy selection. Because the interim action is not designed to remove co-contaminants, monitoring will be limited to extraction well locations and the GTS influent and effluent. The co-contaminant list for 100-HR-3 includes nitrate, strontium-90, tritium, uranium, and technetium-99.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4
132	Ca	Monitoring locations are illustrated in Figure 5-2. The downgradient wells will provide coverage along the entire barrier and will be located approximately halfway between the Columbia River and the barrier axis (approximately 76.2 m [250 ft] downgradient from the barrier wells). Approximately seven compliance wells will be used. Closer spaced monitoring wells will be installed opposite the high-concentration portion of the chromium plume.	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4
133	Ca	Monitoring shall be performed at sufficient locations above the common high river mark to evaluate the performance of the remedial action.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 2.4.2
134	Ca	Monitoring wells (13 wells) sampled for ICP metals filtered and anions.	DOE/RL-99-51, Rev. 1 (5.2)	Complete	Requirement not carried forward. Section 2.4 discusses current monitoring.
135	Ca	On an infrequent basis, co-contaminants will be monitored to support ongoing activities associated with selecting a final remedy.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 2.4
136	Ca	Operational Sampling. Field measurement will be used to monitor Cr(VI), temperature, pH and specific conductance at the extraction wells. Sampling will be a one-time event during the pre-startup phase and semiannually during the operational phase. Semiannual events will be planned to occur during periods of low river stage. Extraction and injection wells are sampled once for the same constituents, plus co-contaminants, during the pre-startup phase as are the performance wells. Extraction wells will be monitored monthly during the startup phase for Cr(VI) and quarterly during the operational phase. Co-contaminants will be sampled semiannually at the extraction wells during the operational phase. The co-contaminants that will be analyzed in. the 100-H Area are nitrate, strontium-90, technetium-99, tritium, and uranium. Strontium-90 and tritium will be analyzed for in the 100-D Area. Wells will be sampled by following ERC groundwater sampling procedures. Cr(VI) will be measured in the field using a modified version of the Hach method. Analysis for co-contaminants will be performed by a state certified laboratory using EPA approved methods. If OU monitoring data indicate other contaminants are also of concern, the co-contaminant list will be revisited. During startup and operation, samples for the treatment system evaluation will be collected daily.	DOE/RL-96-90, Rev. 0	Active	Section 2.4.1
137	Ca	Prior to startup of P&T facilities, 100-HR-3 and 100-KR-4 wells will be monitored to establish a baseline.	DOE/RL-96-90, Rev. 0	Complete	Requirement not carried forward. Baseline sampling completed prior to startup.
138	Ca	Prior to system startup, an initial chromium concentration level will be established for each compliance monitoring well location. This initial concentration will be determined from the average of three to four samples collected over the 8 to 12 month period preceding startup.	DOE/RL-96-84, Rev. 0 (5.2.3)	Complete	Requirement not carried forward, system startup completed.
139	Ca	Quality assurance for all other analytes will be provided through 10% field duplicate and field blank samples. Field splits for offsite laboratory analysis of these analytes are not necessary.	DOE/RL-99-51, Rev. 1 (5.2.4)	Active	Section 2.4
140	Ca	Quarterly sampling is planned for the first 2 years, and semi-annual sampling is planned for the following 3 years. After 5 years, annual sampling is planned (Table 5-1). This approach will be reevaluated during the project's 5-year review.	DOE/RL-99-51, Rev. 1 (5.2.2)	Active	Section 2.4
141	Ca	River-stage data are recorded in support of the ongoing interim action at the 100-D Area.	DOE/RL-99-51, Rev. 1 (5.3)	Active	Section 2.4

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
142	Ca	Sample and screening event coordination will be performed in accordance with BHI-EE-01 EIP 2.0, "Sample Event Coordination." A SAF number will be assigned to the project, and all sample numbers will be associated with this SAF number in the HEIS Sample Number Library. Sample collection information associated with groundwater well sampling will be supplied to Data Management in accordance with BHI-EE-01, EIP 4.1, "Groundwater Sampling." Sample and/or field screening collection information associated with the performance monitoring of the P&T process will be summarized and sent to the HEIS data entry coordinator via electronic mail and/or electronically downloaded.	DOE/RL-96-90, Rev. 0 (6.0)	Complete	Section 2.4 describes current monitoring requirements. The referenced procedures have been replaced.
143	Ca	Samples collected for offsite confirmatory analysis will be managed, processed, verified, and transmitted in accordance with Section 2 of BHI-EE-01 EIPs.	DOE/RL-99-51, Rev. 1 (4.6)	Complete	Requirement not carried forward; Section 2.4 describes current monitoring
144	Ca	Samples collected for onsite field screening will be analyzed at the ISRM mobile trailer. During routine system operations, field screening samples obtained from the injection, reaction, and withdrawal portions of the treatment will be analyzed at the frequencies listed in Table 4-1. DOE and Ecology have the authority to request additional samples.	DOE/RL-99-51, Rev. 1 (4.5)	Complete	Requirement not carried forward - ISRM implementation complete
145	Ca	Samples collected for onsite field screening analysis will be assigned numbers, as appropriate, and recorded in the project field logbook. At a minimum, each sample will be labeled with the following: sample location, sample date, sample time, and the sampler's initials. The samples will be tracked in accordance with chain-of-custody requirements contained in BHI-EE-01, Procedure 3.0, "Chain of Custody," and logbook requirements contained in BHI-EE-01, Procedure 1.5, "Field Logbooks." Process samples collected to monitor the treatment system, once routine operations begin, will be assigned HEIS numbers for sample tracking and reporting purposes.	DOE/RL-99-51, Rev. 1 (4.3)	Complete	Requirement not carried forward - ISRM implementation complete
146	Ca	Samples collected for onsite field screening analysis will be collected using the equipment and techniques prescribed in the field screening procedures. Samples intended for offsite laboratory analysis will be collected in accordance with Section 4.2 of this RDR/RAWP and the subsequent SAF to be prepared for this activity. All analytical equipment will be operated in accordance with the manufacturer specifications, field screening procedures, EPA analytical methods, and/or similar instructions. Calibration and standardization of the analytical equipment will be done according to manufacturer's recommendations.	DOE/RL-99-51, Rev. 1 (4.4)	Complete	Requirement not carried forward - ISRM implementation complete.
147	Ca	Samples will be analyzed annually for inductively coupled plasma metals and anions analyses.	DOE/RL-99-51, Rev. 1 (5.2.2)	Active	Section 2.4; analytical methods are specified in the SAP
148	Ca	Samples will be taken from the extraction wells and analyzed for chromium. Cr(VI) will be measured during a modified version of the Hach method. During the P&T operations period, a chromium monitor/analyzer will be evaluated. The monitor/analyzer would have the ability to automatically accept samples from multiple sample points and analyze them for chromium. Initially, the monitor/analyzer is not slated for use to meet operational sampling/analysis needs. If, after the evaluation period, the analyzer is found to hold promise for long term application, a proposal for this application, will be initiated.	DOE/RL-96-90, Rev. 0 (2.3.1.3)	Active	Section 2.4.1
149	Ca	Sampling for co-contaminants will be performed semiannually at each of the extraction well locations and from the GTS influent and effluent. This frequency will be maintained until an alternate frequency is determined.	DOE/RL-96-84, Rev. 0 (5.2.3)	Active	Section 2.4.1
150	Ca	Sampling. Operational samples will be collected and analyzed in order to monitor the performance of the P&T system and assure that it is effectively meeting the requirements of the ROD. Location. Operational samples will be taken from four categories of sources for the 100-HR-3 P&T facility: extraction wells, combined influent to the treatment system, combined effluent from the treatment system, and samples after each of the 16 IX vessels.	DOE/RL-96-90, Rev. 0	Active	Section 2.4.1
151	Ca	Testing for the co-contaminants, nitrate, strontium-90, technetium-99, tritium, and uranium, will be performed using EPA approved methods. Quality assurance will include 10 percent field duplicate samples and on-matrix spike/matrix spike duplicated per sample batch	DOE/RL-96-90, Rev. 0	Active	Section 2.4.1, analytical methods are specified in the SAP
152	Ca	The 100-HR-3 and 100-KR-4 P&T interim action performance monitoring activities will comply with requirements in the BHI-QA-01, ERC Quality Program and BHI-QA-02, ERC Quality Program Procedures, ROD (EPA, 1996), and RDR/RAWP (DOE-RL, 1996b).	DOE/RL-96-90, Rev. 0	Active	Section 2.4.2
153	Ca	The actual time frame for sampling to occur in order to minimize river water dilution will be determined using specific conductance, river stage, and compliance monitoring well water level data developed from prestartup and startup monitoring information.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4.2

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
154	Ca	Groundwater extraction and injection wells will be sampled for chromium and co-contaminants following installation and development.	DOE/RL-96-84, Rev. 0 (5.2.3)	Active	Section 2.4.2
155	Ca	The integrity of the river porewater and aquifer sampling tubes will be reviewed and inspected prior to sampling. Tubes with compromised integrity will be noted and removed from the sampling list. Ecology will be notified of sample tubes removed from the sampling list. If available, adjacent sampling tubes will be identified for use, dependent on regulatory review and concurrence.	DOE/RL-99-51, Rev. 1 (5.2.2)	Active	Section 2.4
156	Ca	The interim action monitoring program will include water level measurements, analysis of water quality samples for Cr(VI) and co-contaminants, and measurements of specific conductance. These data will be collected over an 8- to 12- month prestartup period to document baseline conditions, during a 3-month startup period when timely information is necessary to adjust system operations, and during the operational phase to track progress towards achieving RAOs.	DOE/RL-96-84, Rev. 0-A (Pg ii)	Active	Section 2.4
157	Ca	The interim action monitoring program will include water level measurements, analysis of water quality samples for Cr(VI) and co-contaminants, and measurements of specific conductance.	DOE/RL-96-84, Rev. 0 (Pg viii)	Active	Section 2.4
158	Ca	The interim action ROD requires chromium to be removed to the maximum extent practicable with chromium concentrations not to exceed 50 µg/L in the GTS discharge. This requirement will be met through analysis of GTS influent and effluent samples. The samples will be taken from collection points (Figure 5-4) located adjacent to the inline chromium monitors. Once the accuracy and precision of the chromium monitor is established, no further manual testing will be performed except for periodic confirmation samples. Conversion to the inline monitor for influent and effluent testing is expected to occur by the end of the 3-month startup period.	DOE/RL-96-84, Rev. 0 (5.3.1)	Active	Section 2.4
159	Ca	The proposed monitoring network may change as additional field data are obtained during barrier installation. Regulatory agencies will be notified for concurrence.	DOE/RL-99-51, Rev. 1 (5.2.1)	Complete	Requirement not carried forward, ISRM barrier installation complete. Section 2.4 discusses current monitoring. Change management is provided in Section 4.2.
160	Ca	To avoid duplicative sampling efforts and promote data exchange with other ongoing groundwater monitoring programs, coordination will occur during the data quality objectives process for the performance monitoring plan.	DOE/RL-96-84, Rev. 0 (5.2.5)	Active	Section 2.4
161	Ca	To confirm that analysis results from the compliance wells have not been significantly biased by the presence of river water, field measurements of specific conductance will be performed during each sampling event.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4
162	Ca	Vertical sampling in the 100-H Area using the above approach is limited by the relatively thin aquifer thickness throughout the plume area (3 to 5.4 m [10 to 17 ft]). To obtain information on the vertical distribution of chromium once the interim action is under way, sampling of well clusters H4-12B, H4-12C, H4-15B, and H4-15C will be performed.	DOE/RL-96-84, Rev. 0 (5.2.4)	Active	Section 2.4
163	Ca	Water level measurements are taken at the performance wells using either a transducer or tape measurements (Table 2-1). Transducers will be used in wells located where gradients are expected to vary or trend and at select reference wells outside the area of influence of the P&T system. Where transducers are used, water levels will initially be measured on an hourly basis. The frequency of measurements may be modified as necessary to meet project objectives.	DOE/RL-96-90, Rev. 0 (3.2)	Active	Section 2.4.2
164	Ca	Water level measurements will be performed using dedicated pressure transducers. Water level data from the extraction and injection well locations are available on a continuous basis through the OIC. Water level data from the compliance and performance monitoring wells will either be manually downloaded or telemetered to a central location.	DOE/RL-96-84, Rev. 0 (5.2.2)	Active	Section 2.4.1
165	Ca	Water quality samples for laboratory chromium analysis will be tested using EPA Method SW7421, which has a detection limit of 2 µg/L.	DOE/RL-96-84, Rev. 0 (5.2.2) DOE/RL-99-51, Rev. 1 (5.2.3)	Active	Section 2.4 (SAP currently specifies EPA Method 7196, detection limit 2 µg/L)
166	Ca	Water quality samples for laboratory chromium analysis will be tested using EPA Method 7196 (detection limit of 0.5 µg/L), or other approved method.	DOE/RL-96-90, Rev. 0 (4.0)	Active	Section 2.4 (SAP currently specifies EPA Method

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
					7196, detection limit 2 µg/L)
167	Ca	Water level measurements will be recorded in six monitoring wells using standalone data loggers and transducers with confirmatory standardized electric-tape (e-tape) measurements (Table 5-3).	DOE/RL-99-51, Rev. 1 (5.3)	Active	Section 2.4
169	Ca	Wells will be sampled in a manner consistent with ERC groundwater sampling procedures.	DOE/RL-96-90, Rev. 0 (2.1)	Active	Section 2.4
170	Ca,B	Standard Fixed Laboratory (SFL) analyses will be performed for all co-contaminants. The SFL analyses will be accompanied by a higher-level documentation and higher frequency of quality control verification. All data entry will be performed in accordance with BHI-EE-09, Environmental Data Management Procedures, Section 2.0. Analytical data in the PSDB shall be reviewed for quality and made accessible for general viewing within two days after the data has been entered into the PSDB. Hard copy and electronic analytical data will be entered in to the PSDB and, when applicable, into the HEIS within a reasonable time period (2 days) after ERC Data Management receives the data. Data associated with well sampling in support of this project will be stored in HEIS in compliance with Tri-Party Agreement. Data stored in the PSDB will use HEIS data fields when applicable and project-specific data fields when required. Reports and graphs of operational and aquifer-response monitoring will be generated. A user's guide, BHI-00790, Pump and Treat Database User's Guide, Rev. 0, (BHI, 1996c) is available through BHI Document and Information Service, the electronic Document Management System, and through Netscape on the Data Management home page. The user's guide provides information on accessing and operating the database for data entry and data queries, and for generating project reports	DOE/RL-96-90, Rev. 0 (6.0)	Active	Section 2.4
171	Ca,Cd	Sample ports located between the columns and inline chromium monitors located on the influent and effluent sides of the treatment system will be used for monitoring treatment system performance and determine when resin changeout is required.	DOE/RL-96-84, Rev. 0 (3.4.4)	Active	Section 2.4.1
172	Ca,Cp	Chromium concentrations will be regularly monitored at locations between the extraction wells and the river, or as near the river as practicable. A declining concentration trend, calculated using a four-sampling-event running average, will be a positive indication of interim action effectiveness.	DOE/RL-96-84, Rev. 0 (5.1.1)	Active	Section 4.3.4
173	Ca,Cp	Groundwater monitoring wells will be sampled and analyzed for chemical and physical groundwater parameters to evaluate the compliance and performance of the ISRM barrier. The monitoring network consists of wells that are located upgradient, within, and downgradient of the barrier; river porewater sampling tubes; and aquifer sampling tubes.	DOE/RL-99-51, Rev. 1 (5.2)	Active	Section 2.4.2
174	Ca,Cp	Performance monitoring will be conducted at upgradient, barrier, and downgradient wells and river porewater tubes.	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4.2
175	Ca,Cp	Samples from selected river porewater tubes and aquifer sampling tubes will be analyzed annually at low river stage. The samples will be analyzed for Cr(VI), field parameters, dissolved oxygen, and sulfate (Table 5-1).	DOE/RL-99-51, Rev. 1 (5.2.2)	Active	Section 2.4.2
176	Ca,Cp	This well (H4-12C) will be regularly monitored during the interim action to obtain additional information for determining whether its inclusion in the extraction network is warranted.	DOE/RL-96-84, Rev. 0 (3.3.1.2.2)	Active	Section 2.4.2 (H4-12C still monitored)
177	Ca,Cp	Water levels will be monitored at selected upgradient, barrier, and downgradient wells. Because application of ISRM does not alter the natural hydraulic system, water level monitoring is not considered to be an aspect of performance monitoring for this interim action (i.e., demonstration of hydraulic capture is not applicable). However, water level data will be used to help evaluate the performance monitoring data.	DOE/RL-99-51, Rev. 1 (5.0)	Active	Section 2.4.2
178	Cd	A barrier length of approximately 680 m (2,230 ft) may be required.	DOE/RL-99-51, Rev. 1 (2.2.4)	Complete	Requirement not carried forward - ISRM implementation complete.
179	Cd	A bird deterrent device consisting of ecology blocks, wire rope, wire rope clips, music wire, and bird scare tape will be installed over the exposed pond surface.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
180	Cd	A chain-link fence approximately 560 in ft long by 1.8 in ft tall with controlled access gates will be constructed around the perimeter of the pond.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
181	Cd	A fence will be constructed around the perimeter of the pond to prevent unauthorized access.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
182	Cd	A return pipe at each (extraction) well (Figures 3-8a and 3-8b) will allow water from the conveyance pipe to drain back into the well in the event of system shutdown.	DOE/RL-96-84, Rev. 0 (3.4.1)	Active	Section 3.3
183	Cd	A staff gauge will be mounted in the pond to measure pond water depth when in use.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete.
184	Cd	Access to the database will be read only, and the databases are located on a file server available to both the ERC Local Area Network (LAN) and the Hanford LAN. Access to the database will be controlled by password protection.	DOE/RL-96-90, Rev. 0 (6.0)	Active	Section 2.4
185	Cd	Alignment of the ISRM barrier will be generally perpendicular to the groundwater flow direction to intercept contaminants migrating with the groundwater. Given the proximity of the site to the Columbia River, the barrier alignment will be roughly parallel to the river shoreline.	DOE/RL-99-51, Rev. 1 (2.2.3)	Complete	Requirement not carried forward – ISRM implementation complete.
186	Cd	Automatic features will be provided to shut down portions of the system to prevent tank and injection well overflow or if a pipe leak occurs.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.3
187	Cd	Based on numerical modeling results, the injection system will require three wells.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
188	Cd	Because of the remote site locations, each system shall require minimal operator attention and allow for remote monitoring.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.3
189	Cd	Blocked conveyance piping will be detected by high-pressure shutoff switches.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
190	Cd	Compliance wells will be located between the barrier and the river.	DOE/RL-99-51, Rev. 1 (2.2.3)	Active	Section 2.4.2
191	Cd	Depth of the pond will be approximately 2 m (6 ft) in depth, including freeboard.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
192	Cd	Design service flow rate through each (IX) module will be 380 L/min (100 gal/min) with service flow direction downward through each vessel. At design service flow rate, pressure drop across four vessels in series will not exceed 276 kPa (40 lb/in^2) with water at 1.7 to 26.7°C (35 to 80°F). Valves for aligning the vessels in different operating configurations will be manually operated.	DOE/RL-96-84, Rev. 0 (3.4.4.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
193	Cd	Details of construction (for downgradient wells) will be identified in the Description of Work for Drilling ISRM Wells. These same downgradient wells will also be monitored to evaluate the performance of the ISRM barrier.	DOE/RL-99-51, Rev. 1 (5.0)	Active	Not applicable – ISRM implementation complete
194	Cd	Double containment will not be required for piping and tanks because extracted groundwater is not a dangerous waste by WAC 173-303-070.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.3, Section 2.5 (ARARs)
195	Cd	Downgradient wells will be installed between the barrier and the river and monitored to demonstrate groundwater compliance with regulatory requirements; these wells will be referred to as compliance wells. These wells will be constructed as monitoring wells (Figure 5-1).	DOE/RL-99-51, Rev. 1 (5.0)	Active	Section 2.4.2
196	Cd	During extreme conditions, drainage of extraction and injection well piping between the transfer pump building and the wells will occur automatically once the system is shut down.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
197	Cd	Each extraction well pipeline will have two methods of sensing flow from a well. A flowmeter and a flow switch will be used as indicators to ensure that a well pump is operating. The flow rate will be displayed on the OIC and stored for future use. The flow switch will provide a check for proper operation of the extraction well pump.	DOE/RL-96-90, Rev. 0 (2.3.1.2)	Active	Section 3.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
198	Cd	Each vessel (IX module) will be equipped with a relief valve discharging to a common return header. Each module outlet pipe will be equipped with a manually operated valve for flow balancing.	DOE/RL-96-84, Rev. 0 (3.4.4.1)	Active	Section 3.3
199	Cd	Effluent from the treatment facility at 100-H Area will be injected at Wells 199-H3-3, 199-H3-4, and 199-H3-5. Typical well completion details for 100•HR-3 OU injection wells are shown in Figure 2-7. Each injection well will be capable of injection rates up to 757 L/min (200 gal/min). At the design flow rate of 1,514 L/min (400 gpm), two wells will be online with the third injection well available as needed.	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
200	Cd	Existing wells (H4-4 and H4-5) and new wells (H4-63 and H4-64), which initially will be used for compliance monitoring, have been designed for potential use as extraction wells in the event that additional pumping along the shoreline is necessary.	DOE/RL-96-84, Rev. 0 (3.3.1.2.1)	Active	Section 3.3
201	Cd	External polyvinyl chloride piping and the collection tanks will be heat traced and the GTS buildings heated and insulated.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
202	Cd	Extracted groundwater will be treated, using an IX treatment process to remove Cr(VI), and treated groundwater returned to the aquifer using injection wells.	DOE/RL-96-84, Rev. 0 (Pg vii)	Active	Section 3.3
203	Cd	Extraction wells will be equipped with electric, adjustable frequency drive submersible pumps, pressure transducers for water level monitoring, high-low set points for pump on-off control, high-pressure shutoff sensors, sample ports, and inline flow sensors.	DOE/RL-96-84, Rev. 0 (3.4.1)	Active	Section 3.3.1
204	Cd	Flowmeters will be used to monitor the flow from each extraction well, through each IX vessel, and into each injection well.	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Active	Section 3.3
205	Cd	Four separate IX skids, each with 379 L/min (100 gal/min) capacity, will be housed in the 1713-H treatment facility. Each IX system consists of four vessels in series. The four vessels are connected with piping and valves that allow a combination of three or four vessels to be in service at one time.	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Complete	Section 3.2 describes initial systems; updated systems also described in Section 3.2
206	Cd	Groundwater conveyance pipe will be installed in a manner that minimizes disturbance to existing vegetation.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
207	Cd	Groundwater extracted from the 100-D Area will be conveyed by an aboveground pipeline to the 100-H Area for treatment and injection into the aquifer.	DOE/RL-96-84, Rev. 0 (Pg vii)	Complete	Section 3.2 describes initial systems; updated systems also described in Section 3.2
208	Cd	Groundwater extraction systems will be installed at both 100-H and 100-D Reactor Areas. These systems will discharge to a common treatment facility at the 100-H Area. All treated groundwater will be injected at the 100-H Area.	DOE/RL-96-90, Rev. 0	Complete	Section 3.2 describes initial systems; updated systems also described in Section 3.2
209	Cd	Groundwater from the 100-HR-3 extraction wells will be conveyed through 38 to 100 mm (1.5 to 4 in.) diameter high-density polyethylene pipe to 34,826 L (9,200 gal) storage tanks.	DOE/RL-96-84, Rev. 0 (3.4.3)	Active	Section 3.3
210	Cd	However, to reduce overall project costs and facilitate operation and maintenance requirements, the two areas will share a common treatment system and injection area located in the 100-H Area.	DOE/RL-96-84, Rev. 0 (3.3.1)	Complete	Not applicable – the initial design has been revised, Section 3
211	Cd	Hydrogeologic injection criteria contained in the interim action ROD include the following: (1) treated water will be injected into the upper aquifer and (2) injection wells will be located upgradient of the existing chromium plume.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.3/Location criteria revised in IAROD amendment
212	Cd	In the 100-D Area, groundwater will be drawn from wells 199-D8-53 and 199-138-54A at a rate of 151 L/min (40 gal/min) each.	DOE/RL-96-90, Rev. 0	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
213	Cd	In the 100-H Area, five extraction wells will be used. The wells are 199-H4-7, 199-H4-11, 199-H4-12A, 199-H4-15A, and 199-H3-2A with estimated extraction rates of 76, 38, 38, 38, and 151 L/min (20, 10, 10, 10, and 40 gal/min), respectively	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
214	Cd	Initially, two wells will be used while the third will serve as a backup for monitoring purposes.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
215	Cd	Mechanisms and/or processes will be initiated to minimize and prevent wildlife access.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
216	Cd	New monitoring wells will be constructed so that the well screen is open to a significant portion of the saturated thickness of the aquifer to provide improved monitoring flexibility and promote cost effectiveness.	DOE/RL-96-84, Rev. 0 (5.2.1)	Active	Section 2.4.3, DOE/RL-2013-35
217	Cd	Nominal extraction well flow rates from the 100-HR-3 wells will vary from 38 to 151 L/min (10 to 40 gal/min), with an initial combined flow rate of 341 L/min (90 gal/min) from the 100-H Area wells and 303 L/min (80 gal/min) from the 100-D Area wells.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
218	Cd	One tank located in the 100-H Area will collected water from the near-river extraction wells and H4-7, while the second tank will collect water from the two 100-D Area extraction wells (Figure 3-9a). Groundwater from the 100-D collection tank (Transfer Pump Building) will be pumped approximately 3,900 m (4,266 yd) through one of two parallel 100 mm (4 in.) high-density polyethylene pipes to the 11,356 L (3,000 gal) GTS influent tank located inside the 1713-H Building (Figure 3-9b).	DOE/RL-96-84, Rev. 0 (3.4.3)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
219	Cd	Operating parameters and controls set points will be established and verified during plant startup. Once the system becomes operational, set points will be changed to optimize operation.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 2.4.3
220	Cd	Operation of the treatment system will be essentially continuous or will be of durations necessary to process water from the continuous operation of the extraction well network.	DOE/RL-96-84, Rev. 0 (4.4.3)	Active	Section 4.3.1
221	Cd	Pond footprint surface dimensions will be approximately 140 m (460 ft) by 150 m (490 ft) by 70 m (230 ft) by 150 m (490 ft).	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
222	Cd	Power poles will be installed in both OUs to supply power for well pumps and transfer pump buildings. Overhead power is less costly than on-ground conduit and will help limit disturbance to cultural and ecological resources. Following completion of the interim action, an assessment will be made to determine if the power poles will be needed.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
223	Cd	WAC 173-304-430 is applicable to the design, construction, and operation of the evaporation pond that will be used to contain the water withdrawn from ISRM barrier emplacement well activities.	DOE/RL-99-51, Rev. 1 (8.2)	Complete	Requirement not carried forward, ISRM implementation complete.
224	Cd	The (pond) design will be a commercially single-lined design.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
225	Cd	The 100-HR-3 and 100-KR-4 P&T systems will use a series of extraction wells, equipped with submersible pumps, to draw groundwater from the unconfined aquifer. Extracted groundwater will be conveyed through aboveground piping to a collection tank (s) where it will be combined with water from the other extraction wells. From the collection tank (s), the water will be pumped to an enclosed treatment system where chromium will be removed by IX. Treated groundwater will be transferred through an aboveground pipe to the injection well network.	DOE/RL-96-84, Rev. 0 (3.4)	Active	Section 3.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
226	Cd	The 100-HR-3 GTS will be located inside an existing building (1713-H), which has been renovated for use at significantly less cost than purchasing a new building.	DOE/RL-96-84, Rev. 0 (3.4.4)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
227	Cd	The 100-HR-3 GTS will consist of four 379 L/min (100 gal/min) modular IX units with four columns per unit (Figure 3-10). Groundwater will be pumped from the 11,356 L (3,000 gal) influent storage tank located inside the 1713-H building to a manifold system that distributes the water in 3,790 L/min (100 gal/min) increments to the IX units. Within each modular unit, individual columns will be operated in a lead, lag, and polishing series configuration.	DOE/RL-96-84, Rev. 0 (3.4.4)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
228	Cd	The 100-HR-3 treated groundwater injection system includes three new wells located in a triangular array approximately 100 m (109 yd) apart. Each well will be 152.4 mm (6 in.) in diameter with an estimated depth between 18.3 and 21.4 m (60 and 70 ft). The wells will have 9.1 m (30 ft) screens with 6.1 m (20 ft) extending below the water table and 3 m (10 ft) above. Initially, two wells will be used to inject treated groundwater into the unconfined aquifer. The third well will serve as a backup or will provide additional capacity if extraction system throughput is increased. Water will be injected through a perforated pipe, 76 mm (3 in.) in diameter, which extends below the ambient water table (Figure 3-8a).	DOE/RL-96-84, Rev. 0 (3.4.2)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
229	Cd	The 100-HR-3 treatment system will have four 380 L/min (100 gal/min) trains with four columns connected in series for each train.	DOE/RL-96-84, Rev. 0 (Pg vii)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
230	Cd	The balance of plant will include all control systems, piping, valves, pumps, and electrical and mechanical equipment that enable groundwater from the extraction wells to be conveyed to the treatment system and returned to the injection well for injection back into the aquifer.	DOE/RL-96-84, Rev. 0 (3.4.3)	Active	Section 3.3.1
231	Cd	The bottom of the pond will remain wetted or sprayed with a fixative as needed to control fugitive dust.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
232	Cd	The extraction system shall be flexible to enable additional wells to be connected to the system if necessary.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.3
233	Cd	WAC 173-400-040 are applicable to the owner or operator of any emissions unit engaged in materials handling, construction, demolition or any other operation which is a source of fugitive emissions.	DOE/RL-99-51, Rev. 1 (8.2)	Complete	Requirement not carried forward, ISRM implementation complete.
234	Cd	The injection area should be of sufficient distance from the extraction wells such that closed cell circulation will not occur until an effective, optimal capture zone in the aquifer is established.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
235	Cd	The injection area should be placed in an area where chromium and co-contaminants are expected to occur or potentially be present at low concentrations in vadose zone soil and groundwater.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
236	Cd	The injection area should be placed in an area where mounding of the water table will not adversely impact the distribution or movement of known chromium occurrences.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.2
237	Cd	The injection well system will use new wells designed specifically as injection wells. This should limit the amount of well maintenance required. In addition, backup wells will be available in both OUs to allow continued injection in the event of a well problem.	DOE/RL-96-84, Rev. 0 (4.4.4)	Active	Section 2.4.3; DOE/RL-2013-35
238	Cd	The injection/withdrawal wells will consist of 10 to 15 cm (4 to 6 in.) diameter Type 316/316L stainless steel with 20-slot continuous wire-wrapped screen or 10 to 15 cm (4 to 6 in.) diameter polyvinyl chloride with 20-slot continuous wire-wrapped polyvinyl chloride screen. Figure 2-2 shows the general well design of the injection/withdrawal well. These wells will fully penetrate the aquifer, which is approximately 5 to 6 m (15 to 20 ft) in thickness. The wells will penetrate the top of the fine-grained mud unit of the Ringold Formation, which is at a depth of approximately 30.3 m (100 ft).	DOE/RL-99-51, Rev. 1 (2.2.2)	Complete	Requirement not carried forward - ISRM wells, implementation complete.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
239	Cd	The interconnecting piping will be configured to allow series flow through three or four vessels with any of the vessels as the first (or lead) vessel.	DOE/RL-96-84, Rev. 0 (3.4.4.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
240	Cd	The irrigation drip field will be constructed upgradient of the proposed layout of the ISRM barrier wells, within the surface area overlying the chromium groundwater plume. The drip field will be approximately 304.8 in ft) in length of perforated pipe, designed to minimize surface ponding when operable.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
241	Cd	The large number of wells in which the ISRM process will be performed has facilitated the need to construct a lined evaporation pond to dispose of extracted groundwater. The primary design of the localized evaporation pond shall meet the performance and design standards established in WAC 173-304-430.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete.
242	Cd	40 CFR 61 and WAC 246-247 are applicable for radionuclide emissions from facilities owned and operated by DOE.	DOE/RL-99-51, Rev. 1 (8.2)	Complete	Requirement not carried forward (specific to radionuclides), ISRM implementation complete.
243	Cd	The number (and cost) of new injection wells could be minimized by allowing the water table to mound into the overlying vadose zone and injecting treated 100-D Area groundwater in the 100-H Area.	DOE/RL-96-84, Rev. 0 (3.3.1.3)	Active	Section 3.1
244	Cd	The OIC will be located in the treatment system building and represents the primary link between the operator and the P&T system.	DOE/RL-96-84, Rev. 0 (3.4.3)	Active	Section 3.3
245	Cd	The OIC also serves as a data storage and retrieval device and will be configured so that system status can be viewed via a laptop computer from offsite locations.	DOE/RL-96-84, Rev. 0 (3.4.3)	Active	Section 3.3
246	Cd	PLCs will be located in the D-Area Transfer Pump Station, H-Area Transfer Pump Station and 1713-H Treatment Facility. An OIC will be located at the 1713-H Treatment Facility. The OIC will be the connection between the operators and the P&T system.	DOE/RL-96-90, Rev. 0 (2.3.1.1)	Active	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
247	Cd	The pond will be less than or equal to 1.5 m (4.9 ft) above grade.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
248	Cd	The P&T system shall have a design life of 10 years under normal operation and maintenance conditions. However, the actual operating lifetime is expected to be significantly less.	DOE/RL-96-84, Rev. 0 (3.3.1.4)	Active	Section 3.3
249	Cd	The P&T systems will include a number of devices designed to detect typical system upsets.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
250	Cd	The resin loading system will use treated water (from tank T-H02) to sluice (slurry) fresh resin into any vessel using a common transport header. Excess sluice water will be simultaneously removed from each vessel and returned to the process system (to tank T-H01).	DOE/RL-96-84, Rev. 0 (3.4.4.2)	Active	Section 4.3
251	Cd	The State's Minimum Standards for Construction and Maintenance of Wells are applicable for the location, design, construction, and abandonment of resource protection (i.e., extraction, reinjection, and monitoring) wells.	DOE/RL-96-84, Rev. 0 (A1.2)	Active	Section 2.5
252	Cd	The substantive requirements of this code are relevant and appropriate to the construction, operation, maintenance, and closure of any tanks and associated components (e.g., piping) that contain dangerous waste associated with both the water treatment system and the resin stabilization system. The tank system requirements specify requirements for system design when dangerous waste is associated with the system.	DOE/RL-96-84, Rev. 0 (A1.2)	Active	Section 2.5
253	Cd	The treatment system and selected equipment, when operated and maintained in accordance with the manufacturer's recommendations, will have a minimum design operating life of 10 years. To meet the ROD and Tri-Party Agreement Milestone M-16-06B, full-scale operation will begin before July 1, 1997, for the 100-HR-3 P&T Facility.	DOE/RL-96-90, Rev. 0 (2.3.1.2)	Active	Sections 3.3, 3.2.1,

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
254	Cd	To implement the interim action, the following nine new wells will be constructed at the 100-HR-3 OU: 1) three compliance monitoring well in 100-D Area, 2) one performance monitoring well in 100-D Area, 3) two compliance monitoring well in 100-H Area, 4) three injection well in 100-H Area.	DOE/RL-96-84, Rev. 0 (4.1.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
255	Cd	Treated groundwater will be pumped to an 11,356 L (3,000 gal) effluent tank for distribution to the injection wells.	DOE/RL-96-84, Rev. 0 (3.4.4)	Active	Section 3.3.1
256	Cd	Treated water (from tank T-H02) will be used to backwash (expand by 50%) any IX vessel resin bed. Backwash water from any IX vessel will return to tank T-H01 via a common header equipped with a screened trap.	DOE/RL-96-84, Rev. 0 (3.4.4.4)	Complete	New systems in place, Section 3.3.
257	Cd	Treated water (from tank T-H02) will be used to sluice exhausted resin from any vessel to a dewatering device using a common transport header. The dewatering device will have a porous surface to retain exhausted resin and fines. Water removal will be by gravity drainage. Resin removal from the dewatering device will be performed by the operators. Drained water from the dewatering device will be returned to the process system (to tank T-H01). Components of the resin removal/dewatering system will be protected from unsafe operating conditions (e.g., overflowing or running dry) by automatic protective features. Use of a PLC to control system functions will be considered. Compressed air will not be used for any phase of the resin removal or dewatering.	DOE/RL-96-84, Rev. 0 (3.4.4.3)	Complete	New systems in place, Section 3.3.
258	Cd	Using the OIC loaded with Wonderware® software, the treatment system operator will quickly determine equipment status and system operating conditions. Treatment process equipment and tanks will be shown graphically, and flow rates will be displayed. Information on the screens will be regularly updated on a nearly continuous basis using the OIC interface with the PLCs.	DOE/RL-96-90, Rev. 0	Active	Section 3.3
259	Cd	Using these data for treatment capacity (Tc), a barrier width (bw) of 12 m (40 ft), and a groundwater velocity (v) of 0.3 m/day (1 ft/day) results in an estimated barrier longevity (B,) of approximately 6,840 days, or 19 years.	DOE/RL-99-51, Rev. 1 (2.2.5)	Complete	Requirement not carried forward - ISRM implementation complete.
260	Cd	Water level drawdown will be monitored by a sensor that shuts the pump off if the water level drops below the low-level set point.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
261	Cd	Water levels will be used in the treatment system to control extraction well pumps, transfer and booster pumps, process tanks, and injection wells. Water level set points will alarm abnormally high- or low-water levels. Pressure transducers will monitor water level in the extraction and injection wells, while ultrasonic level sensors will measure water level in the process tanks. Level information will be collected by the PLC and made available to the operator through the OIC. The transducers will be initially calibrated by the manufacturer. After startup, groundwater levels and pumping rates will be monitored. This information along with additional modeling, will support determination of the optimal sustained rate of extraction and injection for the 100-HR-3 OU to meet the ROD requirements.	DOE/RL-96-90, Rev. 0 (2.3.1.2)	Active	Section 3.3
262	Cd	Well H4-12C, where chromium concentrations ranging from 270 to 290 µg/L have been detected, will not initially be connected to the groundwater extraction network.	DOE/RL-96-84, Rev. 0 (3.3.1.2.2)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
263	Cd,B	Air and drain valves have been placed at selected high- and low-elevation points that enable the pipeline to be drained manually if desired. Conditions and procedures for draining of the line will be presented in the O&M plan.	DOE/RL-96-84, Rev. 0 (3.4.5)	Active	Section 3.3
264	Cd,Cw	Piping will allow the drip field to be accessed directly to both the evaporation pond and well discharge manifolds. The piping will also allow for extracted water to be directed to portable storage tanks to transport concentrated water, when and as needed, to PSTF and/or ETF using Hanford Site purgewater trucks.	DOE/RL-99-51, Rev. 1 (2.3.2.3)	Complete	Requirement not carried forward - ISRM implementation complete.
265	Cp	Approximately 10 barrier wells will be monitored to track changes in Cr(VI) within the barrier.	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4

® Wonderware is a registered trademark of Schneider Electric Software, Lake Forest, CA 92630 USA

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
266	Cp	As the interim action progresses, the efficiency of the injection wells may decrease due to air entrainment, biofouling, well screen encrustation, or other effects. Measures will be taken to mitigate, as practicable, the loss of injection well efficiency. If injection well efficiency decreases significantly, maintenance activities will be performed, as practicable, to address the problem.	DOE/RL-96-84, Rev. 0 (4.4.4)	Active	Section 3.3.3
267	Cp	Compliance monitoring wells are designed for obtaining water level and water quality data at locations as near the river as practicable. Data collected from the compliance monitoring wells will be used to assess the effectiveness of the interim action at protecting aquatic receptors.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 2.4
268	Cp	Data collected during the ISRM interim action will provide information on both the immediate effectiveness of the treatment zone and the long-term longevity of the treatment.	DOE/RL-99-51, Rev. 1 (5.4)	Active	Sections 2.1.4, 2.4, 4.3.4
269	Cp	Data will be collected to evaluate both short-term and long-term geochemical impacts such as downgradient dissolved oxygen concentrations, residual reagents and reaction products, and trace metal mobilization.	DOE/RL-99-51, Rev. 1 (5.4)	Active	Sections 2.1.4, 2.4, 4.3.4
270	Cp	Data will be gathered to develop a cost model to compare the ISRM technology with conventional alternatives such as P&T. Cost data will be gathered to confirm the economies of scale-up. Determination of the removal efficiency in percent may be necessary for comparability to other projects. This would be a relative performance standard, rather than a regulatory standard. Costs and efficiency will be compared with those of the 100-HR-3 P&T system. Cost data will be estimated on a total life-cycle cost basis and will include such factors as construction costs, well installation and abandonment costs, sampling and analysis costs, operational and maintenance costs, and costs for reinjection for maintaining the reductive capacity of the treatment zone.	DOE/RL-99-51, Rev. 1 (5.4)	Complete	Requirement not carried forward, Section 2.1.4 describes current monitoring.
271	Cp	Deployment of ISRM should demonstrate a quantifiable reduction in the concentrations and mass of Cr(VI) in the aquifer. This will be accomplished by comparing Cr(VI) concentrations measured in the wells upgradient of the reduced zone with Cr(VI) concentrations measured in the wells downgradient of the reduced zone.	DOE/RL-99-51, Rev. 1 (5.4)	Active	Section 2.4
272	Cp	Dissolved oxygen will also be monitored to protect aquatic receptors. Dissolved oxygen may be reduced to very low levels less than 75% of saturation (BHI 1999) that may pose a risk to aquatic life. Monitoring of this constituent will enable actions to take place to increase the oxygen in groundwater (if required). One action that could occur is injecting air into selected wells.	DOE/RL-99-51, Rev. 1 (5.1.1)	Active	Section 2.4
273	Cp	During the ISRM interim action, groundwater monitoring will generate data that can be used to evaluate treatment cost, barrier efficiency based on chromium removal, barrier emplacement, barrier longevity, and geochemical impacts of the barrier.	DOE/RL-99-51, Rev. 1 (5.1.3)	Active	Sections 2.1.4, 2.4, 4.3.4
274	Cp	Extraction wells H3-2A and H4-7 will be pumped initially at rates of 151 L/min (40 gal/min) and 76 L/min (20 gal/min), respectively. These rates may be adjusted during startup to increase the rate of mass removal or expand the area of hydraulic gradient control.	DOE/RL-96-84, Rev. 0 (3.3.1.2.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
275	Cp	Following completion of the interim action, an assessment will be made to determine whether the wells at these locations will continue to be needed.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 6.2
276	Cp	Groundwater monitoring for the first 5 years is expected to provide adequate data to assess barrier treatment success and reevaluate the laboratory test results regarding expected treatment duration.	DOE/RL-99-51, Rev. 1 (5.2.5)	Active	Sections 2.1.4, 2.4
277	Cp	If unexpected conditions are encountered, copies or verbal notification of preliminary field screening data will be available to the project lead or other onsite personnel immediately after completion of the analyses. If desired by the project, field screening personnel will prepare trend plots of selected field screening data such as pretreatment or post-treatment analyte concentrations for the liquid streams.	DOE/RL-99-51, Rev. 1 (4.6)	Complete	Requirement not carried forward - ISRM implementation complete.
278	Cp	Injection well performance will be assessed using water level monitoring data collected during the startup and operation phase. These data will be used to develop guidelines for long-term operation and to confirm the final number of wells necessary to support interim action operations.	DOE/RL-96-84, Rev. 0 (3.3.3.2)	Active	Section 2.4.2
279	Cp	Monitoring wells constructed similar to the extraction wells and in accordance with WAC 173-160 standards are the preferred method for monitoring interim action performance. However, where acceptable existing wells are available, new wells will not be installed.	DOE/RL-96-84, Rev. 0 (5.2.1)	Active	Section 2.4.3
280	Cp	Once all of the extraction wells are shut down, the compliance wells will be sampled on a quarterly basis for I year and the data used to calculate an upper-confidence interval using the methodology described in WAC 173-340-720(8e). If, at the end of the 1-year monitoring period, the upper-confidence interval is less than the protective level, a request for interim action termination would be submitted. If, at any time during the 1 year compliance monitoring period, the data indicate a confirmed increase above the protective level, a proposal for restarting the interim action would be prepared.	DOE/RL-96-84, Rev. 0 (5.4.1)	Active	Section 6

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
281	Cp	Once water quality samples from both the extraction wells and compliance wells have remained below 22 µg/L for a full 1 year period, a phased shutdown of the extraction system will be implemented. Extraction wells will be shut down at quarterly intervals beginning with perimeter wells and concluding with interior wells. During the phased shutdown period, water quality samples collected from idled extraction wells and downgradient compliance wells will provide an early indication as to whether chromium concentrations will remain below 22 µg/L.	DOE/RL-96-84, Rev. 0 (5.4.1)	Active	Section 6
282	Cp	Performance monitoring wells are designed for water level and less frequent water quality measurements at inland areas and will provide independent verification of interim action effectiveness at reducing chromium flux towards the river.	DOE/RL-96-84, Rev. 0 (5.2)	Active	Section 2.4
283	Cp	Prior to selecting a final remedy, a cumulative risk assessment will be performed to assess human health and environmental exposures that result from all remaining contaminants.	DOE/RL-96-84, Rev. 0 (5.4.3)	Complete	Risk assessment in DOE/RL-2010-95
284	Cp	Protection of aquatic receptors will be demonstrated by evaluating interim action groundwater monitoring data to show that Cr(VI) concentrations do not exceed 20 µg/L in ISRM compliance wells. Based on the anticipated dilution occurring between the downgradient wells and the point of discharge into the Columbia River, attainment of this concentration at the downgradient compliance wells will ensure that chromium levels in the river substrate do not exceed 10 µg/L.	DOE/RL-99-51, Rev. 1 (5.1.1)	Active	Section 2.4.2
285	Cp	Pumping of the extraction wells will continue as long as chromium concentrations remain above 22 µg/L and the rate of progress towards this level is reasonable and cost effective.	DOE/RL-96-84, Rev. 0 (5.4.1)	Active	Section 6
286	Cp	Results of operational monitoring will be used to determine the effectiveness of the treatment system in removing Cr(VI).	DOE/RL-96-90, Rev. 0 (3.3)	Active	Section 2.4
287	Cp	Samples from the compliance monitoring wells near the river will be collected to confirm that values in these wells do not exceed 22 µg/L.	DOE/RL-96-90, Rev. 0 (1.3)	Active	Section 2.4
288	Cp	Sampling will be conducted quarterly at the downgradient compliance monitoring wells (Table 5-1). Performance sampling will be conducted quarterly at the upgradient, barrier, and downgradient monitoring wells.	DOE/RL-99-51, Rev. 1 (5.2.2)	Active	Section 2.4
289	Cp	Seven wells will be used as compliance monitoring wells: 199-D8-68, 199-D8-69, 199-D8-70, 199-H4-4, 199-H4-5, 199-H4-63, and 199-H4-64. These wells are all within 305 m (1,000 ft) of the river edge.	DOE/RL-96-90, Rev. 0 (2.1)	Active	Section 2.4
290	Cp	Shutdown of the system will be determined with regulatory agreement and will be based on the results of the compliance monitoring program and the final remedy selection.	DOE/RL-96-90, Rev. 0 (3.3.1.2)	Active	Section 6
291	Cp	Spacing of this [performance] monitoring is expected to be one well about every 61 m (200 ft) within the barrier.	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4
292	Cp	Successful completion of the interim action will be based on its ability to remove chromium to a level that provides long-term protection of aquatic receptors in the river. This success will be measured by water quality samples collected from both the extraction and compliance monitoring wells.	DOE/RL-96-84, Rev. 0 (5.4.1)	Active	Sections 2.3, 2.4, 6
293	Cp	System efficiency will be based collectively on chromium removal efficiency and system operating efficiency. Chromium removal efficiency will be determined based on the percentage of chromium removed by the treatment system. System operating efficiency will be determined from the percentage of time the GTS operates divided by the total time available for operation.	DOE/RL-96-84, Rev. 0 (5.1.3.2)	Active	Sections 2.4, 4.3.4
294	Cp	The authority to implement the federal program has been delegated to the state. The State's Underground Injection Control Program specifies procedures and practices applicable to the injection of fluids through wells. In particular, the regulation states that no fluids may be injected that result in a violation of any primary DWSs or that otherwise adversely affect the beneficial use of the aquifer. The primary DWS for chromium, the primary contaminant of concern, is 100 µg/L.	DOE/RL-96-84, Rev. 0 (A1.1)	Active	Section 2.5
295	Cp	Downgradient wells will be used for compliance monitoring.	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4
296	Cp	Effectiveness of the P&T system will be assessed based on monitoring data collected over the lifetime of the interim action.	DOE/RL-96-84, Rev. 0 (Pg viii)	Active	Section 2.4.2
297	Cp	Effectiveness of chromium removal will be determined using the results of concentration monitoring performed after the interim action is terminated. Co-contaminants will not be included in this evaluation because no significant removal by the GTS is required.	DOE/RL-96-84, Rev. 0 (5.1.3.4)	Active	Section 2.4

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
298	Cp	Hydraulic impacts of P&T technology will be assessed by estimating the extent of chromium plume capture that can be achieved for various pumping strategies. This determination will include estimates of hydraulic impacts in the vicinity of the river where variable river stage is expected to have a pronounced effect on plume capture.	DOE/RL-96-84, Rev. 0 (5.1.3.3)	Active	Section 4.3.4
299	Cp	In situ treatment for Cr(VI) could result in low dissolved oxygen groundwater. If low dissolved oxygen is detected at the compliance wells, the project team will propose a corrective action to DOE-RL and regulatory agencies.	DOE/RL-99-51, Rev. 1 (5.2.5)	Complete	Requirement not carried forward. No corrective actions required.
300	Cp	The interim action ROD does not establish a fixed treatment level for chromium. It does, however, state that chromium shall be treated to the maximum extent practicable, and treated water containing chromium exceeding 50 µg/L will not be injected.	DOE/RL-96-84, Rev. 0 (3.3.1.5)	Active	Section 2.3
301	Cp	ISRM deployment will be conducted so that the technical feasibility of emplacing a barrier treatment zone on a large scale can be assessed.	DOE/RL-99-51, Rev. 1 (5.4)	Complete	Requirement not carried forward, Section 2.1.4 provides ISRM description.
302	Cp	The ISRM interim action should provide enough data so that if ISRM is both technically and economically feasible, the technology can be presented to the community as a final remedy for other chromium-contaminated groundwater plumes in the 100 Areas.	DOE/RL-99-51, Rev. 1 (5.4)	Complete	Requirement not carried forward, Section 2.1.4 provides ISRM description.
303	Cp	The ISRM interim action will be conducted to minimize waste. Comparison of the volume of waste generated using ISRM will be compared to that generated using the 100-HR-3 P&T system. Waste disposal costs will be factored into the cost comparison.	DOE/RL-99-51, Rev. 1 (5.4)	Complete	Requirement not carried forward, Section 2.1.4 provides ISRM description.
304	Cp	Performance evaluations will integrate data collected from other ongoing 100-HR-3 and 100-KR-4 programs and will be conducted at the conclusion of 6 months, 18 months, 30 months, 42 months, and 66 months of interim action operation. Performance evaluation results will be used to make recommendations on modifications to the target areas, alternate pumping strategies, treatment system modifications, or alternate sampling parameters and frequencies.	DOE/RL-96-84, Rev. 0 (5.5)	Active	Annual P&T reports present the evaluations. Section 2.4.3 discusses remedial process optimization for ongoing system modifications. Section 6.3 identifies interim action reporting requirements.
305	Cp	The pre-injection [sampling] results will be compared with both the process/operational and performance monitoring results to determine the effectiveness of the ISRM emplacement process. Table 4-1 lists the sample matrix, analytes/parameters of concern, and the frequency at which pre-injection samples will be taken, and Table 4-2 reviews the analytical requirements. Samples can be obtained from either the injection/withdrawal wells or observation well. Observation wells in most cases are nearby injection/withdrawal wells.	DOE/RL-99-51, Rev. 1 (4.2.1)	Complete	Requirement not carried forward - ISRM implementation complete.
306	Cp	The standards presented are protective of freshwater aquatic organisms from chronic exposure to contaminants.	DOE/RL-96-84, Rev. 0 (A1.1)	Active	Section 2.2
307	Cp	The type of resin used in each GTS will be periodically evaluated for performance and cost effectiveness.	DOE/RL-96-84, Rev. 0 (3.4.4.5)	Active	Section 3.2.4
308	Cp	The variability in aquifer response and plume concentrations caused by river stage fluctuations will be considered when evaluating the effectiveness of the P&T system.	DOE/RL-96-84, Rev. 0 (2.2.4)	Active	Section 2.4.2
309	Cp	Water level data from regional monitoring wells and ISRM site-specific wells will be used to assist in determining the hydraulic gradient, groundwater flow directions and velocities, and the variability in these parameters of the time scale of the first 3 to 5 years of the barrier emplacement. The data will be used to assist in evaluating the effectiveness of the barrier in intercepting the chromium-contaminated groundwater. The data will also be used to estimate arrival times for treated water at the compliance wells and upgradient chromium concentrations at the barrier.	DOE/RL-99-51, Rev. 1 (5.3.1)	Active	Section 2.4
310	Cp	These data will be collected over an 8- to 12- month prestartup period to document baseline conditions, during a 3-month startup period when timely information is necessary to adjust system operations, and during the operational phase to track progress towards achieving RAOs.	DOE/RL-96-84, Rev. 0 (Pg viii)	Active	Annual reports present data summaries/Section 2.4.2 identifies performance monitoring requirements.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
311	Cp	These downgradient wells plus selected upgradient wells, barrier wells, aquifer sampling tubes, and river porewater tubes will constitute the performance monitoring wells.	DOE/RL-99-51, Rev. 1 (5.0)	Active	Section 2.4
312	Cp	Thirteen upgradient wells have been selected from existing wells (for performance monitoring).	DOE/RL-99-51, Rev. 1 (5.2.1)	Active	Section 2.4
313	Cp	This criterion, 20 µg/L of Cr(VI) at the compliance wells, will be applied after sufficient time has elapsed to allow ISRM-treated groundwater to reach the downgradient wells. This criterion is the primary standard for assessing success of the ISRM remediation. Metals and anions will be monitored to assist in the chemical description of the groundwater and to note any changes over time.	DOE/RL-99-51, Rev. 1 (5.1.1)	Active	Section 2.4
314	Cp	To minimize the potential influx of river water, Wells H4-12A, H4-15A, and H4-11 will initially be pumped at a conservative rate of 38 L/min (10 gal/min). Water level and river stage data collected during startup will be used to determine if pumping rates should be adjusted to achieve the desired hydraulic gradient control.	DOE/RL-96-84, Rev. 0 (3.3.1.2.1)	Complete	Section 3.2 describes initial systems, updated systems also described in Section 3.2.
315	Cp	The cost of treatment will be determined on a dollar per liter of groundwater extracted. The cost will be determined using the interim action capital (amortized over an assumed 10 year design lifetime) plus annual O&M costs, divided by the annual volume of groundwater extracted for each OU.	DOE/RL-96-84, Rev. 0 (5.1.3)	Active	Section 2.4
316	Cp	Twenty-one performance monitoring wells for the 100-HR-3 OU have been selected for obtaining water levels and water quality measurements at inland areas. Data from these wells will be used to evaluate the interim-action's effectiveness in reducing chromium concentrations at the river.	DOE/RL-96-90, Rev. 0 (2.2)	Active	Section 2.4.2
317	Cp	Water level data collected during interim action implementation will be used to determine if pumping rates should be adjusted to achieve the desired hydraulic gradient control.	DOE/RL-96-84, Rev. 0 (3.3.1.2.2)	Active	Section 2.4.2
318	Cp	Wells H4-7 and H3-2A are located within the core region of the plume and are favorably positioned to intercept the chromium plume migrating from the 100-D Area. Pumping from these wells will result in rapid mass removal and will decrease the flux of chromium migrating toward the river.	DOE/RL-96-84, Rev. 0 (3.3.1.2.1)	Complete	Section 3.2 describes initial systems; updated systems also described in Section 3.2
319	Cp,B	Inspections of the equipment, facilities, operations, and procedures will be conducted routinely. Inspection schedules will be developed, including an evaluation of the rate of possible equipment and signage deterioration. Appropriate inspection records will be prepared and retained to document the findings and recommended and implemented corrective actions resulting from the routine inspections.	DOE/RL-99-51, Rev. 1 (6.3)	Complete	Requirement not carried forward; ISRM implementation complete
320	Cp,B	Performance evaluations will be conducted at the end of 6 months of interim action operation and annually thereafter. The report will include recommendations on modifications to pumping target areas, pumping strategies, treatment system operation, and sampling parameters and frequency. The performance evaluation report will document success of the P&T facility in meeting the following interim action objectives: Protection of the aquatic receptors in the river bottom Protection of human health Development of information leading to a final remedy	DOE/RL-96-90, Rev. 0 (7.3)	Active	Annual P&T report; Section 2.4.2
321	Cp,B	The analytical results from the groundwater monitoring wells will be used to assess the compliance and performance of the ISRM barrier. The evaluation will be reported annually in the performance evaluation report (Section 9.0).	DOE/RL-99-51, Rev. 1 (5.2.5)	Active	Sections 4.3.4, 6.3
322	Cp,Ca	The P&T system is designed to reverse the gradient in the contaminated area. This hydraulic effect will be verified by taking water level measurements using dedicated pressure transducers in the compliance wells at an hourly frequency, or as necessary	DOE/RL-96-90, Rev. 0	Active	Section 2.4.2
323	Cp,Cw	Both field screen and laboratory confirmation samples will be collected periodically during the ISRM process to characterize the wastewater directed to and contained in the evaporation pond (Section 4.0). These data will be evaluated to determine when Phase II (FY 2001) and Phase III (FY 2002) extracted groundwater is suitable for ground-surface discharge without adversely affecting the underlying aquifer.	DOE/RL-99-51, Rev. 1 (B.4)	Complete	Requirement not carried forward; ISRM implementation complete
324	Cr	Applicable due to the known roosting of bald eagles in the general vicinity of potential extraction wells.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5
325	Cr	Applicable to actions in order to preserve historic properties controlled by a federal agency.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5
326	Cr	Applicable to planning, designing, and locating activities in a manner that minimizes direct and adverse effects on the values for which the river is under study.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
327	Cr	Applicable to recover and preserve artifacts in areas where an action may cause irreparable harm, loss, or destruction of significant artifacts.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5
328	Cr	Because occasional maintenance of the wells and well pumps is likely over the course of the interim action, these disturbed areas will not be restored following interim action construction.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
329	Cr	Cultural resources, ecological resources, and site access will also be considered for exact barrier placement. The ISRM barrier will be approximately 150 to 180 m (500 to 600 ft) from the Columbia River.	DOE/RL-99-51, Rev. 1 (2.2.3)	Complete	Requirement not carried forward – ISRM implementation complete
330	Cr	Disturbance to natural vegetation and habitat will be minimized by using existing roads and drill sites where practicable. Where disturbance is unavoidable, as where water lines must cross a previously undisturbed area, cultural resources and ecological reviews will be conducted to identify controls to limit disturbances.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
331	Cr	During all phases of the P&T project, workers must remain sensitive to cultural/ecological conditions. Workers can maintain this sensitivity by adhering to the following: • watching for cultural material during all work activities • refraining from collecting any historic or prehistoric objects • confining activities, where possible, to previously disturbed areas • keeping vehicles on existing roads	DOE/RL-96-90, Rev. 0	Active	Section 5.4
332	Cr	Following completion of the interim action, conveyance pipe will be removed, if not needed for other activities, and the disturbed areas restored according to the mitigation action plan. If planned source remediation activities will disturb the area at a later time, restoration of the disturbed areas may be postponed until the source remediation activities have been completed.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
333	Cr	Relevant and appropriate to activities within the floodplains and wetlands.	DOE/RL-96-84, Rev. 0 (A1.4)	Active	Section 2.5
334	Cr	Relevant and appropriate to protection of migratory birds in the areas.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5
335	Cr	The *Endangered Species Act of 1973* requires that federal agencies consult with the U.S. Department of Interior to ensure that actions they authorize, fund, or implement do not jeopardize the continued existence of endangered or threatened species or adversely affect their critical habitat.	DOE/RL-96-84, Rev. 0 (A1.3)	Active	Section 2.5
336	Cr	Where (cultural or ecological) disturbances do occur, restoration will be performed according to a mitigation action plan.	DOE/RL-96-84, Rev. 0 (4.1.4)	Active	Section 5.4
337	Cs	Uncontaminated miscellaneous solid waste streams will be disposed to an offsite solid waste landfill or onsite demolitions landfill (if appropriate). Treatment will be approved by the regulatory agencies prior to being conducted.	DOE/RL-99-51, Rev. 1 (C.3)	Active	Section 5.3
338	Cw	At the completion of the project, the evaporation pond would be dismantled and disposed at an approved Hanford Site landfill, including any sediments and precipitants remaining on the inside base of the pond liner.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward; ISRM implementation complete (Section 4.3.3 for pond removal)
339	Cw	A formal waste designation will be proposed for any waste required to be containerized due to exceedance of regulatory limits. Waste generated will be certified in accordance with WCH-191.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Section 5.3
340	Cw	A wastewater management and disposal strategy consists of the following: Post-treatment extraction purgewater shall be collected and disposed to a localized evaporation pond (constructed at the ISRM site) and/or onsite facilities (PSTF and ETF). High concentrated purgewater generated during post-treatment extraction shall be disposed at the evaporation pond with the option of sending the concentrated purgewater to the PSTF and/or to the ETF, both of which are located in the 200 Areas. Subsequent low-concentrated purgewater volumes will continue to be disposed to the evaporation pond or to ground surface through a localized drip field constructed at the ISRM site. The withdrawn water will be analyzed and evaluated to confirm that water discharged to the ground will not result in an exceedance of the sulfate secondary DWS of 250 mg/L.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete
341	Cw	All containerized waste shall be tracked from the point of generation until disposed.	DOE/RL-96-84, Rev. 0 (10.0)	Active	Section 5.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
342	Cw	All final packaging and labeling must meet WAC 173-303 and U.S. Department of Transportation requirements, as appropriate. Containers will be labeled and marked appropriately to match the designation established for each waste stream. The container will be sealed and shipped to the identified disposal facility. The container document preparation must be completed as specified in BHI-EE-10, *Waste Management Plan*.	DOE/RL-99-51, Rev. 1 (C.7)	Active	Section 5.3
343	Cw	All groundwater that is contained will be processed at a future date through the 100-HR-3 IRM P&T system.	DOE/RL-96-84, Rev. 0 (pg D-11)	Active	Section 5.3
344	Cw	All nonregulated remediation-derived wastes will be managed in accordance with their respective waste management plans. Examples of nonregulated wastes include gloves, tape, sampling equipment, and paper. All nonregulated remediation-derived waste will be disposed of in accordance with BHI waste management procedures.	DOE/RL-96-84, Rev. 0 (D1.4)	Active	Section 5.3
345	Cw	All samples used for on-line analysis are considered waste streams and will be disposed of in a sampling discharge tank located at the mobile trailer. During the injection stage, the waste streams will potentially contain increased levels of dithionite and sulfate. During the reaction and withdrawal stages, the waste streams will potentially contain increased sulfur levels (sulfite, sulfate, and thiosulfate). Additional wastes (reagents, preservatives, calibration solutions) will also be generated during analysis activities.	DOE/RL-99-51, Rev. 1 (4.1)	Complete	Requirement not carried forward - ISRM implementation complete
346	Cw	All waste shall be separated and segregated as follows: -Mixed waste debris versus mixed waste -Mixed waste debris versus dangerous waste debris -Dangerous waste debris versus dangerous waste -LDR waste versus mixed or non-LDR dangerous waste -Radioactive waste versus nonradioactive waste -Mixed waste versus radioactive waste -Dangerous waste versus nonregulated waste -Large noncompactible debris waste versus waste soils	DOE/RL-96-84, Rev. 0 (pg D-21)	Active	Section 5.3
347	Cw	Any waste transported offsite will be in accordance with appropriate requirements in 49 CFR 171 through 173 and DOE Order 1540.1.	DOE/RL-96-84, Rev. 0 (pg D-23)	Active	Section 5.3
348	Cw	Appendix B provides ISRM purgewater background information and guidance to determine when withdrawn extraction water is suitable for discharge to ground surface. Field data will be collected and evaluated against the guidance to confirm that the purgewater concentration is suitable for discharge to ground surface. The majority of all withdrawn water is expected to remain in the evaporation pond. The drip-irrigation system will be used as a wastewater alternative to manage and dispose of low-concentrated purgewater.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete
349	Cw	Applicable for the identification, treatment, storage, and disposal of wastes determined to be dangerous wastes.	DOE/RL-96-84, Rev. 0 (A1.2)	Active	Section 2.5
350	Cw	As a precautionary measure, soil piles will be surveyed for radioactivity a minimum of once each day soils are added to the pile. Measurements will be made by a Radiological Control Technician (RCT) using hand-held screening instruments. Moist soil (i.e., soil generated from the aquifer) samples will be periodically tested for Cr(VI) by Hach kit analysis.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Section 2.4.3; DOE/RL-2013-35
351	Cw	At the completion of the project, any remaining concentrated pond water would be transferred to the PSTF or ETF.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete. Section 4.3.3
352	Cw	Containment of decontamination rinsate will not be required, providing that downhole tools and equipment are wiped down to remove residual material prior to steam cleaning. The wiping must be sufficient to remove any solid contaminants that could conceivably show up in the rinsate. The subsequent steam cleaning will use potable water only (with no additives).	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
353	Cw	Contaminated groundwater or soil will be contained, when required, in steel 209 L (55 gal) open head drums. Drums are to be no more than 80 percent full. Any water generated during waste preparation will be stored and then processed through the 100-KR-4 remedial action P&T system when the system is operating.	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
354	Cw	Contaminated groundwater, above release limits, that is generated during well drilling will be contained in a portable tank and will subsequently be transferred to approved storage containers.	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
355	Cw	Contaminated soils will be contained and packaged, as required, to meet WCH-191.	DOE/RL-96-84, Rev. 0 (Appendix D 6.0)	Active	Section 5.3
356	Cw	Drill cuttings and other waste from drilling activities will be controlled in accordance with waste management plans.	DOE/RL-96-84, Rev. 0 (4.1.1)	Active	Section 5.3
357	Cw	Dry (vadose zone) spoils will be accumulated in piles near the point of generation. If the moist soils must be contained, the soils will be placed on plastic to prevent any residual, free groundwater from being released to the soil as an attempt to prepare soils to meet applicable waste acceptance or disposal criteria.	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
358	Cw	Dry (vadose zone) uncontaminated soils will be accumulated in piles near the point of generation and placed on the drill pad. If the moist soils must be contained, the soils will be placed on plastic and allowed to drain. Any residual free groundwater will be collected to prevent release to the soil. This will allow soils to meet applicable waste acceptance or disposal criteria. Groundwater draining from soil piles will be contained as described below.	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
359	Cw	During Phase I, the first four withdrawn purgewater volumes from the wells will be contained to prevent the release of wastewater to ground surface that could impact the groundwater above the secondary DWS for sulfate. The fifth purgewater volume will be directed to the evaporation pond or to the drip field when determined appropriate and necessary for waste management controls.	DOE/RL-99-51, Rev. 1 (4.2.2)	Complete	Requirement not carried forward - ISRM implementation complete
360	Cw	During this project, additional disposal approaches may be evaluated and proposed for regulatory review and concurrence (if such approaches are determined to be beneficial to the development and emplacement of the ISRM barrier technology).	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete
361	Cw	Extracted ISRM process groundwater will be evaporated at the localized evaporation pond, and/or treated at PSTF or ETF with the possibility of reinjecting low-concentrated purgewater to the soil column using a localized irrigation drip system.	DOE/RL-99-51, Rev. 1 (C.3)	Complete	Requirement not carried forward, ISRM implementation complete
362	Cw	Field parameters will be used to determine when, if any, purgewater can be directed to the drip-irrigation system for disposal to ground surface as a secondary option, if needed, for waste management optimization.	DOE/RL-99-51, Rev. 1 (4.2.2)	Complete	Requirement not carried forward - ISRM implementation complete
363	Cw	Groundwater contaminated above discharge limits generated during well drilling will be contained in a portable tank and will subsequently be placed in a U.S. Department of Transportation approved drum.	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
364	Cw	Groundwater or contaminated soil will be contained, when required, in steel 209 L (55 gal) open head drums. Drums are to be no more than eighty percent (80%) full (see document for description of information to be written on the lid, maintenance of container).	DOE/RL-96-84, Rev. 0 (pg D-22)	Active	Section 5.3
365	Cw	If the resins meet WCH-191, the resin will be disposed onsite at the ERDF. If the spent resin does not meet WHC-191, a disposal option will be determined following a technical evaluation of various options and a cost benefit analysis.	DOE/RL-96-84, Rev. 0 (D1.2)	Active	Section 5.3
366	Cw	In general, contaminated solid waste streams will be disposed at ERDF if they meet WCH-191 or can be treated to meet the criteria.	DOE/RL-99-51, Rev. 1 (C.3)	Active	Section 5.3
367	Cw	In general, solid waste streams will be disposed at ERDF if they meet WCH-191 or can be treated to meet the criteria. Key criteria are the chromium LDR requirement of TCLP of 5 mg/kg and the absence of free liquids.	DOE/RL-96-84, Rev. 0 (D1.0)	Active	Section 5.3
368	Cw	In the event that some contaminated material cannot be disposed of at the ERDF or other onsite facilities such as the ETF, PTSF, or Central Waste Complex and disposal at an offsite facility is required, such a facility must be in compliance with 40 CFR 300.440 concerning offsite disposal of wastes.	DOE/RL-99-51, Rev. 1 (C.3)	Active	Section 5.3
369	Cw	In the event that some material cannot be disposed of at the ERDF or other onsite facilities and disposal at an offsite facility is required, such a facility must be in compliance with 40 CFR 300.440 concerning offsite disposal of wastes.	DOE/RL-96-84, Rev. 0 (D1.0)	Active	Section 5.3
370	Cw	Laboratory analysis results from waste stream samples for trace metals, anions, uranium, and sulfur levels (sulfate, sulfite, and thiosulfate) will be periodically compared to field screens to verify field parameter indicators for waste disposal alternatives as described in Sections 2.3.1.3 and 2.3.2.3. Adjustments will be made as required.	DOE/RL-99-51, Rev. 1 (4.2.2)	Complete	Requirement not carried forward - ISRM implementation complete
371	Cw	Liquid waste streams will be processed at the 100-HR-3 and 100-KR-4 treatment system if it is technically feasible to do so.	DOE/RL-96-84, Rev. 0 (D1.0)	Active	Section 5.3

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
372	Cw	Management of specific ISRM waste streams is described in the following sections: C.5.1, Drill Cuttings and Associated Solid Wastes; C.5., Purgewater Liquid Wastes; C.5.3, Extraction Liquid Wastes; C.5.4, Evaporation Pond/Drip Field - Operations Waste; C.5.5, Miscellaneous Waste; C.5.5.1, Miscellaneous Liquid Waste; C.5.5.2, Miscellaneous Solid Waste.	DOE/RL-99-51, Rev. 1 (C.5)	Complete	Requirement not carried forward, ISRM implementation complete
373	Cw	Phase I emplacement data will be used to establish a correlation between field screening measurements and laboratory analyses to determine when purgewater from subsequent phases can be discharged to the ground. (Additional information for ISRM determination to discharge purgewater to ground surface is provided in Appendix B.)	DOE/RL-99-51, Rev. 1 (4.2.2)	Complete	Requirement not carried forward - ISRM implementation complete
374	Cw	Post-treatment extraction purgewater shall be collected and disposed to an evaporation pond constructed at the ISRM site. High-concentrated purgewater generated during post-treatment extraction shall be disposed at the evaporation pond with the option of sending a portion of the concentrated purgewater to the PSTF (RCRA interim status unit) and/or to the ETF (RCRA final status unit), both of which are in the 200 Areas.	DOE/RL-99-51, Rev. 1 (1.1)	Complete	Requirement not carried forward – ISRM implementation complete. Section 4.3.3
375	Cw	Process residuals from the IX system will consist of spent resin that will be dewatered and placed in a disposal container. Liquids will be returned to the influent collection tank for treatment. Spent resin is not expected to exceed the TCLP chromium reference level and will be transported to ERDF for disposal.	DOE/RL-96-84, Rev. 0 (3.4.4)	Active	Section 5.3
376	Cw	Purgewater associated with well installation, monitoring, and maintenance will be managed in accordance with DOE-RL, 1990, *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington*, and BHI-EE-01, *Environmental Investigations Procedures*, Volume 1, Procedure 1.1, "Purge Water Management." Purgewater that requires collection will be trucked to either the PSTF or ETF. Decontamination fluids will generally be managed as purgewater.	DOE/RL-99-51, Rev. 1 (C.3)	Active	Section 5.3
377	Cw	Purgewater shall be managed in accordance with BHI-EE-01, Volume I, EIP 1.1.	DOE/RL-96-84, Rev. 0 (Pg D-11)	Active	Section 5.3
378	Cw	Purgewater will be processed at the 100-HR-3 or 100-KR-4 treatment system if technically feasible. If not technically feasible, purgewater will continue to be managed at the Hanford Site purgewater tanks.	DOE/RL-96-84, Rev. 0 (D1.5)	Active	Section 5.3
379	Cw	Radioactive waste will be managed separately from nonradioactive waste. Storage and control of radioactive material/waste will comply with the requirements of BHI-SH-02, Vol. 1, Procedure 1.19, "Designation and Controlling Radioactive Material Areas."	DOE/RL-99-51, Rev. 1 (C.8)	Active	Section 5.3
380	Cw	Solid waste will be treated as necessary before disposal to ensure that it meets WCH-191.	DOE/RL-99-51, Rev. 1 (C.3)	Active	Section 5.3
381	Cw	Spent resin testing requirements will be based on ERDF waste acceptance requirements performed at an appropriate frequency to demonstrate compliance with the criteria.	DOE/RL-96-84, Rev. 0 (5.3.3)	Active	Section 5.3
382	Cw	Spent resin will be sampled to determine whether it meets WCH-191 for chromium. Resins will be sampled to characterize the waste prior to shipment for disposal. Once a trend is established, sampling requirements may be reduced.	DOE/RL-96-84, Rev. 0 (D1.2)	Active	Section 5.3
383	Cw	Substantive requirements of WAC 173-216 are applicable to the use of the purgewater drip field to discharge extracted ISRM purgewater to the soil column.	DOE/RL-99-51, Rev. 1 (8.2)	Complete	Requirement not carried forward, ISRM implementation complete
384	Cw	Subsequent low-concentrated purgewater volumes will continue to be disposed to the evaporation pond with an option of sending a portion of this purgewater to the ground surface through a localized drip field constructed at the ISRM site. The withdrawn water discharged to the ground will be analyzed to confirm that the sulfate secondary DWS of 250 mg/L will not be exceeded in the underlying groundwater.	DOE/RL-99-51, Rev. 1 (1.1)	Complete	Requirement not carried forward – ISRM implementation complete
385	Cw	The amount of waste stored at the site shall be kept to a minimum. Containers shall be prepared for disposal as quickly as economically feasible. Any designated dangerous waste will be stored in a temporary storage area that meets the substantive requirements of WAC 173-303-630 and will be inspected weekly. The waste will be accumulated and stored near the ISRM site or other appropriate location in the 100-D or 100-H Areas pending final disposal.	DOE/RL-99-51, Rev. 1 (C.8)	Complete	Requirement not carried forward, ISRM implementation complete
386	Cw	The construction of the onsite, localized evaporation pond will be used as temporary storage and disposal (evaporation) of the extracted ISRM barrier installation well purgewater. Wastewater will be managed between the localized evaporation pond, PSTF, ETF, and the localized irrigation drip field. The majority of the wastewater will be stored and disposed through the use of the evaporation pond.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location
387	Cw	The drill cuttings and contaminated solid wastes will be disposed of at the ERDF. This waste will be managed in accordance with respective waste management plans. The waste management plans for 100-HR-3 and 100-KR-4 drilling activities are included as attachments to DOE/RL-96-84, Rev. 0 Appendix D. Drill cuttings and other contaminated solid waste will be treated as necessary before disposal to ensure that they meet WCH-191 prohibiting free liquids.	DOE/RL-96-84, Rev. 0 (D1.3)	Active	Section 5.3
388	Cw	Federal LDRs prohibit land disposal of hazardous waste unless those wastes are treated to meet LDR standards or a treatability variance is obtained. State LDR regulations incorporate federal RCRA LDR requirements (currently maintained under federal authority).	DOE/RL-96-84, Rev. 0 (A1.2)	Active	Section 2.5
389	Cw	The groundwater generated during well drilling that exceeds release criteria (i.e., 80 µg/L Cr(VI); 45,000 µg/L nitrate; and 250,000 µg/L sulfate) will be stored for future treatment in the 100-HR-3 IRM P&T system. Based on these analyses, groundwater will either be contained or disposed of on the ground surface.	DOE/RL-96-84, Rev. 0 (3.0)	Active	Applicable to wells installed prior to system operations; Section 5.3 identifies current waste management requirements
390	Cw	The local disposal system(s) will be located upgradient from the proposed ISRM barrier at an approximated minimal distance of 300 m (984 ft) from the river.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete
391	Cw	The treatment system is designed with inline filters to collect fine particulates from the treatment stream. Fine particles collect on filters located in filter housings. The filter elements will be removed from the filter housing and replaced when prescribed differential pressures are reached. These filters will be disposed per the requirements specified in a waste management plan for system operations.	DOE/RL-96-84, Rev. 0 (D1.1)	Active	Section 5.3
392	Cw	Uncontaminated soil piles will be leveled following well installation.	DOE/RL-96-84, Rev. 0 (Pg D-11)	Active	Section 5.3
393	Cw	Waste acceptance criteria (e.g., concentration limits and waste form limitations) have been developed for the ERDF. This document provides the primary requirements that waste must meet in order to be accepted at ERDF. At a minimum, the waste generated from the construction and operation of the P&T system must not contain free liquids or exceed toxic characteristic leaching procedures levels listed in WCH-191.	DOE/RL-96-84, Rev. 0 (A1.4)	Active	Section 5.3
394	Cw	Waste that has been designated will be kept separate from undesignated waste or waste assigned a different designation. Radioactive waste will be segregated from nonradioactive waste. Waste container tracking and traceability will be controlled through the Hanford Site Solid Waste Information Tracking System.	DOE/RL-99-51, Rev. 1 (C.4)	Active	Section 5.3
395	Cw	Waste will be designated using process knowledge, historical analytical data, or analyses of samples generated during the ISRM implementation. The waste will be designated in accordance with BHI-FS-03, *Field Support Waste Management Instructions*, Procedure W-002, "Waste Certification," as amended. The appropriate disposal option will be based on the waste designation.	DOE/RL-99-51, Rev. 1 (C.3)	Complete	Requirement not carried forward; ISRM implementation complete
396	Cw	Wastewater (purgewater) generated during the injection process must be extracted from the injection/withdrawal well.	DOE/RL-99-51, Rev. 1 (2.3.1.3)	Complete	Requirement not carried forward - ISRM implementation complete
397	A	Prior to using any new chemical, an evaluation will be made to demonstrate that the chemical will not result in a violation of a DWS or otherwise adversely affect the beneficial use of the groundwater.	DOE/RL-96-84, Rev. 0 (A1.1)	Active	Section 2.5

Note: Access is a registered trademark of Microsoft Corporation, Redmond, Washington. Hach is a copyright of the Hach Company, Loveland, Colorado.

a. Categories are as follows:

RAOs – A

Reporting Requirements – B

Design, Construction, and Performance – C (general); Ca (sampling and analysis); Cd (construction design); Cp (performance); Cr (resources); Cw (waste)

b. A table or figure citation reference is to the document cited for the requirement.

c. Documents include the following:

DOE/RL-96-84, Rev. 0, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*.

DOE/RL-96-84, Rev. 0-A, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*.

Table A-2. Summary of Previous Planning Document Requirements

Number	Category[a]	Requirement[b]	Document/Section[c]	Status	RD/RAWP Location

DOE/RL-96-90, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*.

DOE/RL-99-51, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*.

ERC = environmental restoration contractor

IRM = interim remedial measure

ISRM = in situ redox manipulation

SAF = sampling analysis form

This page intentionally left blank.

A4 References

11-AMCP-0002, 2010, "Non-Significant Change for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision, Hanford Site, Washington July 2010, Memo to File Regarding: Supplemental Actions for the In-Site Reduction/Oxidation Manipulation Barrier Performance for the 100-HR-3 Groundwater Operable Unit Interim Remedy" (letter to J.A. Hedges, Washington State Department of Ecology, and D.A. Faulk, U.S. Environmental Protection Agency from R.A. Holten), U.S. Department of Energy, Richland Operations Office, Richland, Washington, October 26. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1011290677.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml.

40 CFR 144, "Underground Injection Control Program," Subpart B, "General Program Requirements" *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/xml/CFR-2010-title40-vol22-part144-subpartB.xml.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300.xml.

300.440, "Procedures for Planning and Implementing Off-Site Response Actions."

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300-appB.xml.

49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol2/xml/CFR-2009-title49-vol2-part171.xml.

49 CFR 172, "Transportation," "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol2/xml/CFR-2009-title49-vol2-part172.xml.

49 CFR 173, "Transportation," "Shippers—General Requirements for Shipments and Packagings," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2009-title49-vol2/xml/CFR-2009-title49-vol2-part173.xml.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

Section 121(d), "Cleanup Standards," "Degree of Cleanup."

DOE-EH-0256T, 1994, *Radiological Control Manual*, Rev. 1, Assistant Secretary for Environment, Safety and Health, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1990, *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA02406712.

DOE/RL-96-84, 1996, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196246917.

DOE/RL-96-84, 2003, *Remedial Design and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action*, Rev. 0-A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196246917. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1348764.

DOE/RL-96-90, 1997, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D197194770.

DOE/RL-99-51, 2000, *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 Groundwater Operable Unit In Situ Redox Manipulation*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D8373878.

DOE/RL-2001-41, 2014, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*, Rev. 7, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0085328.

DOE/RL-2003-63, 2004, *Sampling and Analysis Plan for In Situ Redox Manipulation Project*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D6455099.

DOE/RL-2010-95, 2014, *Remedial Investigation/Feasibility Study for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0090581.

DOE/RL-2013-13, 2013, *Calendar Year 2012 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump-and-Treat Operations, and 100-NR-2 Groundwater Remediation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087503.

DOE/RL-2013-30, 2014, *Sampling and Analysis Plan for the 100-HR-3 Groundwater Operable Unit*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082922H.

DOE/RL-2013-35, 2013, *100-HR-3 Groundwater Operable Unit Well Installation Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087915.

DOE/RL-2013-49, 2014, *100-HR-3 Pump-and-Treat System Operations and Maintenance Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082920H.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 2012, "Inter-Agency Management Integration Team (IAMIT) Meeting Minutes," Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, January 26. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1202221574.

Endangered Species Act of 1973, Pub. L. 93-205, as amended, 7 USC 136, 16 USC 1531, et seq. Available at: http://www.nmfs.noaa.gov/pr/pdfs/laws/esa.pdf.

EPA, Ecology, and DOE, 2002, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D9192299.

EPA, Ecology, and DOE, 2009, *Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Action Record of Decision: Hanford Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096029.

EPA/AMD/R10-00/122, 2000, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/a1000122.pdf.

EPA/ESD/R10-03/606, 2003, *Explanation of Significant Difference for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Washington State Department of Ecology, and U.S. Department of Energy, Seattle, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/e1003606.pdf.

EPA/ROD/R10-96/134, 1996, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1096134.pdf.

Lee, T.A. and R.F. Raidl, 2000, "Fall 1999 Aquifer Sampling Tube Results at the 100 Area and Hanford Townsite Shoreline" (Environmental Restoration Contractor Interoffice Memorandum No. 078404 to Bechtel Hanford, Inc., Richland, Washington), CH2M HILL Hanford, Inc., Richland, Washington, May.

PNNL-11573, 1997, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1659822.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

WAC 173-162, "Regulation and Licensing of Well Contractors and Operators," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-162.

WAC 173-201A-240, "Water Quality Standards for Surface Waters of the State of Washington," "Toxic Substances," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-240.

WAC 173-216, "State Waste Discharge Permit Program," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-216.

WAC 173-218, "Underground Injection Control Program," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-218.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

303-070, "Designation of Dangerous Waste."

303-630, "Use and Management of Containers."

WAC 173-304-430, "Minimum Functional Standards for Solid Waste Handling," "Surface Impoundment Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/wac/default.aspx?cite=173-304-430.

WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/wac/default.aspx?cite=173-340-720.

WAC 173-400-040, "General Regulations for Air Pollution Sources," "General Standards for Maximum Emissions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-400-040.

WAC 246-247, "Radiation Protection—Air Emissions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-247.

WCH-191, 2015, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080195H.

Appendix B

DX and HX Design Documents

This page intentionally left blank.

Contents

SGW-40243, Rev. 4, 2010, *Functional Design Criteria for the 100-DX Pump and Treat System*

SGW-43616, Rev. 4, 2011, *Functional Design Criteria for the 100-HX Pump and Treat System*

This page intentionally left blank.

SGW-40243
Revision 4

Functional Design Criteria for the 100-DX Pump and Treat System

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

SGW-40243
Revision 4

EDC #: ECR-10-000453

Functional Design Criteria for the 100-DX Pump and Treat System

Document Type: FDC Program/Project: S&GW

M. A. Przybylski
ARES

A. L. Esparza
Fluor Government Group

Date Published
June 2010

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

JUN 17 2010 (27)
DATE:
STA:
HANFORD RELEASE
ID:

Release Approval 6/14/2010 Date

Release Stamp

Approved for Public Release;
Further Dissemination Unlimited

SGW-40243
Revision 4

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Total Pages: 72

CHPRC RECORD OF REVISION (ROR)	(1) Document Number SGW-40243	Page 1 of 2

(2) Title
Functional Design Criteria for the 100-DX Pump and Treat System

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release (5) DA/TA	Date
RS 4	Changed talbe 1-1 value to read 20 ppb at the injection well, updated the amount and type of water being transferred between HX and DX, and added a reference to document SGW-40044 ECR-10 0003453	A.L. Engel for M.A. Przybylski	6-14-10

A-6004-786 (REV 1)

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 BACKGROUND 1-2
1.2 FACILITY TYPE 1-4
1.3 SCOPE, MISSION, AND PERFORMANCE SUMMARY 1-4
1.4 SITE LOCATION 1-6
1.4.1 Treatment Facility 1-6
1.5 PROJECT INTERFACES 1-8
1.5.1 Organizational and Physical Interfaces 1-8
1.6 ANTICIPATED DESIGN / CONSTRUCTION SCHEDULE 1-9
1.7 METHOD OF PERFORMANCE 1-9

2.0 FUNCTIONS 2-1
2.1 PROCESS PRODUCTION RATES AND CHEMICAL END STATES 2-1
2.2 OPERATIONAL EFFECTIVENESS REQUIREMENTS AND AVAILABILITY 2-2
2.3 PREFERRED TECHNOLOGY AND JUSTIFICATION 2-2
2.4 SAFETY 2-3
2.5 UNIQUE ENVIRONMENTAL PROTECTION REQUIREMENTS 2-3
2.6 WASTE ACCEPTANCE CRITERIA 2-4
2.7 TESTING AND INSPECTION REQUIREMENTS 2-4
2.8 DESIGN LIFE 2-5
2.9 SPECIAL OPERATION AND MAINTENANCE REQUIREMENTS 2-5
2.10 SPECIAL SAFEGUARDS AND SECURITY REQUIREMENTS 2-6
2.11 CHEMICAL STORAGE 2-6

3.0 PROJECT INPUTS 3-1
3.1 EXISTING SSCS TO BE MODIFIED 3-1
3.2 SYSTEM DESCRIPTION 3-1
3.3 SYSTEM OPERATION 3-2
3.4 SAFETY BASIS 3-2
3.5 DESIGN ASSUMPTIONS AND ASSOCIATED RISKS 3-2
3.6 CONSTRAINTS 3-3

4.0 DESIGN CRITERIA 4-1
4.1 GENERAL CRITERIA 4-1
4.1.1 Quality Assurance Requirements for Design 4-1
4.1.2 Additional Criteria 4-2
4.1.3 Flexibility and Future Expansion 4-5
4.1.4 Natural Phenomena Hazards Criteria 4-6
4.1.5 Materials of Construction and Protective Coatings 4-6
4.1.6 Human Factors 4-7
4.1.7 Fire Protection 4-7
4.1.8 Cleanliness and Foreign Material Exclusion 4-8
4.2 PROCESS DESIGN CRITERIA 4-8

4.2.1 Process Design and Operating Limits 4-8
4.2.2 Mechanical/Piping 4-9
4.2.3 Electrical 4-10
4.2.4 Process Control and Instrumentation 4-12
4.2.5 Process Data 4-15
4.2.6 Process System Structural 4-15
4.2.7 Design criteria for the supports and attachments of nonstructural components (pipe supports, electrical equipments and other items) shall be per IBC 2006, as outlined in Section 4.1.4. Expansion anchors shall use any industry standard wedge-type expansion anchor having capacities published by the International Code Council Evaluation Service (ICC-ES) and approved for resistance to wind and seismic loading.General Process Criteria 4-15
4.3 FACILITY DESIGN CRITERIA 4-16
4.3.1 General 4-16
4.3.2 Architectural and Civil/Structural 4-17
4.3.3 Heating, Ventilation and Air Conditioning 4-19
4.3.4 Utilities 4-20
4.4 GENERAL REQUIREMENTS 4-20
4.4.1 Equipment and Instrument Identification and Labeling 4-21
4.5 DECONTAMINATION AND DECOMMISSIONING 4-22

5.0 CODES AND STANDARDS 5-1
5.1 ARCHITECTURAL/CIVIL/STRUCTURAL 5-1
5.2 MECHANICAL 5-2
5.3 ELECTRICAL 5-3
5.4 WASHINGTON STATE CODES 5-3
5.5 FEDERAL CODES 5-4

6.0 REFERENCES 6-1

APPENDICES

Attachment A ..... A-i

FIGURES

Figure 1-1. Hanford Site 1-2

TABLES

Table 1-1. 100-DX Design Influent and Effluent Concentrations 1-6

TERMS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFDs	Adjustable Frequency Drives
AHJ	Authority Having Jurisdiction
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirement
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
AWWA	American Water Works Association
BOP	balance of plant
CAT	Construction acceptance test
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
CMAA	Crane Manufacturer's Association of America
COC	constituent of concern
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EIA	Electronic Industries Association
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FBR	fluidized bed reactor
FDC	Functional Design Criteria
FHA	Fire Hazards Analysis
FME	foreign material exclusion
FRP	fiber reinforced plastic
HC	Hazard Category
HDPE	high-density polyethylene

HMI	human-machine interface
HVAC	heating, ventilation, and air conditioning
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IMC	International Mechanical Code
IRM	interim remedial measure
ISA	Instrument Society of America
IX	ion exchange
MCL	maximum contaminant level
MNA	Monitored Natural Attenuation
NAAMM	National Association of Architectural Metal Manufacturers
NCP	National Contingency Plan
NCR	nonconformance report
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Agency
NPL	National Priorities List
NRTL	nationally recognized testing laboratory
OSHA	Occupational Safety and Health Administration
OTP	Operational test procedure
OU	Operable Unit
P&ID	process and instrumentation diagram
PC	Performance Category
PFHA	Preliminary Fire Hazards Analysis
PLC	programmable logic controller
PPE	personal protective equipment
PSIG	Pound per square inch
PVC	Poly(Vinyl Chloride)
QAPP	Quality Assurance Program Plan
RAM	reliability, availability and maintainability
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Revised Code of Washington

RD/RA	remedial design/remedial action
RFAR	Radio Fire Alarm Reporter
ROD	Record of Decision
RPO	Remedial Process Optimization
RTO	regenerative thermal oxidizer
S&GRP	Soil & Groundwater Remediation Program
SARA	Superfund Amendments and Reauthorization Act of 1986
SCMP	software configuration management plan
SDD	system design description
SDI	Steel Deck Institute
SGRP	Soil and Groundwater Remediation Project
SSC	structures, systems, and components
TAP	toxic air pollutant
T-BACT	toxics best available control technology
TCE	Trichloroethylene
TM	Technical Memorandum
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPS	uninterruptible power supply
USC	United States Code
WMA	Waste Management Area
WSDOT	Washington State Department of Transportation

SGW-40243, Rev. 4

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
Inches	25.40	millimeters	millimeters	0.0394	inches
Inches	2.54	centimeters	centimeters	0.394	inches
Feet	0.305	meters	meters	3.281	feet
Yards	0.914	meters	meters	1.094	yards
Miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	Ounces
pounds	0.454	kilograms	kilograms	2.205	Pounds
ton (short)	0.907	ton (metric)	ton (metric)	1.102	ton (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	Pints
fluid ounces	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts	0.946	liters	cubic meters	1.308	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Celsius	Celsius	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
Picocuries	37	millibecquerel	millibecquerel	0.027	Picocuries

This page left intentionally blank.

1.0 INTRODUCTION

This document is the Functional Design Criteria (FDC) for the new 100-DX Pump and Treat System for the 100-HR-3 Groundwater Operable Unit (OU), located adjacent to the Columbia River in the northeast corner of the Hanford Site in southeastern Washington State (Figure 1-1). This FDC provides the fundamental technical criteria and design requirements necessary for remedial design of this project to meet the cleanup goals established for the OU as specified in the *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units at the Hanford Site (Interim Remedial Action)* (referenced from here on out as the Interim Record of Decision [ROD]).

The three subsystems for the 100-DX Pump and Treat System addressed by this FDC are as follows:

1. The Treatment Facility, which is to be centrally located with respect to the location of the extraction and injection wells, will house all of the process treatment equipment as well as the control system for the project.

2. The injection and extraction wells.

3. The balance of plant (BOP) that includes the well pumps, network and associated Transfer Buildings with transfer pumps to pump the contaminated well water to the Treatment Facility. The Treatment Facility will then pump the treated water to the injection wells.

Criteria for design, drilling, and installation of the injection and extraction wells are not in the scope of this document beyond stating that each extraction well is designed to provide the nominal flow rates presented in Appendix A.

This FDC was prepared following the guidance of HNF-PRO-8258, *Functional Design Criteria,* and HNF-GD-8004, *Functional Requirements Document.* In addition, the 100-KR-4 and 100-KX Expansion Project criteria, and experiences gained from those projects, provided the basis for design criteria used in this functional design criteria document.

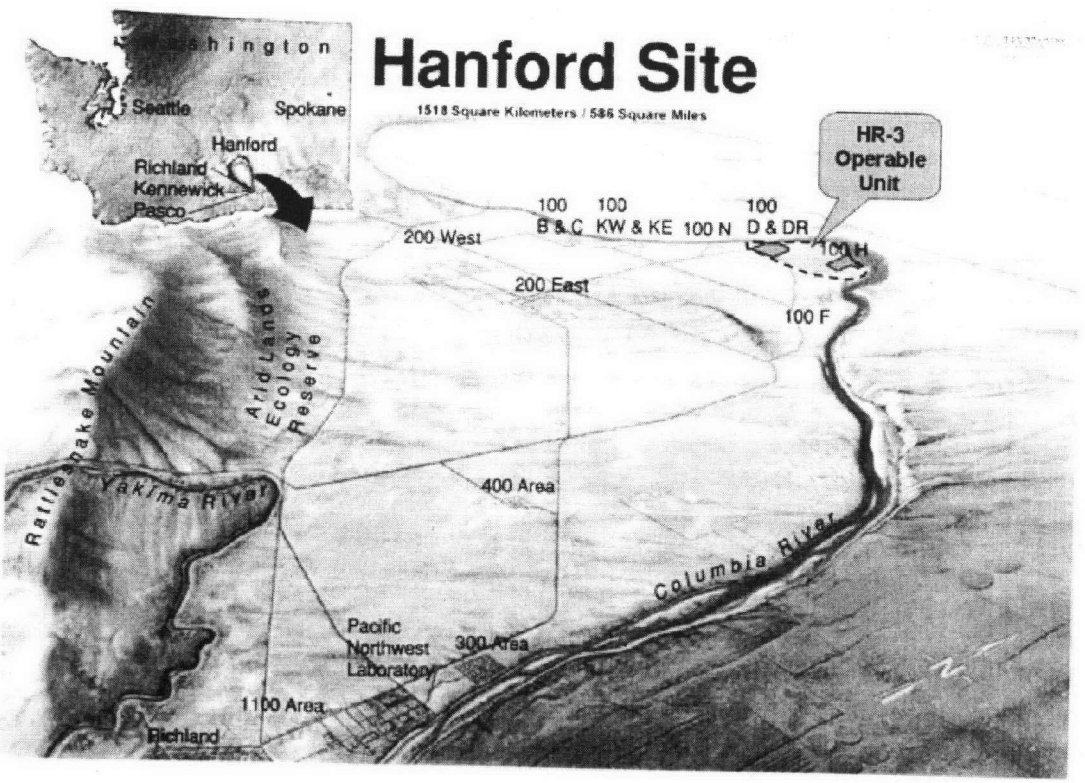
The use of "shall", "will", "should" and "may" in this document is as follows:

- Whenever the word "shall" appears, it shall be interpreted to mean that the requirements are binding.
- The words "will", "should" and "may", shall be interpreted as non-mandatory provisions.
- The word "will" is used to express declaration of purpose or simple futurity.
- The word "should" is used to express non-mandatory desired or preferred method of accomplishment.
- The word "may" is used to express an acceptable or suggested means of accomplishment.

1.1 BACKGROUND

The U.S. Department of Energy's (DOE's) Hanford Site is a 1,517-km^2 (586-mi^2) Federal facility located in southeastern Washington State along the Columbia River (see Figure 1-1). The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area commonly known as the Tri-Cities. This region includes the incorporated cities of Richland, Pasco, and Kennewick, as well as surrounding communities in Benton, Franklin, and Grant counties. For administrative purposes, the Hanford Site was divided into four National Priorities List (NPL) (Title 40, Protection of Environment, *Code of Federal Regulations* [CFR], Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300], Appendix B) sites under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), one of which is the 100 Area. The CERCLA site identification number for the 100 Area is WA3890090076.

Figure 1-1. Hanford Site



The contaminated groundwater in the 100 Areas reactor sites has been grouped into five operable units, specifically; the 100-HR-3 Groundwater OU includes the 100-D/DR and 100-H reactor sites. Hexavalent chromium (Cr[VI]) is the primary contaminant of concern in groundwater beneath the 100-D Area, which comprises the west part of the operable unit (100-HR-3-D). The 100-D Area encompasses the operating areas of two former DOE production reactors (the former D and DR reactors). While these reactors were operational, large volumes of river water were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as a coolant for the reactors. After a single pass through the reactor and before being discharged back to the river, the coolant water was sent to unlined retention basins to cool and so the short-lived radioactive contaminants would decay. This approach to reactor cooling led to the introduction of large volumes of process water contaminated with low concentrations of hexavalent chromium into the vadose zone, and ultimately into the groundwater aquifer and adjacent Columbia River. In addition, numerous leaks and spills of concentrated sodium dichromate stock solution over the lifetime of reactor operations led to higher concentrations of chromate in the vadose zone and ground water in localized areas. Chromium is distributed in north and southwest plumes and other contaminant plumes include tritium, nitrate, and sulfate in the same general area.

As a result of the discharge of groundwater from the operable units into the river, chromium, a metal that is toxic to aquatic organisms in low concentrations, poses a risk to aquatic organisms in the Columbia River adjacent to the 100D/DR, 100-H and 100-K Areas. The most toxic form of chromium, hexavalent chromium, readily dissolves in water and, therefore, moves freely with groundwater. Hexavalent chromium has been detected in groundwater and in the groundwater/river interface where groundwater upwells into the river. Once discharged into the river, it is easily assimilated by aquatic organisms, some of which are adversely affected.

In order to mitigate the impacts of contamination at the 100-D Area to human health and the environment, both in situ and ex situ remedial actions have been implemented in an attempt to achieve the following remedial action objectives (RAOs) specified in the Interim ROD:

- RAO #1: Protect aquatic receptors in the river bottom substrate from contaminants in ground water entering the Columbia River.
- RAO #2: Protect human health by preventing exposure to contaminants in the groundwater.
- RAO #3: Provide information that will lead to the final remedy.

Basis: Interim ROD Section VII.

Roughly 50 gpm of contaminated groundwater in the 100-D Area is being treated by ion-exchange at the 100-DR-5 treatment plant. An additional 95 gpm of groundwater extracted from the 100-D Area is transported to the HR-3 ion-exchange treatment plant located in the 100-H Area. An *in situ* redox manipulation barrier (ISRM) was completed in 2003 to intercept and passively treat the elevated Cr(VI) concentrations migrating to the river in the southern part of the 100-D Area. Owing to the large size of the plume and the likely presence of continuing

contamination sources in the vadose zone, the existing remedial actions have not significantly reduced the concentrations of Cr(VI) in the groundwater of the 100-D Area.

1.2 FACILITY TYPE

1.2.1 Treatment Facility

Construction Type: Type IIB non-combustible
International Building Code (IBC), Section 602.2, Table 601)

Occupancy Classification (mixed use occupancy):

The Occupancy Classification of specific rooms of the Treatment Facility in accordance with IBC Chapter 3 will be determined during remedial design phase. The goal will be to arrange and manage chemicals in the facility to keep the Occupancy Classification as low as possible.

Special Purpose Industrial Occupancy, per National Fire Protection Agency (NFPA) 101, *Life Safety Code.*

1.2.2 Transfer Buildings

Construction Type: Type IIB non-combustible
IBC, Section 602.2, Table 601

Occupancy Classification:

The Occupancy Classification of the Transfer Buildings in accordance with IBC Chapter 3 will be determined during the design phase. The goal will be to arrange and manage chemicals in the facility to keep the Occupancy Classification as low as possible. The Transfer Buildings are not normally occupied.

Special Purpose Industrial Occupancy, per NFPA 101, *Life Safety Code.*

1.2.3 Facility Hazard Category

The 100-DX Pump & Treat Facility has been categorized as less than *Hazard Category (HC)-3.* This includes all facilities and systems associated with 100-DX Pump & Treat. See FDC Section 3.4 (Safety Basis).

All facilities and systems will be General Service.

1.3 SCOPE, MISSION, AND PERFORMANCE SUMMARY

Contaminated groundwater in the 100-D Area is currently being treated by two pump and treat systems (DR-5 and HR-3) and in situ by an ISRM. These treatments are not significantly

reducing the concentrations of hexavalent chromium and are unlikely to prevent contamination of the Columbia River. Therefore, the goal of this project is to accelerate remediation of the 100-D Area by adding pump and treat capacity to provide plume control. The additional capacity will serve to remove contaminant mass from the groundwater in order to achieve the remedial action objectives and remedial milestones for the site, as summarized below:

- Immediately protect the river (aquatic receptors) by 2012.
- Clean up the bulk of the groundwater by 2020.

Regulatory criteria in the Amended ROD require the following:

"The treatment goal of the project is to reduce effluent chromium concentrations to the maximum extent possible; however, treated groundwater above 50 μg/L chromium will not be discharged to the injection wells. Because it is impractical to routinely monitor chromium concentrations at aquatic receptor exposure points, onshore monitoring of groundwater near the river has been used to assess the effectiveness of the treatment. Based on a preliminary dilution factor of 1:1 between the compliance wells and the river, a remediation goal of 22 μg/L was established (i.e., a 22 μg/L hexavalent chromium concentration in near-river compliance monitoring wells is considered to be equivalent to 11 μg/L at the location of the aquatic receptors)." **Basis**: Amended ROD, Section III.

The 100-DX treatment system shall be designed to capture and treat contaminated groundwater to reduce the effluent concentration of the hexavalent chromium to less than 20 μg/L at compliance monitoring locations to achieve 10 μg/L at the river using the preliminary dilution factor of 1:1. **Basis:** Amended ROD, Section V. The chronic ambient water quality standard (WAC 173-201A-040) reduced Cr(VI) values from 11 μg/L to 10 μg/L.

The 100-DX Pump and Treat System will be physically independent of the existing DR-5 and HR-3 groundwater treatment systems.

Hexavalent chromium is the only constituent requiring removal. Although there is no requirement for the removal of co-contaminants for this interim action, monitoring and sampling to include potential co-contaminants will be performed to aid in final remedy selection.

The treated groundwater (meeting the preliminary cleanup level of Table 1-1) will then be returned to the aquifer through injection wells. **Basis:** Interim ROD

Table 1-1. 100-DX Design Influent and Effluent Concentrations

COC	Design Average Influent Concentration	Federal Drinking Water Standard MCL[1]	State[2] Water Quality Standards	Effluent Concentration
Non-Radionuclides				
Hexavalent chromium	500 µg/L	N/A	10 µg/L	< 20 µg/L (at compliance wells) < 20 µg/L (at injection)
Nitrate (as Nitrogen)	< 10 mg/L	10 mg/L	N/A	< 10 mg/L
Radionuclides				
Strontium-90	6 pCi/L	8 pCi/L	8 pCi/L	8 pCi/L
Technetium-99	12 pCi/L	900 pCi/L	900 pCi/L	900 pCi/L
Tritium	6,500 pCi/L	20,000 pCi/L	20,000 pCi/L	20,000 pCi/L
Uranium (total)	1.5 pCi/L	30 µg/L	30 µg/L	30 µg/L

NOTES:
1. 40 CFR 141 (Primary MCL = maximum contaminant level).
2. Water Quality Standards for Surface Waters of the State (chronic value).

The construction, startup and operation of the 100-DX Pump and Treat System will be done in a single phase. Depending on facility and well field performance, additional phases may be conducted to facilitate chromium removal, including well realignment, plant modifications to improve performance, incorporation of bioremediation, etc.

1.4 SITE LOCATION

1.4.1 Treatment Facility

The Treatment Facility will be centrally located with respect to the extraction and injection wells. The facility will house all the process treatment equipment as well as control systems for the project.

The site selected for the Treatment Facility is on the corner of Palouse Street and D Avenue in the 100-D Area. A sketch of the location is provided in Figure 1-3. The final site location for the transfer buildings will be confirmed/determined during the early stages of the remedial design.

1.4.2 Wellfield

The results of the 100 D Area RPO effort, SGW -40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater in the 100-HR-3 Operable Unit in Support of Remedial Process Optimization*, recommended the installation of new extraction and injection wells to

ensure maximized hydraulic capture of the dissolved hexavalent chromium plume and protect the river (aquatic receptors) by the year 2012.

Since the size and influence of the various 100 Area groundwater P&T remedies has increased through time, recent efforts have focused on the development of a single flow model that encompasses these various P&T remedies and can be used to support decisions at each of the 100-K, N, D and H Areas. **Basis**: SGW-40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater in the 100-HR-3 Operable Unit in Support of Remedial Process Optimization.*

Table A-1 provides a comprehensive list of all existing and proposed wells with respect to the RPO design; immediate goals related to system operation under the maximized capacity; and/or projected well operation for attainment of aquifer cleanup by 2020. Specifically, Table A-1 lists the following information:

a) The names and geographic coordinates of the wells;

b) The corresponding plume (i.e. 100-D North or South);

c) Primary function (extraction/injection);

d) Pumping rates as determined for attainment of the 2012 RPO goals;

e) The well casing sizes;

The actual locations may need to be adjusted in the field to accommodate interference from utilities, roads, waste management units, buildings, on-going soil remediation activities, and other practical considerations and may also be adjusted based on numerical groundwater modeling as design and operations proceed. If further adjustment moves these wells outside the numerical model cell they were located in, then the numerical model shall be evaluated to confirm the location for its adequacy.

Monitoring shall be conducted to evaluate the performance of the 100-DX Pump and Treat System. Monitoring well locations are designed and operated to demonstrate whether or not the 100-DX Pump and Treat System is attaining aquifer cleanup goals.

Flow-path control is also required and shall be achieved by injecting the treated groundwater into the aquifer to the southeast and northwest of the groundwater contamination (see Table A-1 well locations) such that the treated injected water in these locations will slow the natural westward flow of most of the groundwater and, as a result, keep COCs within the capture zone, as well as increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

The output from extraction wells may be pumped to an Extraction Transfer Building(s), (as determined during remedial design by pipeline pressure limitation, pump performance or operational factors), for accumulation and pumping to the Treatment Facility. Also, depending upon well proximity to the Treatment Facility, some wells may be piped directly to the facility. The size, number, and location Transfer Buildings will be determined during remedial design with the goal being to minimize the total cost of pipe and pumping equipment. The output from the Treatment Facility will be split up and pumped directly to the individual injection wells.

1.5 PROJECT INTERFACES

Both organizational and physical interfaces are defined in the following subsection.

1.5.1 Organizational and Physical Interfaces

Organizational interfaces are defined in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System*.

Access Roads –

Existing roads shall be used in lieu of developing new roads, as practicable. Where new roads are required, such as to transfer buildings, wells, and the treatment facility, their layout shall minimize disturbance of the site.

Communications –

Communications shall be provided by and coordinated with Lockheed Martin Information Technology. Phone and Hanford Local Area Network (HLAN) services will be provided in the Treatment Facility. The SCADA system will be connected to the groundwater engineering network.

Electrical –

Tie-ins to existing electrical utilities shall be coordinated and approved by the site electrical utilities organization.

Site –

The site location is as described in Section 1.4. Where possible the Treatment Facility location and pipeline routes will be selected to minimize disturbance of existing plant life and wildlife resources. Coordination with cultural and natural resource management personnel shall be performed as part of site selection and excavation processes.

Existing Remediation Projects –

The 100-D Area has numerous remediation efforts currently underway. Coordination with 100-D Area project work from other Contractors shall be performed as part of the site selection process.

Other –

No connections to raw water, sanitary water or sewer systems are required.

1.6 ANTICIPATED DESIGN / CONSTRUCTION SCHEDULE

The project schedule for design and construction is contained in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System.*

1.7 METHOD OF PERFORMANCE

The method of performance for the project is contained in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System.*

This page left intentionally blank.

2.0 FUNCTIONS

2.1 PROCESS PRODUCTION RATES AND CHEMICAL END STATES

Projected total groundwater extraction in 100-D Area is approximately 560 gpm, see Table A-1; however, to afford contingency for operations and system optimization, the remedial design shall include all the process unit operations required to treat a sustained flow of groundwater from the 100-D Area at a maximum rate of 600 gpm.

The actual production rate at each well will depend on hydrogeologic factors, well screening, etc. Each of the extraction and injection wells will have a minimum and maximum flow rate as shown in Table A-1. **Basis:** SGW-40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater In The 100-HR-3 Operable Unit In Support of Remedial Process Optimization*. Decisional Draft A, Received 4/10/09. **Basis:** To provide a basis for flexibility in pump sizing and operation of the treatment facility.

To account for future throughput (up to the 600 gpm), up to 9 additional penetrations and influent connections on the influent tank shall be provided at the treatment facility; each line thereby capable of providing 15 gpm.

To compensate for system downtime for planned and unplanned maintenance, and to allow additional flexibility in the system, the treatment facility shall be designed with six IX treatment trains (four IX vessels per train) with each train having a design maximum flow rate of approximately 100 gpm, to achieve a total peak production capacity of 600 gpm. **Basis:** SGW-40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater In The 100-HR-3 Operable Unit In Support Of Remedial Process Optimization.*

Each train shall be capable of operating continuously between 50 percent and 100 percent of maximum design flow rate (50 gpm to 100 gpm) to accommodate variations in well pump operation.

The minimum and maximum flow rates for injection wells are shown in Table A-1. Injection well spares shall be provided in the treatment facility effluent piping manifold. The range of flows through the spare injection connections is 30 to 50 gpm.

The 100-DX treatment shall be designed to accommodate an additional up to 150 gpm of treated well water, which is received via a pipeline(s) from the 100-HX (100-H Area) Pump and Treat System.

Following treatment in the process facility, the water shall meet the preliminary cleanup level requirement of Table 1-1 prior to re-injection into the ground water through the injection wells. **Basis:** Interim ROD

A recirculation line shall be installed at the effluent tank such that treated groundwater that does not meet the preliminary cleanup level requirement of Table 1-1 prior to re-injection during start-up or system testing and optimization may be reprocessed. It is anticipated that this feature will be used during plant startup and during resolution of upset conditions. This line does not need to

be sized to flow the maximum flow rate of 600 gpm. **Basis:** Process design and the need to assure groundwater meets specifications prior to re-injection.

Treated water shall have neutral pH (6.5 to 8.5) and be essentially particulate- and foulant-free to avoid scaling or plugging the injection wells. The treated injection stream shall be no lower than a pH of 6.5. **Basis:** Past project experience. WMP-30899, "Design Criteria for the 100-K Expansion Pump and Treat."

2.2 OPERATIONAL EFFECTIVENESS REQUIREMENTS AND AVAILABILITY

The extraction and treatment system shall be designed to run on a continuous basis such that routine procedures such as resin changes and mechanical maintenance can be conducted with minimal impact to system operations. **Basis**: ROD. The 100-DX Pump and Treat System will not incorporate redundancy, but equipment selection will be such to provide a high overall system availability goal without providing redundancy of all systems. However, transfer pumps within the facility shall have redundancy, e.g, two pumps running and one installed spare. **Basis:** Experience with current systems.

The 100-DX facility will operate twenty-four hours per day, seven days per week, unattended after start-up and stabilization, excepting during routine surveillance and operation cycles, effluent sampling, and maintenance.

2.3 PREFERRED TECHNOLOGY AND JUSTIFICATION

As stated previously in Section 1.3, the selected remedy for the 100-HR-3 Groundwater OU in accordance with the Interim ROD is, "Pump-and-Treat, Flow-Path Control, and Institutional Controls."

As recommended by the resin evaluation "Report on Resin Evaluations to Support DX Treatment System", SGW-41642, dated August 2009 the preferred technology will be based on an ion exchange process using a ResinTech SIR-700 granular or WBG30-B spherical disposable resin. The resin will be used for start-up, and the facility will be modified after start-up to optimize using this resin. In the unlikely event that the operational issues cannot be resolved for ResinTech SIR-700 during start-up phase, Purolite A500 with off-site regeneration will be used. To facilitate the capability of handling the SIR-700 resin or Purolite A500 resin with off-site regeneration in the future, the following will be accommodated in the design.

- Materials of construction capable of handling the pH range of either resin
- IX vessel diffusers capable of handling both types of resins
- Install points of connection for a system supporting the removal of the SIR-700 resin from the IX vessels
- Design overall pressure drops to accommodate both types of resin

- Install points of connection to allow the automated adjustment of pH prior to treatment and discharge to the influent wells and allowing sufficient space to accommodate the necessary tanks for the associated acid and base for pH adjustment

- Install points of connection to allow for injection of a reagent for reducing Cr(VI) to Cr(III) prior to removal from the IX vessels

The ion exchange vessels will be similar to existing columns in the KX facility. The vessels and facility will be designed to accommodate conversion to Purolite A500 resin in the future. All aspects of vessel conversion to Purolite A500 are to be addressed, including but not limited to materials of construction, instrumentation, distributor design etc. as described above.

Energy savings principles that apply executive order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, shall be incorporated into the design and shall be documented.

2.4 SAFETY

The 100-DX Pump and Treat System shall be assessed as to whether 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," requirements are applicable due to the presence of hazardous chemicals. If applicable, then the requirements shall be complied with. **Basis:** 29 CFR 1910.119.

Eye wash station(s) and safety shower(s) shall be located in the Treatment Facility where the eyes or body of any person may be exposed to injurious corrosive materials in accordance with 29 CFR 1910.151, "Medical Services and First Aid." Access to eyewash and showers shall be unrestricted. **Basis:** 29 CFR 1910.151

The design of the facility shall include fixed ladders, stairs, and platforms wherever possible to do so. Space shall be provided for scaffolding or rolling ladders around equipment to permit maintenance activities. Space the trains far enough apart to allow the rolling platforms to easily pass between trains. The design of the facility shall be such as to avoid the use of portable ladders during maintenance. **Basis**: CH2M-Hill Plateau Remediation Company (CHPRC) ladder policy.

Allow sufficient safe clearances for aisles, at loading docks, through doorways. Minimize overhead obstructions which could create head bumping hazards. Other Occupational Safety and Health Administration (OSHA) regulations shall be complied with as applicable in accordance with 29 CFR 1910.

2.5 UNIQUE ENVIRONMENTAL PROTECTION REQUIREMENTS

The project shall seek to minimize the impact of existing plant and wildlife resources through the site selection process. It is preferred that only previously disturbed habitat will be used for siting of structures, systems, and components (SSC) where possible. Where undisturbed habitat must

be used, the footprint will be limited and appropriate Biological, Ecological, and Cultural Resource Reviews will be conducted.

The S&GW program will coordinate and implement reviews of culturally sensitive sites through the site selection/evaluation process, which may result in relocation of some structures.

Basis: Interim ROD.

Construction and operation of the new Treatment Facility should not interfere with ongoing/future remediation of wastes sites in the vicinity. **Basis:** HNF-RD-15332, *Environmental Protection Requirements,* and HNF-PRO-15333, *Environmental Projection Processes.*

2.6 WASTE ACCEPTANCE CRITERIA

Treatment facility solid waste (sludge, spent ion exchange resin if disposable resin is used or resin is past its useful life, and miscellaneous solid waste) requiring ERDF disposal shall meet WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria.* Additional criteria for smearable surface contamination fixed contamination, and activity levels are described in 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for the Environmental Restoration Disposal Facility.* **Basis:** Interim ROD

Other wastes such as paint, epoxies and expired glues shall be incorporated into waste acceptance plans. Treatment facility liquids generated from well surging, development, and sampling shall be disposed at the modular tanks or at the Effluent Treatment Facility (ETF). The ETF waste acceptance criteria is defined in HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria.* **Basis**: Interim ROD

Other wastes that meet the criteria for acceptance at a Resource Conservation and Recovery Act of 1976 (RCRA) Subtitle D facility (e.g., construction debris, office waste, excess chemicals) may be disposed of off-site if radiological free-release requirements are met. If waste cannot be free-released it could be managed as the Central Waste Complex (CWC) or disposed at the Low-Level Burial Grounds (LLBG) in accordance with HNF-EP-0063. **Basis**: Interim ROD

Where possible, the treatment process should be designed so hazardous wastes and radioactive wastes are segregated (i.e., avoid generating mixed wastes). A regulator approved waste management plan shall be prepared before treatment facility waste generation activities are conducted.

2.7 TESTING AND INSPECTION REQUIREMENTS

Any unique or special testing requirements shall be identified by engineering as remedial design proceeds.

Factory acceptance tests (FATs) will be conducted as specified by engineering to ensure the systems, structures, and components (SSCs) and software meet certain requirements prior to

shipment. FATs are conducted by the vendor and may be witnessed as desired by engineering or operations representatives, and/or an inspector.

Construction acceptance tests (CATs) will be conducted as specified by engineering to verify proper installation of SSCs and software. Typically, CATs include visual and other non-destructive examination, leak/pressure tests, cleanliness, electrical continuity tests, equipment alignment, motor rotation checks, and verification of component functionality. System functional checks may be specified in lieu of continuity checks. Pressure testing in compliance with ASME B31.3 of the piping and system internal to the facility will be conducted.

Construction acceptance testing is performed by the Construction Contractor in accordance with their procedures to ensure that the construction activities were properly performed in accordance with the design requirements, industry practices, codes and standards, and the quality requirements of the contract. These tests ensure the electrical and mechanical integrity of the new or modified SSCs, and ensure that all equipment was properly installed.

Basis: PRC-PRO-EN- 286, *Testing of Equipment and Systems*

A schedule of inspections shall be determined by engineering as required for facility safety – for example, anchor bolt inspection – as further detailed in General Criteria, Quality Assurance.

Operational testing will be conducted upon successful completion of any CATs and turn-over of the facility to Operations. Operational testing is performed by the Operator with items in their final in-service configuration to verify that functional, operational, and design criteria have been met.

Any additional unique or special testing requirements shall be identified by the design engineering organization as the design proceeds.

2.8 DESIGN LIFE

The design life for the 100-DX Pump and Treat System is 15 years. Replacement of equipment and piping during this period is allowed to meet this goal if life-cycle cost analysis shows it is the lowest cost option of meeting this criterion. **Basis:** Project experience.

2.9 SPECIAL OPERATION AND MAINTENANCE REQUIREMENTS

No special operation and maintenance requirements have been identified during the preparation of this Functional Design Criteria. (Nibco brand PVC valves NOT to be used. Hayward or Spears are acceptable.)

The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate.

Facility and equipment layout and design shall consider the provision of adequate space and means of access to perform maintenance, material handling, and operations. Design shall

consider such items (but not be limited to) change out of ion exchange resin, changing of filters, access to instrumentation, access to valves, pump maintenance, air compressor maintenance, and other activities.

2.10 SPECIAL SAFEGUARDS AND SECURITY REQUIREMENTS

There are no special safeguards and security requirements identified for the 100-DX Pump and Treat System. Security to buildings will be maintained by coded (OMNI) locks. Safeguards and security personnel will participate in design reviews to determine if any additional security measures are required.

2.11 CHEMICAL STORAGE

Space within the facility shall be planned for chemical storage cabinets.

The process shall use acid and caustic. Maximum quantity in the facility at any time must not exceed fifty gallons. The use of acid and other chemicals in regard to concentration, container size, and quantity will be determined during the conduct of the Environmental Preparedness Review. An eye wash station and safety shower shall be provided and located adjacent to the acid work station. An outdoor safety shower shall be provided for the areas that need the acid and caustic tank connections/ delivery locations. The line running from inside the building out shall be insulated and heat traced.

As discussed in Section 2.3, space and points of connection in the effluent and influent tanks will be provide for the future addition of necessary tanks, secondary containment, and associated systems to all for pH adjustment using acid and base to accommodate the SIR-700 resin. Space and points of connection for a reagent used to convert Cr(VI) to Cr(III) will also be provided.

3.0 PROJECT INPUTS

3.1 EXISTING SSCS TO BE MODIFIED

No existing SSCs will be modified by this project with the exception of tie-ins with existing wells, electrical utilities, roads, and communication systems described in Section 1.5.1.

3.2 SYSTEM DESCRIPTION

In order to reduce remedial design costs and expedite the installation of the 100-DX Treatment Facility, the design of the facility will be based, with necessary modifications, on the 600-gpm treatment facility at the 100-K Area (the 100-KX Pump and Treat) that became operational in 2008. The 100-KX treatment system includes:

- Influent groundwater collection
- Acid pH adjustment including automated pH adjustment to reduce the groundwater pH to nominally 5.0.
- A minimum of three parallel process feed pumps (and transfer and injection boost pumps) shall be provided to transfer water to the IX column trains (and influent tanks and injection wells), and shall achieve a maximum flow rate of 600 gpm with one pump shutdown.
- Six, skid-mounted ion exchange treatment trains with four columns/train; the flow through each train is 100 gpm at full system capacity. Refer to Section 2.3 for additional details.
- Ion exchange columns contain ResinTech SIR-700. Backwash and resin sluicing system, with resin tote sump load-in/load-out area to remove resins for off-site regeneration.
- Compressed air system to supply the tote sump diaphragm pump and for operational use throughout the process building
- Caustic addition and pH monitoring of effluent to prevent treated water from being injected into the groundwater if the pH is too low.
- Manual sampling and portable test kits for analysis are used to verify Cr(VI) concentrations on a scheduled basis.
- Treated water storage and AFD controlled injection well booster pumps
- Totes (40 ft^3 each) for resin storage and shipment
- Transfer building(s) to include transfer tank, AFD driven transfer pumps, filters, piping manifold and associated controls

- Extraction wells to include AFD driven well pumps, instrumentation and controls
- Injection wells with level instrumentation

3.3 SYSTEM OPERATION

Each IX skid is configured so that water can flow through any number of columns in any sequence. During normal operation, groundwater flows through the four columns in the following order: lead, lag 1, lag 2, polish. When the Cr(VI) concentration in the effluent from the polishing column reaches 5 µg/L, the lead column is removed from service for resin replacement. At this time, the lag 1 column becomes the lead column, lag 2 column becomes the lag column, and the polish column remains as the polish column. After the resin has been replaced, the former lead column is returned to service as the polish column, the former lag 2 column becomes the lag 1 column, and the former polish column becomes the lag 2 column. Prior to resin removal, treated groundwater is used to backwash the depleted resin to remove fines and to sluice depleted resins into 40-ft^3 totes for shipment off-site. The backwash and sluicing water is collected in a sump and returned to the influent tank The resin in the totes is sampled for radiological analysis and shipped off-site for regeneration.

3.4 SAFETY BASIS

The Hazard Category of the facility is based on DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. The HC is determined in accordance with PRC-PRO-NS-8366.

The 100-DX Pump & Treat Facility sum-of-fractions for the HC-3 threshold is well below unity; therefore, the facility is less than HC-3. This is documented in PRC-PRO-NS-8366, Form B and Form E, which are included in SGW-40201, *Initial Hazard Categorization for the 100 DX Pump and Treat System*.

3.5 DESIGN ASSUMPTIONS AND ASSOCIATED RISKS

It is assumed that the nominal flow rates indicated in Appendix A can be achieved from the extraction wells by increasing the open screen intervals, determining well packing based on the formation, and revised methods of well development. The risk of not meeting the capacity requirements is introduced by the lack of quantitative data on the ability of the aquifer to yield sufficient quantity of groundwater to the extraction wells. This information will not be available until the wells are drilled and tested after the completion of the design. The well design shall be in accordance with standard well completion practices, as well as meeting state requirements for well construction. Well field modifications may include but not necessarily be limited to pump motor size, well locations, number of wells needed to satisfy the operational objectives. These can be a combination of extraction, injection, and monitoring wells.

Well production numbers are estimated and needed for proper pump and pipe sizing. Over or under sizing could cause pipeline freezing or over pressurizing of the pipes. Wells with low

production rates will be monitored and/or shut down during low temperature conditions to minimize potential freezing. Changes to pumps or transfer lines may be required when actual well production is established.

It is assumed that the treatment technologies chosen will treat Cr(VI) at the design influent concentrations with sufficient efficiency to reduce them to the preliminary cleanup levels. Cr(VI) treatment using IX resins has proven successful at currently operational pump and treat facilities.

It is assumed that no backup power supply is required.

3.6 CONSTRAINTS

There will be constraints on the routing of piping and location of road crossings to and from wells, transfer and process facilities. Routing of pipelines will be resolved during remedial design.

Road crossings should be built up on existing roads to the extent possible so that excavation permits are not required. When building up crossings above grade, ensure that carbon steel pipe casings are sufficiently long to prevent sloughed back fill material from entering casing.

Low ambient temperature may require pump systems to be shut-down for a period of time due to potential for line freezing. It may be necessary to wait for higher temperatures to start-up.

This page left intentionally blank.

4.0 DESIGN CRITERIA

4.1 GENERAL CRITERIA

4.1.1 Quality Assurance Requirements for Design

The CHPRC QA Program is comprised of PRC-MP-QA-599, *Quality Assurance Program* and implementing documents. PRC-MP-QA-599 describes how CHPRC implements DOE O 414.1C *Quality Assurance* and 10 CFR 830 "Nuclear Safety Management". The design contractor was to implement a QA Program that addresses the criteria stated in PRC-MP-QA-599, as appropriate. Subsequent engineering, procurement and construction activity shall utilize PRC-MP-QA-599 as the primary Quality Assurance Planning document.

The CHPRC-00189, Environmental Quality Assurance Plan, Appendix C, *Soil and Groundwater Remediation Project Quality Assurance Project Plan*, describes a graded approach for applying quality levels to items and services on the Soil and Groundwater Remediation Program (S&GRP).

1. Utilize the approach to applying quality levels as outlined in PRC-PRO-QA-259, *Graded Approach*, Section 3, "Process".

2. Additional Items and Services in S&GRP that are Enhanced Commercial (General Service, Quality Level 3) include:

   a. Design and construction of critical elements of in-situ groundwater barriers.

   b. Testing of instruments used to demonstrate regulatory compliance.

   c. Procurement of services or standards used to calibrate instruments used to collect environmental data.

   d. Procurement of services to develop CERCLA and RCRA response action documents that include tasks requiring the use of computational and analytical software, including spreadsheets. Such tasks would include, but not be limited to vadose zone and groundwater contaminant fate and transport modeling and the conduct of human health, ecological, and protection of groundwater risk assessments. CERCLA and RCRA response action documents include the administrative and technical plans and reports developed to support the selection and implementation of removal and/or remedial actions.

   e. Procurement of selected items that are susceptible to counterfeiting as described in DOE G 414.1-3 *Suspect/Counterfeit Items Guide* (e.g., graded fasteners, circuit breakers, ratchet type tie downs and other items as determined by the Design Authority and QA). Purchase orders for such items shall include clauses or statements regarding procurement of potentially suspect or counterfeit items and shall require receipt inspection.

Some SSCs may be Enhanced Commercial (General Service, Quality Level 3) as described in PRC-PRO-QA-259, such as American Society of Mechanical Engineers (ASME) Code items (requiring independent verification), and procurement of items shown to be vulnerable to counterfeiting (requiring receipt inspection). Items will be specified and procured in accordance with the Codes and standards defined in Section 5.0.

Additional QA requirements for this project are listed below.

- Any materials or components that, due to economic constraints must be tolerated by design as a single point of failure with respect to safety of life, health and property, must appear in a suitable inspection plan, or in a submittal of an inspection report:
  - QA inspection plan (e.g., pressure vessels, ASME piping, NEC electrical inspection), and
  - Engineer's inspection report.
- Other material and components that are not single points of failure, yet may have some consequence with respect to safety of life, health and property; these will require individual engineering assessment of any risks remaining with partially redundant systems, throughout the course of design. Specifications, submittals, inspection plans, and reports are to be included, as appropriate.
- The design and construction of the system shall comply with the cleanliness and foreign material exclusion requirements of Section 4.1.8.
- Hydrostatic and in-service leak/pressure testing shall be conducted and documented by a qualified individual.

4.1.2 Additional Criteria

4.1.2.1. Radiological

Conduct radiological design reviews in accordance with HNF-PRO-1622, *Radiological Design Review Process.* Goal shall be to maintain exposure levels below 0.05 mrem/hr at 30 cm. and as far below that as is reasonably achievable per 10 CFR 835, *Occupational Radiation Protection.*

It is desirable to contain the radionuclide constituents as much as possible in order to minimize exposure and the potential contact with radioactive material, especially if that would require the use of personnel protective equipment (PPE). The process system should avoid the used of ferric materials, where Tc-99 tends to plate out. Stainless steel, fiber reinforced plastic or polyvinyl chloride materials are preferable.

The facility should be designed to minimize the generation of radioactive material for storage or as waste.

4.1.2.2. Hazard Identification and Environmental Description

The 100-DX Pump and Treat System shall be assessed as to whether OSHA's Process Safety Management Standard, 29 CFR 1910.119 requirements are applicable due to the presence of hazardous chemicals. If applicable, then the requirements shall be complied with. **Basis:** 29 CFR 1910.119.

If a hazards analysis is required, it shall be performed in accordance with the guidance DOE-STD-1100, *Chemical Process Hazards Analysis*.

4.1.2.3. Environmental Compliance and Permitting

No permitting actions are necessary for this project, as the project is being conducted under the authority of the under CERCLA Section 121(e) which exempts any response action conducted entirely on-site from having to obtain a Federal, State, or local permit, where the action is carried out in compliance with Section 121. In lieu of permitting, substantive compliance with ARARs in state and federal codes and regulations will be achieved. The ARARs are fully identified in the Interim ROD, USDOE Hanford 100 Area, 100-HR-3 and 100-KR-4 Operable Units, Benton County, Washington. The new 100-DX Pump and Treat System will discharge treated groundwater to injection wells in the aquifer being remediated by this CERCLA remedial action. It is expected that the new Treatment Facility will have the potential for radiological and nonradiological point source and/or diffuse/fugitive emissions to the atmosphere. The ARARs and compliance strategy are summarized here.

Discharge to Groundwater

The final clean up levels for the 100-HR-3 OU groundwater are federal and state drinking water maximum contaminant levels (MCLs) and state groundwater cleanup standards (where more stringent than the MCLs) that are ARARs for the selected remedy. These cleanup levels define acceptable risk levels for potential beneficial use of the groundwater as drinking water. The final cleanup levels for the contaminants of concern in the 100-HR-3 OU groundwater were developed using federal MCLs and the criteria and equations in the Model Toxics Control Act Method B cleanup levels for potable groundwater (Washington Administrative Code (WAC) 173-340-720[4][b][iii][A] and [B], and WAC 173-340-720 [7][b] and the federal and state water standards for radionuclides. The preliminary cleanup levels are provided in Table 1-1.
Basis: Interim ROD,

Radiological Air Emissions

The Revised Code of Washington (RCW) 70.94, "Washington Clean Air Act," requires regulation of radioactive air pollutants. The State implementing regulation WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," sets standards that are as stringent or more so than the federal *Clean Air Act of 1990* and Amendments (42 United States Code [USC] 7401 et seq.), and under the Federal implementing regulation, 40 Code of Federal Regulations (CFR) 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." The U.S. Environmental Protection Agency (EPA) partial delegation of the 40 CFR 61 authority to the State of Washington includes all substantive emissions monitoring, abatement, and reporting

aspects of the federal regulation. The State standards protect the public by conservatively establishing exposure standards applicable to the maximally exposed (public) individual, be that individual real or hypothetical. To that end, the standards address any member of the public, at the point of maximum annual air concentration in an unrestricted area where any member of the public may be. All combined radionuclide airborne emissions from the DOE Hanford Site "facility" are not to exceed amounts that would cause an exposure to any said member of the public of greater than 10 mrem/yr effective dose equivalent (EDE). The State implementing regulation WAC 246-247, "Radiation Protection – Air Emissions," which adopts the WAC 173-480 standards and the 40 CFR 61, Subpart H standard, requires verification of compliance with the 10 mrem/yr standard, and would be applicable or relevant and appropriate to this remedial action.

WAC 246-247 addresses potential radioactive airborne emissions from point sources and from fugitive or diffuse sources by requiring monitoring of such sources. Such monitoring requires physical measurement of the effluent or ambient air and QA measures to assure the precision, accuracy, and completeness of the environmental measurements. The substantive provisions of WAC 246-247 that require monitoring of radioactive airborne emissions would be applicable or relevant and appropriate to this remedial action.

The implementing regulations further address control of radioactive airborne emissions where economically and technologically feasible [WAC 246-247-040(3) and -040(4), "Radiation Protection - Air Emissions," "General Standards," and associated definitions]. To address the substantive aspect of these requirements, best or reasonably achieved control technology will be addressed by ensuring that applicable emission control technologies (those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit). The proposed remedial activity will address control of emissions and monitoring in a manner consistent with substantive aspects of applicable or relevant and appropriate requirements.

The proposed remedial activity will be evaluated with respect to determining the potential-to-emit radionuclides from any point source or diffuse/fugitive source. To accomplish this, the total unabated potential release, in curries, will be determined, and the annual dose to the maximally exposed individual calculated using the DOE guide, "Calculating Potential-to-Emit Radiological Releases and Doses" (DOE/RL-2006-20) or modeled using the CAP-88PC computer model. Control and monitoring requirements for potential radiological air emissions will be based on the calculated/modeled value of the potential-to-emit. The evaluation threshold is 0.1 mrem/yr for the differentiation between major (>0.1 mrem/yr) and minor (<0.1 mrem/yr) sources

Basis: 42 United States Code 7401 et seq., 40 CFR 61 Subpart H, Revised Code of Washington 70.94, WAC 173-480, WAC 246-247.

Nonradiological Air Emissions

Under WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," requirements are established for the regulation of emissions of criteria/toxic air pollutants. Nonradioactive emissions resulting from this remedial action could be gaseous or particulate matter. In accordance with

WAC 173-400-040, "General Standards for Maximum Emissions," reasonable precautions must be taken to (1) meet emissions standards for a specific emissions unit, (2) prevent the release of air contaminants associated with fugitive emissions resulting from excavation, materials handling, or other operations; and (3) prevent fugitive dust from becoming airborne from fugitive sources of emissions. In accordance with WAC 173-400-113, "Requirements for New Sources in Attainment or Unclassifiable Areas," the proposed new source will comply with all applicable new source performance standards, employ best available control technology, and not delay the attainment date for an area not in attainment nor cause or contribute to a violation of any ambient air-quality standard. Under WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," a person shall not establish, operate, or cause to be established or operated any new toxic air pollutant source which is likely to increase toxic air pollutant (TAP) emissions without installing and operating toxics best available control technology (T-BACT) and demonstrating that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.

To demonstrate compliance with applicable or relevant and appropriate requirements of WAC 173-400 and WAC 173-460, an acceptable source impact analysis will be completed. The analysis will demonstrate that, after application of T-BACT, the new source's maximum incremental ambient air impact levels do not exceed the WAC 173-460 Class A or Class B acceptable source impact levels; or, if applicable, the new source TAP emission rates do not exceed the small quantity emission rates specified in WAC 173-460.

Basis: WAC 173-400 and WAC 173-460

4.1.2.4. Security

There are no special safeguards and security requirements identified for the 100-DX Pump and Treat System. Security to new buildings will be maintained by coded locks (OMNI Locks).

4.1.3 Flexibility and Future Expansion

Wells will be completed and started in phases as determined for attainment of the 2012 RPO goals, as well as to perform aquifer testing for optimization of well locations. **Basis:** SGW-40044 Rev 1.

The 100-DX Treatment Facility will be comparable to the 100-KX facility; however, provisions for the possible future installation of a pretreatment system to remove soluble iron and manganese species [Fe(II) and Mn(II)] shall be included in the remedial design. These ions have the potential to encourage bacterial growth or precipitate within the treatment system or in injection wells upon oxidation. Several methods are available for removing Fe(II) and Mn(II) from groundwater (Minnesota Rural Water Association, 2007). Processes to remove iron usually consist of oxidation to convert Fe(II) to insoluble Fe(III) hydroxide, followed by filtration. Manganese is not as easily removed by this process unless the pH is raised to at least 9.5 (National Drinking Water Clearinghouse. 1998). An alternative when Mn(II) is present is the use of pyrolusite (natural manganese dioxide) or manganese greensand; a filter medium in which the greensand is coated with manganese dioxide (Water and Wastes Digest, 2003). In this process, oxidation and filtration occur in a single step. Exhausted pyrolusite and greensand need

to be re-oxidized, usually with potassium permanganate to restore iron and manganese removal capacity. **Basis**: In situ biological or chemical treatment of groundwater with elevated Cr(VI) concentrations is being considered for further implementation at the 100-D Area, which can introduce substantial levels of soluble iron and manganese.

The pretreatment system would be selected, sized, and located based on the composition and flow of water from the location of the in situ biological treatment zone. A pretreatment could be installed upstream of the influent feed tank and in close proximity and downstream of the extraction wells. An area of 40 feet x 40 feet shall be set aside in the 100-DX Treatment Facility for the allocation of the Fe (II) and Mn (II) pretreatment system.

4.1.4 Natural Phenomena Hazards Criteria

Natural Phenomena Hazard Criteria shall conform to the guidance in PRC-PRO-EN-097, *Engineering Design and Evaluation (Natural Phenomena Hazard)*, as modified below;

Design for Performance Category (PC) 1 and PC 2 will be per IBC 2006 for seismic and ASCE 7-05 for wind with the following parameters:

	PC2	PC1
WIND		
Wind Speed	38 m/s(85 mi/h)	38 m/s(85 mi/h)
Importance Factor (I)	1.15	1.0
Exposure Category	C	C
SEISMIC		
Site Class	D*	D*
S_s	0.46	0.46
S_1	0.15	0.15
Importance Factor (I_p)	1.5	1.0
* Site Class C may be used, if soil properties are known		

The Treatment Facility is a PC-1 facility.

4.1.5 Materials of Construction and Protective Coatings

The Treatment Facility and Transfer Buildings will be pre-engineered steel structures. If high humidity, exposure to chemicals, or other corrosive environmental conditions are present, ferrous materials will receive a high-build epoxy coating. These facilities will be supported on reinforced concrete foundations.

The floors will be slabs on grade and shall be coated with an epoxy resin coating finish. An evaluation shall be conducted to determine if the floors should be coated with a non-slip epoxy resin coating finish or remain un-coated concrete.

Generally the piping will be non-metallic (HDPE, PVC, or fiber reinforced plastic), or stainless steel where applicable. Pipe supports will be of corrosion resistant materials. Galvanized steel or aluminum ductwork will be used for the HVAC applications.

Indoor process piping shall be PVC Schedule 80 as established by precedent, while outdoor transfer piping shall be HDPE.

4.1.6 Human Factors

The design should be consistent with the guidance of DOE-HDBK-1140, *Human Factor/Ergonomics Handbook for the Design for Ease of Maintenance*. **Basis:** HNF-PRO-8258.

4.1.7 Fire Protection

Facilities shall conform to the fire resistance requirements of the International Building Code (IBC) (latest edition) in regard to the allowable floor area, building height limitations, and building separations.

Basis: DOE O 420.1B (Supplemented Rev. 4), Section B.1).a

Building construction related to egress and life safety shall comply with NFPA 101, *Life Safety Code*. Conflicts between the IBC and NFPA 101 related to fire resistance rating shall conform to the more restrictive body of requirements contained in either document.

Basis: DOE O 420.1B (Supplemented Rev. 4), Section B.1).a

The Hanford Fire Marshal's Office shall perform the following services:

Review and approve Acceptance Test Procedures
Review and approve site construction documents and shop drawings
Perform the initial review of the facility fire hazards analysis
Issue an Occupancy Permit for the facility

Basis: DOE O 420.1B (Supplemented Rev. 4), Section E.1), Subsections 1, 2, & 3

The fire alarm system (if required) shall comply with the requirements in NFPA 72, *National Fire Alarm Code*, and HNF-36174, *Hanford Chapter of the DOE Fire Protection Resource Manual.*

The installation of a Radio Fire Alarm Reporter (RFAR) shall be in compliance with the requirements of HNF-36174. The RFAR is only required if the fire suppression system and/or the fire alarm system is installed.

The Treatment Facility and Transfer Buildings shall be furnished with hand held portable fire extinguishers in approximate classes to effectively serve extinguishing purposes specific to the

area (i.e., electrical room versus process or pump room). Units shall be spaced at distance intervals established by NFPA 10, and mounted in cabinets on the wall. The number and location shall be reviewed and approved by the Fire Marshal.

4.1.8 Cleanliness and Foreign Material Exclusion

Cleanliness and foreign material exclusion (FME) requirements throughout the project life-cycle (manufacturing, shipment, storage, installation, operation, and maintenance) shall be in accordance with HNF-PRO-33415, *Structures, Systems Components Cleaning/Cleanliness and Foreign Material Exclusion*. **Basis:** HNF-PRO-8258.

During shipment and installation, precaution will be taken to keep foreign material out of all the piping, equipment, components, pumps, and vessels. These precautions include the following:

- Ensure the initial removal of any deleterious contaminants;
- Minimize the introduction of foreign materials into interior surfaces and spaces; and
- Ensure the cleanliness of SSC during/after installation, operation, maintenance, repair, or modification.

Extra precaution to prevent laying pipe against sharp objects is to be taken when installing the high-density polyethylene (HDPE) groundwater transfer pipe across the ground and through road crossing casings. **Basis:** Site experience. This has been accomplished by centering the HDPE pipe in the steel casing/sleeve and then filling the void with expanding foam.

4.2 PROCESS DESIGN CRITERIA

4.2.1 Process Design and Operating Limits

Design concentrations of the COCs at the Treatment Facility are based on numerical groundwater modeling and are provided in Table 1-1 for the ion exchange portion of the facility for hexavalent chrome treatment.

Range of outdoor temperatures is -23°F (February 1950) to +113°F (August 1961), as reported by Hanford Meteorological Station. Deviation can be approved by engineering management on a case-by-case basis.

Max design temperature for the IX resin is 180°F. Process shall be controlled to <130°F.

Additional process limits are to be determined during remedial design and explicitly stated in a System Design Description, as complete sets of limits and operating points:

- Physical Design Limit.

- Operating Limit, if different than physical design limit due to a margin of safety being provided.
- Maximum Operating set-point recommendation should be sufficiently inside of the Operating Limit to allow a reasonable margin of controller/operator overshoot as well as effective warning indications.

Provisions shall be made in transfer and/or treatment buildings for sampling individual extraction well influent flows, and treated water flows.

Acid shall be added to the flow upstream of the Ion Exchange process. The acid injection system shall be required to control pH to a set point. The acid injection system capacity shall be capable of maintaining a nominal 7.0 pH in continuous operation for A500 and a nominal 5.0 pH for SIR 700.. **Basis**: Resin Performance Characteristics.

Overland conveyance piping shall not be fitted with any leak detection or double-containment system. Leak detection shall be by routine surveillance of the pipeline, and supplemented with low flow detection and/or flow balance monitoring systems.

4.2.2 Mechanical/Piping

Groundwater transfer piping shall be HDPE SDR 9 PE 3408/3608 or PE 4710, single wall, and designed in accordance with ASME B31.3, *Process Piping*. The piping service shall be Category D. The piping shall not to be restrained to provide flexibility to allow for expansion and contraction associated with ambient temperature changes. The pipe will be installed above grade and inspected on a periodic basis to meet the leak detection requirements of WAC 173-303-640, "Tank Systems". HDPE piping shall not be placed on sharp surfaces. The ends of metal pipe sleeves (for road crossings) shall be rounded smooth and/or a PVC sleeve will be added around the HDPE to prevent the steel pipe from cutting the HDPE pipe. Materials other than HDPE may be used on a case-by-case basis with the approval of the mechanical design authority. **Basis:** Current operating practice. HDPE piping shall be routed as close to access roads as possible, but with 8' minimum from edge to road, to aid in required daily inspection of piping. At road crossings HDPE piping and electrical cables will be routed within metal pipe sleeves under the road.

Pump impellers for centrifugal pumps driven by Adjustable Frequency Drives (AFD) shall not be trimmed except to limit deadhead pressure at maximum rated speed or to ensure that the pumps will operate at the proper place on the pump curve. All pumps that operate as a group, in parallel, shall be of the same size and capacity. In addition, pumps shall have a stable head/capacity curve that continuously rises from rated capacity to shut-off. **Basis:** Current operating practice, necessary for process control of pumps operating in parallel.

The transfer pumps, feed pumps and injection (booster) pumps shall each be a scalable set of pumps sized so that the process may continue at peak capacity upon loss of one individual pump out of the set. Preferred pumps are a vertical inline pump similar to existing facilities. This facilitates maintenance since the facility craft are familiar with these pumps. **Basis:** Current operating practice to maintain flow.

Transfer station intake and discharge manifolds, and tanks, shall be sized to provide for a minimum of two (2) spare connections. Tanks shall be sized considering the maximum expected extraction well flow and an influent flow rate of 15 gpm per each spare connection. **Basis**: To provide contingency for optimization.

Outdoor piping velocity (and flow rate) is critical to prevent overheating and freezing. Optimum line sizing shall be calculated to minimize freezing potential and to minimize solar heating of the water. **Basis:** Current operating practice.

Motor drivers shall be sized for at least 125% of the maximum operating set-points. **Basis:** Necessary for process control.

Well level sensing and pump discharge pressure shall be available at the remote monitoring location. Extraction well heads are to be insulated and heat traced for freeze protection. Piping connections, wiring and insulation shall be arranged to allow removal of the extraction well pump without 100 percent removal of all the heat trace and discharge piping, etc. There will be no backup protection in the form of an automatic line drain back into the well upon shut down other than removal of the extraction well pump foot valve to allow drain back into the well.

Individual extraction flow streams shall be controlled by adjustable frequency drives on the extraction pumps. Extraction well flow rate settings shall be manually controlled as the master set point for overall system flows.

An air compressor station shall be provided in the Treatment Facility for operating diaphragm operated pumps used for resin transfers and flushing. The compressor shall be nominally 35 CFM @ 175 psi, with an ASME receiver tank with nominal capacity of 120 gallons. The system shall deliver 100 psig to the plant. Additionally, compressor shall be sized to accommodate resin SIR 700 air requirement.

Piping containing acid (if acid is used) shall be double-contained in appropriate clear plastic tubing/or other appropriate manner. (hose-in-hose).

The new facility shall utilize high quality long life materials for gaskets, and shall utilize mechanical seals for pumps in lieu of packing.

4.2.3 Electrical

Electrical power shall be supplied from existing 13.8 kV power lines.

There will be no combined neutral circuits (Edison circuits). **Basis**: NEC 2008 compliance.

It is preferred that each well head shall have an electrical rack with a main disconnect, an AFD, a remote input/output process controller interface, panelboard with step down transformer, heat trace controller, and a 120 V convenience outlet.

Electrical service design, and any required extension of utilities distribution system, shall be compliant with Hanford Electrical Utilities organization and engineering standards, the *National*

Electrical Safety Code (Institute of Electrical and Electronics Engineers [IEEE] C2) and the *National Electrical Code* (NFPA 70).

All circuit breakers shall be provided with a permanently attached lock-out provision.

Arc-flash calculations for distribution components and loads, starting with the service transformer primary fuse, are required and shall be performed in accordance with IEEE 1584, *Guide for Performing Arc-Flash Calculations*.

All electric driven pumps and motorized equipment greater than 1/2 HP shall be 480 VAC, and all motors greater than 1/4 HP shall be three phase to minimize motor maintenance. **Basis:** Cost of motor maintenance.

All control systems equipment and wiring shall be 24 VDC. **Basis:** Worker safety and Hanford lock and tag implementation.

Power supplies fed by 120 VAC and all other circuits more than 50 V shall be located in separate cabinets from the process control sensing and control and communication equipment. **Basis:** Current operating practice, and Hanford hazardous energy control implementation.

Outdoor electrical enclosures shall be outdoor rated and dust-tight. **Basis:** NEC compliance and site experience.

All electrical panelboards shall have approximately 20% spare capacity for future expansion.

All electrical equipment installed or used on the Hanford Site must be approved by the AHJ for the *National Electrical Code* (NFPA 70). Electrical equipment is approved, and, therefore, acceptable for use, under the following conditions.

1. If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by an Occupational Safety and Health Administration-recognized nationally recognized testing laboratory (NRTL) as indicated by an NRTL label applied by the manufacturer; or

2. If it has been labeled by an NRTL representative following an NRTL field evaluation; or

3. With respect to an installation or equipment that does not comply with Item 1 or 2 listed above, and for which written justification for the non-compliance is provided to the AHJ prior to installation and energization, it may be approved if it is inspected or tested, using the Non-NRTL Electrical Equipment AHJ Approval Report Checklist, by a Technical Representative designated by the AHJ.

Basis: HNF-RD-11827, *Hanford Electrical Safety Program Requirements*.

Adjustable Frequency Drives (AFDs)

Adjustable Frequency equipment with AFDs is the preferred method of providing pump speed/flow control rather than throttling valves. **Basis:** To meet energy management goals,

reduce cost of maintenance, reduce cost of control system engineering, and reduce operating costs.

AFDs shall be located at their motors to comply with NFPA work-safety requirements for proximity of motors, motor controllers and disconnects.

No motor disconnect, circuit breaker, power supply, or any other device shall be enclosed in the same cabinet with an AFD. Expressly for electrical work safety, motor disconnect switches shall disconnect the source of power to the AFD housing, rendering the entire AFD housing energy free. NEMA 1 factory-supplied housing will be appropriate unless intended to be purposely washed down, or located outdoors.

AFDs operator interface will be as manufactured integral to the AFD and of quality appropriate for use by operations personnel (i.e. user friendly).

AFDs shall include PROFIBUS communication adaptors having full access to all configuration parameters and operating status from the PLC.

AFDs located at the wellhead, shall be oriented facing north and sun shades shall be provided to protect the unit from exposure to sunlight.

The PLC and human-machine interface (HMI) software shall accommodate loading of all relevant parameters for every AFD in the facility with a single button push. Motors and AFDs shall be sized so as to:

- Minimize the number of spares required for one or two odd sized motors or AFDs.
- Assure that there is at least 25% spare motor capacity beyond the estimated steady-state operation design load for effective control of process transitions into steady-state operation.

Electric motors shall have a minimum efficiency of that specified in Section 1437 of WAC 51-11. **Basis:** WAC 51-11, Section 1510.

4.2.4 Process Control and Instrumentation

The industrial control system network shall be PROFIBUS standard for compatibility with existing PLC and HMI systems of Supervisory Control and Data Acquisition (SCADA).

The SCADA system, PLCs, HMIs, and distributed control systems (DCS) components of the control system shall be Siemens S7. **Basis:** To be consistent with existing systems and thereby reduce spares, maintenance and operator training, and engineering tool costs.

All treatment and normal process systems and equipment shall be remotely operable from centrally located SCADA stations. All treatment and normal process warning indications and alarms shall be remotely visible and acknowledgeable. All relevant treatment and normal process measurements and status indications shall be visible remotely.

The control system physical design and equipment shall accommodate remote controls to be implemented using HMI and PLC, accommodating as a minimum: basic "manual" start/stop control of each device, and also process measurements, set-point controllers and regulators which assists the operator to specify desired flows and/or levels for wells and tanks.

Flows for each extraction well shall be independently adjustable with insignificant interaction between wells. If adjustment of flow and/or levels is required to achieve proper process performance, then further remote controls should also be accommodated as appropriate.

Measuring instruments and transmitters, shall be provided sufficient to remotely control each process variable (i.e. each flow stream, each pump discharge pressure, each tank or vessel level, each throttle valve position, and any other process attribute to be controlled, such as temperature or pH).

Process control actuators (i.e. Adjustable Frequency Pump Drives, Motor Operated Throttling Valves, Solenoid or Air Powered Valves, Motor Controllers, and other actuators) shall be provided sufficient to remotely control each process variable. **Basis:** Required support for remote control systems, operation efficiency and economic productivity.

Measuring instruments, transmitters, valves, etc. shall be located indoor to the maximum extent possible. **Basis**: Required to support maintenance activities.

Control room shall be network ready so as to facilitate Ethernet (PROFINET) connection among PLC, communications room backboard, and control room desktop HMI, using cabinet or rack mounted Ethernet switch and flush mounted Ethernet receptacle. **Basis**: Option to provide network connectivity to evaluate/restore plant operation from other locations if problems occur during unattended operation.

A flow indicating transmitter will be required for each extraction well (at the final discharge of its conveyance piping) and for each injection well. **Basis:** Mandatory point of process control.

Sampling locations at the treatment facility and at the transfer building(s) shall be provided to sample influent and effluent streams.

A level transmitter in each well will be positioned at the discharge of the pump for extraction wells and at a level to be determined for injection wells. **Basis:** Current operating practice.

Remote control throttle valves shall be installed in the piping to individual injection wells. The valves may be controlled via the PLC. **Basis:** Injection flows are often siphoning, requiring throttle valves to control injection rates. Injection flow distribution control is sufficiently complex—given the size of the piping and valve network--as to be implausible without remote control of the valves and monitoring of the flow distribution given by the PLC. Cannot effectively control flow distribution by hand manipulation on the valves themselves due to the large number of flow interactions and adjustments to make in too short of time.

All motorized equipment shall be both remotely and locally operable and have a local Remote-Off-Local switch. AFD's have built-in local/remote function.

All control interlocks and alarms required to assure safety of life, health, and property, including environment, shall be mechanical or hard wired electrical. Electrical interlock and alarm status shall also be visible remotely.

Unless economically justified by a complete life-cycle cost analysis, no active safety system shall be permitted in the design—safety of life, health and property shall be arranged using passive, non-energized systems—all systems and equipment shall be designed to fail safe on loss of any energy source or communication link. **Basis:** Commercial grade software controls are not sufficiently reliable for protection of life, health and property.

Software systems shall be commercial grade. The economic advantage of the software, in terms of flexibility and adaptability, shall be restricted from imposition of more conservative duties than targeted by commercial grade software process controls industry. **Basis:** Protect the economic value of the software from unrealistic cost burdens of reliability.

Software controls shall exclude any safety-related protective functions, and shall be limited to two specific purposes:

1. Additional protection of equipment and systems from excessive wear and tear or avoidable damage; and

2. Productivity enhancements and measures to optimize cost performance, avoiding design boundaries of operation and facilitating unattended operation performance.

If economical, instrument transmitters shall include local indicators, and their display configuration shall be locally accessible without special communication or programming devices.

Any instrument transmitter that is required to support a mechanized approach to performance monitoring, data acquisition for release beyond the boundaries of engineering and operations organizations, as defined by the RD/RA work plan, shall be provided with a local indicator, and engineered statement of accuracy requirements and calibration check interval. **Basis:** Required for operations verification of data acquisition and reporting accuracy and reliability.

Gravity flow into tanks or other open vessels shall be controlled to prevent overflow, and any requirements for tank headroom (i.e., surge capacity) shall be clearly defined in a system design description (SDD) document.

Floor low-point (or sump) leak detection shall be provided in the transfer buildings and the treatment facility. **Basis:** WAC-173-303-640

4.2.4.1. Operating Assumptions

The facility will be typically be unattended by operating personnel, and shall be designed for continuous operation 24 hrs/day, 7 days/wk. During an unexpected shutdown, the control system shall have an automated calling system to notify responsible personnel to begin recovery operations. **Basis:** Unattended operation provides considerable operational cost savings.

Planned outages for maintenance should be performed during the normal work day, with the system restored to operation by the end of the shift. It is expected that, where possible, the system design will allow maintenance activities without shutting down the (entire) plant. For example, with parallel pumps or trains, one could be taken down for maintenance with only a reduction in plant throughput. **Basis:** Current experience and planned pump-and-treat system availability.

4.2.4.2. Operating Provisions

The system shall shut down on loss of site power, and shall not restart without operator initiation. The need for a master shut down control shall be determined during remedial design.

All operator instruments or adjustments shall be designed for ergonomic access from the operating floor level, or shall be provided with suitable permanent access platforms.

4.2.5 Process Data

All input values, alarms and process control events shall be archived for information and analysis. Current and historical data shall be available in real-time at the control station or by authorized remote logons. **Basis**: Needed for engineering trending.

4.2.6 Process System Structural

4.2.7 Design criteria for the supports and attachments of nonstructural components (pipe supports, electrical equipments and other items) shall be per IBC 2006, as outlined in Section 4.1.4. Expansion anchors shall use any industry standard wedge-type expansion anchor having capacities published by the International Code Council Evaluation Service (ICC-ES) and approved for resistance to wind and seismic loading.

Piping and instrumentation diagrams (P&IDs) shall show all process equipment, instruments and physical interlocks or governances. Inasmuch as practicable, P&IDs should include system and process materials, design limits, ratings, interlock set points, software interlocks and controls, and elements appearing in recent ISA Standards for P&IDs, but only where those can be shown consistently throughout the design, or in limited scope of such information is clearly identified in a P&ID cover sheet.

Design of electrical overcurrent and fault protection shall be made to accommodate ease of illustrating and tabulating electrical loads, wire sizing and protection requirements.

Loop diagrams shall not be acceptable for electrical wiring unless actually illustrating a bona-fide current loop through three or more devices in series and the rare example of such a circuit that cannot be reasonably illustrated on electrical ladder diagrams. Loop diagrams may still be developed but not in place of appropriate wiring diagrams or ladder diagrams.

Ladder diagrams shall include all electrical control wiring, DCS inputs and outputs, Motor control elementary diagrams, with:

- Organization by electrical enclosure, clearly showing the boundaries of the topic enclosure and every source of energy into or out of that enclosure
- Every circuit load and short protective device in the enclosure or otherwise dedicated to the enclosure
- Distinct wire terminal identification for each item of equipment. These may be generic if manufacturer is unknown, and as-built by end of construction
- DCS module terminals should be designed for direct landing of field wiring without auxiliary field-terminal blocks. Land wires directly on all control-device terminals if possible. If field terminal blocks cannot be avoided, use a different termination symbol for field-terminals than for control-device terminals.
- Node based wire identification for all wires, usually by fuse number or signaling device tag, for class 2 control circuits feeding externally mounted transmitters or switches
- Standard motor control elementary, if applicable, to be included in the elementary ladder diagrams
- Cross reference among sheets showing destination/source of wiring leaving/arriving an enclosure
- Standard ladder logic cross reference for location of contacts belonging to relays.

4.3 FACILITY DESIGN CRITERIA

4.3.1 General

The following is a list of design requirements that have been developed from the recently completed 100-KX Pump and Treat Facility. These requirements shall be incorporated into the 100-DX remedial design.

- Resin tank access ports shall be on the bottom of vessels
- Use moveable power rack (Hoffa boot concept) at well pads
- Identify component model numbers on drawings to facilitate maintenance
- Install ground rods a minimum of 6-inches below grade
- Electronic readouts at eye level with horizontal orientation
- Lighting lined up between trains to provide access for rolling platform access
- When penetrating a wall with piping leave a minimum of four feet between the wall and any panel or access restriction so as to support maintenance.
- Provide access to safely change filter media at main and transfer buildings

- On the perimeter apron have no backup hazards or slopes near by
- No overhead hazards or sharp edges for workers
- Provide safety caps on structural channel (uni-strut)
- Keep piping and conduit - if mounted on the floor, close to the equipment
- Brace long horizontal and vertical runs of pipe to stabilize, protect from vibration, and in personnel contact that could compromise the pipe
- Maintain minimum flow to any online pumps to ensure proper pump bowl cooling capacity
- Design supply and discharge manifolds to equalize supply and discharge pressures among all parallel pumps throughout entire range of process flows.
- For pumps operating in parallel, prohibit individual pump flow-pressure curves that show indeterminate flow at any given pressure (prohibit multiple flow possibilities for any one pressure, prohibit 'humped' flow-pressure curve, prohibit range of decreasing flow with decreasing pressure).
- Install flow meter, pressure gauge, etc. with interlocks on pump to ensure that that minimum flow is occurring, and if not, shut the pump down.
- Provide epoxy coating on floors
- Provide an uninterrupted power supply for the control room Human Machine Interface workstation/server
- Vent lines on IX vessels shall allow for drainage
- Filter drains shall have drain valve and pipe to allow for drainage to bucket

4.3.2 Architectural and Civil/Structural

The facility is General Service, Performance Category (PC) 1, it shall be designed in accordance with the IBC 2006 and ASCE 7-05 as outlined in Section 4.1.4.

The facilities shall be a pre-engineered metal building with the following requirements;

- Roof slope - 1 in 12
- Roof Live Load – 20 psf
- Collateral Load – 10 psf
- Ground Snow Load – 15 psf

Both analysis and drawings shall be stamped by Professional Engineer licensed in the state of Washington who is experienced in this work.

Access and egress shall be provided in accordance with the requirements of the IBC and NFPA 101.

Roadway and parking shall be designed in accordance with Washington State Department of Transportation (WSDOT) M41-10, *Standard Specifications for Road, Bridge and Municipal Construction*, or approved equivalent.

A 10-ft asphalt concrete pavement (ACP) shall be provided around the treatment building for operation of fork-lifts and trucks and to provide storage of totes, drums, equipment, etc.

Fences, if required, shall be designed in accordance with WSDOT M41-10, or approved equivalent.

Storm drainage water shall be managed by appropriately sloping paned areas to cause drainage away from the facilities to the surrounding low lying area for infiltration into the native soil.

Steel design, fabrication, and installation shall be in accordance with the American Institute of Steel Construction (AISC) M 011, *Manual of Steel Construction – Allowable Stress Design*, 9th edition.

Welding shall comply with the applicable American Welding Society (AWS) standards.

Concrete design and installation shall be in accordance with American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete.*

In addition, the facilities shall comply with building Construction Specifications developed during design.

The Treatment Facility and Transfer Buildings shall house as much of the equipment and instrumentation as reasonable to minimize exposure to weather and increase the efficiency of maintenance.

Treatment Facility:

- Shall house the process equipment described in Section 3.2, System Description.
- Where ion exchange columns are housed, overhead roll-up doors (12-ft wide x 14-ft high) spaced along building sides located as required for service/equipment access, hollow metal personnel doors located for function/access and per code (egress) requirements.
- Control Room: houses SCADA HMI with view window(s) to process room and facility entrance, access to entry area (off small lobby/viewing hall) and process area.
- Electrical equipment shall be located within the main process area and in close proximity to the process equipment.
- HVAC (wall exhauster, space heater(s)) as required to control the process area environment.
- HVAC to control the control room area environment.

Transfer Buildings:

Pre-engineered metal buildings, with low-maintenance sloped metal roofing, accommodating the following equipment and requirements:

- Pump/Tank Room: for housing equalization tank and transfer pumps, with overhead roll-up doors (possibly a double door) spaced along building sides located as required for service/equipment access, hollow metal personnel doors located for function/access and per code (egress) requirements.
- Electrical/panelboards, AFD's, control cabinets and equipment.
- HVAC (wall exhauster, space heater) as required to control building environment.
- Sampling station

Unrestricted access shall be provided at rollup doors to permit fork truck operations into/out of the process building.

Parking around the Treatment Facility shall be provided for 10 vehicles without obstructing facility operations.

4.3.3 Heating, Ventilation and Air Conditioning

The HVAC design shall comply with the WAC 51-11 and the *International Mechanical Code* (IMC).

Heating and cooling load calculations shall be performed in accordance with the IMC, Section 312, "Heating and Cooling Load Calculations." Heating and cooling system design loads for the purpose of sizing systems, appliances and equipment shall be determined in accordance with the procedures described in the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) *Handbook of Fundamentals.* Heating and cooling loads shall be adjusted to account for load reductions that are achieved when energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE Handbook – *HVAC Systems and Equipment.* Alternatively, design loads shall be determined by an approved equivalent computation procedure, using the design parameters specified in Chapter 3 of the *International Energy Conservation Code* (IECC). **Basis:** IMC, Section 312.

A building that is designed to be both heated and cooled shall meet the more stringent of the heating or cooling requirements as required in this Code when requirements of the exterior envelope differ. **Basis**: WAC 51-11, Section 301.2.

Indoor design temperatures for the 100-DX Pump and Treat System shall be as follows:

Treatment Facility:

- Process Room: 55°F for heating, no cooling*.
- Control Room: 70°F for heating and 78°F for cooling.

Transfer Buildings:

- 55°F for heating, no cooling*.

* Areas that do not require mechanical cooling shall have ventilation provided by exhaust fans and filtered inlet dampers to provide temperature moderation.

Basis: WAC 51-11, Section 302.2.1 for all areas normally manned or used frequently. For the Process Room, and Transfer Buildings, these spaces are infrequently occupied so 55°F was chosen as a minimum to keep processes and equipment above 50°F, ventilation is provided to maintain the high temperature at or near ambient.

The heating or cooling outdoor design temperatures shall be selected from 0.6% column for winter and 0.5% column for summer from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE." (See also *Washington State Energy Code Manual.*) **Basis:** WAC 51-11, Section 302.1.

The building envelope requirements of WAC 51-11, Chapter 5, "Building Design by Component Performance Approach," shall be followed.

HVAC systems shall not use supply or return ducting. **Basis:** Current operating practice.

4.3.4 Utilities

Utilities provided by the project include:

Air – Instrument air shall be provided for the Treatment Facility. The air shall meet the requirements of ISA 7.0.01, *Quality Standard for Instrument Air.*

Chemicals –Storage solutions shall provide for secondary containment in accordance with WAC 173-303-640.

As discussed above, space will be provided for approximate 3500 to 5,000-gal storage tanks for acid and base to accommodate the future use of SIR-700

Communications – Phone and HLAN connections will be provided in the Treatment Facility and the Transfer Buildings. Connection to groundwater engineering network shall be provided at the Treatment Facility.

Electrical – 13.8 kV overhead power lines that are present and in the vicinity will be tapped and extended to provide power to the transfer building and treatment facility.

4.4 GENERAL REQUIREMENTS

Process control set points, interlocks, and behavior of process regulators shall be documented in a System Design Description (SDD) as the definitive configuration control document for the process control system, in addition to the information on the P&ID.

Measurements shall be in English units. Any exceptions shall reflect the most common industry practices for:

- The subject materials and equipment,
- The involved construction organizations, and
- The responsible operations and maintenance organization.

For portability, systems shall not use physical well numbers. Well numbers shall appear only on site plans and on the physical well symbol of the P&ID. **Basis:** Current operating practice.

In addition to industrial safety codes and standards, equipment layout shall provide for most safe and economical maintenance of equipment. **Basis:** Current operating practice.

Routing of piping into and out of buildings shall allow clearances for access by emergency equipment and a minimum 30 ft fire buffer zone free of weeds. **Basis:** Current operating practice.

In addition to *National Electrical Safety Code* (NESC IEEE C2) clearance requirements, layout of 13.8 kV distribution and structural guying shall be arranged to be conspicuous, avoiding blind spots, and out of the way of any interference with safe pedestrian or vehicular traffic, parking and access for loading and unloading. **Basis:** Current operating practice.

All aspects of the outdoor design shall compliment the special requirements to protect cultural resources, wildlife activities and habitat, and environment and any special requirements as identified in the Ecological/Cultural Resource Review. This will be implemented through compliance with PRC-PRO-SH -090, *Excavating, Trenching, and Shoring*, which requires these reviews as part of the excavating permit process. **Basis:** Current operating practice.

Outdoor wiring and signal circuits shall be protected by markers where off road, and by barriers within 5 ft of vehicular traffic. Barriers shall not be designed as vehicular crash barriers. **Basis:** Current operating practice, PRC-PRO-SH-090.

Outdoor piping, electrical cables, and instrument cables shall be marked/protected from vehicular damage in areas with the potential for vehicular traffic.

4.4.1 Equipment and Instrument Identification and Labeling

Unique identification tags are required for all equipment meeting any of these conditions:

- Subject to failure and replacement, or
- Manually operable, or
- Has a purpose in, or is the object of safety lock-out, or
- Valve manifolds for line-up of flow through series of treatment stages.

A project-specific labeling scheme for systems, equipment, instruments, wiring, and piping shall be developed and approved by the 30% design review and shall take into consideration existing schemes developed for existing pump-and-treat systems. **Basis:** DOE O 5480.19, chg 2, Chapter XVIII, *Equipment and Pipe Labeling*.

4.5 DECONTAMINATION AND DECOMMISSIONING

Design of systems and equipment shall consider that all SSCs installed will ultimately be removed and disposed of at the end of their useful life.

Materials that come in contact with hazardous materials should consider the ease with which it can be decontaminated to acceptable levels.

The facility shall be designed for decontamination by use of protective coatings on the floor.

5.0 CODES AND STANDARDS

The following Codes and Standards are applicable to the design of the 100-DX Pump and Treat system and shall be applied as appropriate.

5.1 ARCHITECTURAL/CIVIL/STRUCTURAL

STANDARD NUMBER/REFERENCE	TITLE
American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 350.3-06	Seismic Design of Liquid-Containing Concrete Structures and Commentary
American Institute of Steel Construction (AISC)	
AISC M021	AISC Manual of Steel Construction – Allowable Stress Design, 9th Edition
AISC 360-05	Specification for Structural Steel Buildings
American Welding Society (AWS)	
AWS A 2.4	Weld Symbols
AWS D1.1	Structural Welding Code—Steel
AWS D1.2	Structural Welding Code—Aluminum
AWS D1.3	Structural Welding Code—Sheet Steel
AWS D1.4	Structural Welding Code—Reinforcing Steel
AWS D1.6	Structural Welding Code—Stainless Steel
AWS D9.1	Structural Welding Code—Sheet Metal
AWS QC-1	Guide to AWS Welding Inspector Qualifications and Certification
American Society of Civil Engineers (ASCE)	
ASCE 7	Minimum Design Loads for Buildings and Other Structures
American Society for Testing and Materials (ASTM)	
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 74	Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM C 39/C 39M	Standard Test Methods for Compressive Strength of Cylindrical Concrete Specimens
American Water Works Association (AWWA)	
	AWWA Cross-Connection Control Manual
D100	Welded Carbon Steel Tanks for Water Storage
International Code Council (ICC)	
IBC 2006	International Building Code
IFC 2006	International Fire Code
IMC 2006	International Mechanical Code
IPC 2006	International Plumbing Code
IFGC 2006	International Fuel Gas Code
IECC 2006	International Energy Conservation Code
National Association of Architectural Metal Manufacturers (NAAMM)	
MBG531-00	Metal Grating Manual
MBG532-00	Heavy Duty Metal Grating Manual
Steel Deck Institute (SDI)	
SDI 31	Design Manual for Composite Decks, Form Decks and Roof Decks

5.2 MECHANICAL

STANDARD NUMBER/REFERENCE	TITLE
American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B&PV Code	Boiler and Pressure Vessel Code, Section III, and Section VIII
ASME B16.3	Malleable iron threaded fittings class 150
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ through NPS 24
ASME B16.34	Valves Flanged, Threaded and Welding End
ASME B31.2	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist
American Society of Testing and Materials (ASTM)	
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A182	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM D2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
American Water Works Association (AWWA)	
M55	PE Pipe--Design and Installation
Crane Manufacturers Association of America (CMAA)	
CMAA 70	Single Girder Cranes
CMAA 74	Multiple Girder Cranes
DOE/RL-92-36	Hanford Hoisting and Rigging Manual

5.3 ELECTRICAL

STANDARD NUMBER/REFERENCE	TITLE
Electronic Industries Association (EIA)	
EID/TIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces.
Institute of Electrical and Electronics Engineers (IEEE)	
IEEE 1584	Guide for Performing Arc-Flash Calculations
International Society of Automation (ISA)	
ISA 5.1	Instrumentation Symbols and Identification
ISA 5.4	Instrument Loop Diagrams
ISA 7.0.01	Quality Standard for Instrument Air
ISA RP12.06.01	Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety
National Electrical Manufacturers Association (NEMA)	
NEMA 250	Enclosures for Electrical Equipment (1,000 V Maximum)
NEMA AB1	Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA C12.1	Code for Electricity Metering
NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 5	Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA KS 1	Enclosed and Miscellaneous Distribution Switches (600 V Maximum)
National Fire Protection Agency (NFPA)	
NFPA 70	National Electrical Code
Underwriters Laboratories, Inc. (UL)	
UL 98	Standard for Enclosed and Dead-Front Switches
UL 248	Standard for Low Voltage Fuses
UL 486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
UL 489	Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
UL 508A	Standard for Industrial Control Equipment
UL 943	Standard for Ground-Fault Circuit-Interrupters
UL 1059	Standard for Terminal Blocks
UL 1479	Fire Tests of Through-Penetration Fire Stops
IEEE C2	National Electrical Safety Code (NESC)
NFPA 101	Code for Safety to Life from Fire in Buildings and Structures
NFPA 780	Illuminating Engineering Society of North America (IES) Lighting Handbook

5.4 WASHINGTON STATE CODES

STANDARD NUMBER/REFERENCE	TITLE
WAC 173-160	Minimum Standards for Construction and Maintenance of Wells
WAC 173-218	Underground Injection Control
WAC 173-303	Dangerous Waste Regulations
WAC 173-303-640	Tank Systems

WAC 173-304	Minimum Functional Standards for Solid Waste Handling
WAC 173-340	Model Toxics Control Act - Cleanup
WAC 173-350	Solid Waste Handling Standards
WAC 173-400	General Regulations for Air Pollution Sources
WAC 173-460	General Regulations for New Sources of Toxic Air Pollutants
WAC 173-480	Ambient Air Quality Standards and Emission Limits for Radionuclides
WAC 246-247	On-site Sewage Systems
WSDOT M22-01	Washington State Department of Transportation Design Manual
WSDOT M44-10	Standard Specification for Road, Bridge and Municipal Construction

5.5 FEDERAL CODES

NUMBER	TITLE
10 CFR 835	Occupational Radiation Protection
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 141	National Primary Drinking Water Regulations
40 CFR 268	Land Disposal Restrictions
40 CFR 300.430	Remedial Investigation/Feasibility Study and Selection of Remedy
DOE 0 420.1B	Facility Safety
DOE-STD-1066-99	Fire Protection Design Criteria
DOE STD-1021-93	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
DOE-RL-92-36	Hanford Site Hoisting and Rigging Manual
DOE-HDBK-1132-99	Design Considerations
15 U.S.C. 2601	Toxic Substances Control Act of 1976
16 U.S.C. 470 Section 106	National Historic Preservation Act of 1966
16 U.S.C. 469aa-mm	Archeological and Historic Preservation Act of 1960
16 U.S.C. 1531	Endangered Species Act of 1973
25 U.S.C. 3001	Native American Graves Protection and Repatriation Act
42 U.S.C. 103	Superfund Amendments and Reauthorization Act of 1986
42 U.S.C. 2011	Atomic Energy Act of 1954
42 U.S.C. 6901	Resource Conservation and Recovery Act of 1976
42 U.S.C. 7401	Clean Air Act of 1990
42 U.S.C. 9601	Comprehensive Environmental Response, Compensation and Liability Act of 1980
10 CFR 851	Worker Safety and Health Program

6.0 REFERENCES

10 CFR 830, "Nuclear Safety Management," Code of Federal Regulations, as amended.

10 CFR 835, "Occupational Radiation Protection," Code of Federal Regulations, as amended.

29 CFR 1910.119, Process "Safety Management of Highly Hazardous Chemicals," Code of Federal Regulations, as amended.

29 CFR 1910.151, "Medical Services and First Aid," Code of Federal Regulations, as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Code of Federal Regulations, as amended.

40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities."

42 USC 7401, et seq., *Clean Air Act of 1990* and Amendments, as amended.

ACI 318, *Building Code Requirements for Structural Concrete*, American Concrete Institute, Farmington Hills, Michigan.

AISC M 011, *Manual of Steel Construction – Allowable Stress Design*, 9th edition, American Institute of Steel Construction, Chicago, Illinois.

ANSI/IEEE 1016, *IEEE Recommended Practice for Software Design Descriptions,* New York, New York.

ANSI/ISA S5.5, *Graphic Symbols for Process Displays,* American National Standards Institute, /Instrument Society of America, Washington, D.C.

ASCE 7, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineering

ASHRAE Handbook – *HVAC Systems and Equipment,* American Society of Heating, Refrigeration, and Air Conditioning Engineers

ASHRAE *Handbook of Fundamentals,* American Society of Heating, Refrigeration, and Air Conditioning Engineers

DOE O 420.1B, *Facility Safety,* U.S. Department of Energy, Washington, D.C.

DOE O 414.1c, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

DOE G 414.1-3 *Suspect/Counterfeit Items Guide*, 2004, U.S. Department of Energy, Washington, D.C.

DOE-HDBK-1140, *Human Factor/Ergonomics Handbook for the Design for Ease of Maintenance*, 2001, U.S. Department of Energy, Washington, D.C.

DOE-O-5480.19, *Equipment and Pipe Labeling, 2001, U.S. Department of Energy*

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, 1992, U.S. Department of Energy, Washington, D.C.

DOE-STD-1066, *Fire Protection Design Criteria*, 1999, U.S. Department of Energy, Washington, D.C.

DOE-STD-1100, *Chemical Process Hazards Analysis*, 1996, U.S. Department of Energy, Washington, D.C.

DOE-TSL-1-2007, *Department of Energy Standards Index*, 2007, U.S. Department of Energy, Washington, D.C.

EPA 816-F-00-002, *Implementation Guidance for Radionuclides*

Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*

Handbook of Fundamentals, 2005, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

Hanford Federal Facility Agreement and Consent Order Action Plan.

CHPRC-00189, Environmental Quality Assurance Plan, Appendix C, *Soil and Groundwater Remediation Project Quality Assurance Project Plan*, CHPRC, Richland, Washington.

HNF-36174, *Hanford Chapter of the DOE Fire Protection Resource Manual*, Richland, Washington.

PRC-GD-EN-8004, *Functional Requirements Document*, Project Hanford Management System, Richland, Washington.

PRC-MP-QA-599, *Quality Assurance Program*, Rev. 0, CHPRC, Richland, Washington.

PRC-PRO-EN-097, *Engineering Design and Evaluation (Natural Phenomena Hazard)*, 2006, Project Hanford Management System, Richland, Washington.

PRC-PRO-ER-15333, *Environmental Projection Processes*, Rev. 12, Project Hanford Management System, Richland, Washington.

PRC-PRO-RP-1622, *Radiological Design Review Process*, Rev. 1, Project Hanford Management System, Richland, Washington.

PRC-PRO-QA-259, *Graded Approach,* Rev. 11, Project Hanford Management System, Richland, Washington.

PRC-PRO-IRM-309, *Computer Software Management,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-PRO-EN-8258, *Functional Design Criteria,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-PRO—-NS-8366, *Facility Hazard Categorization*, Rev. 6, Project Hanford Management System, Richland, Washington.

HNF-PRO-33415, Structures, Systems Components Cleaning/Cleanliness and Foreign Material Exclusion, Project Hanford Management System, Richland, Washington.

PRC-RD-SH-11827, *Hanford Electrical Safety Program Requirements,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-RD-EP-15332, *Environmental Protection Requirements*, Rev. 8, Project Hanford Management System, Richland, Washington.

*HVAC Systems and Equipmen*t, 2008, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

IEEE 1016, Recommended Practice for Software Design Descriptions, 1998, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE 1584, *Guide for Performing Arc-Flash Calculations*, 2002, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE C2, *National Electrical Safety Code,* Institute of Electrical and Electronics Engineers, New York, New York.

International Building Code, 2006, International Code Council.

International Energy Conservation Code, 2006, International Code Council.

International Mechanical Code, 2006, International Code Council.

ISA 5.1, *Instrumentation Symbols and Identification*, 1984 (R1992), Instrument Society of America, Research Triangle Park, North Carolina.

ISA 7.0.01, *Quality Standard for Instrument Air,* 1996, Instrument Society of America, Research Triangle Park, North Carolina.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 30, *Flammable and Combustible Liquids*, 2003, National Fire Protection Association, Quincy, Massachusetts.

NFPA 58, *Liquefied Petroleum Gas Code*, 2004, National Fire Protection Association, Quincy, Massachusetts.

NFPA 70, *National Electric Code*, 2008, National Fire Protection Association, Quincy, Massachusetts.

NFPA 72, *National Fire Alarm Code*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 101, *Life Safety Code*, 2006, National Fire Protection Association, Quincy, Massachusetts.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2008, National Fire Protection Association, Quincy, Massachusetts.

RCW 70.94, "Washington Clean Air Act," Revised Code of Washington, as amended.

Record of Decision, US DOE Hanford 100 Area, 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County.U.S. Department of Energy, Richland Operations Office, Richland, Washington.

GRP-PRO-036, *Initial Hazard Categorization for the 100 DX Pump and Treat System*, Rev. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-40524, *Project Execution Plan for the 100-DX Pump and Treat System*, Ref. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-40044, 2009, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum*, Rev. 1, CH2M Hill Plateau Remediation Company, Richland, Washington.

Uniform Building Code, 1997, International Council of Building Organizations.

WAC 51-11, "Washington State Energy Code," *Washington Administrative Code*, Olympia, Washington, as amended.

WAC 173-303-640, "Tank Systems," *Washington Administrative Code*, Olympia, Washington, as amended.

WAC 173-340, "Model Toxics Control Act – Cleanup," Washington Administrative Code, as amended.

WAC 173-400, "General Regulations for Air Pollution Sources," Washington Administrative Code, as amended.

WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," Washington Administrative Code, as amended.

WAC 246-247, "Radiation Protection – Air Emissions," Washington Administrative Code, as amended.

WAC 246-272, *On-site Sewage Systems*, Washington Administrative Code, Olympia, Washington.

WAC 246-290, "Public Water Supplies," Washington Administrative Code, as amended.

WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," Washington Administrative Code, as amended.

WAC 246-272, *On-site Sewage Systems*," Washington Administrative Code, as amended.

WMP-30899, *Design Criteria for the 100-K Expansion Pump and Treat*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WSDOT M41-10, *Standard Specifications for Road, Bridge and Municipal Construction,* 2008, Washington State Department of Transportation, Olympia, Washington.

This page left intentionally blank.

Attachment A

100-DX Well LOCATIONS

This page left intentionally blank.

Table A-1. 100-DX Well Locations[a]

ITEM	PLANT	BOREHOLE	WELL	SC5 NO	PRIMARY FUNCTION	EASTING	NORTHING	PUMPING RATE	PUMPING RATE	MIN PUMPING RATE	MAX PUMPING RATE	WELL CASING DIA
(–)	(–)	(–)	(–)	(–)	(–)	(m)	(m)	(m^3/d)	(gpm)	(gpm)	(gpm)	(in)
1	DX	C7580	199-D4-101	SC5-1	EW	572800.3	151425.8	109.0	20	14	26	6
2	DX	C7083	199-D4-95	—	EW	572613.0	151227.0	43.6	8	6	10	6
3	DX	C7084	199-D4-96	—	EW	572777.0	151520.0	54.5	10	7	13	6
4	DX	C7085	199-D4-97	—	EW	572911.0	151625.0	43.6	8	6	10	6
5	DX	C7086	199-D4-98	—	EW	572606.3	151486.6	43.6	8	6	10	6
6	DX	C7087	199-D4-99	—	EW	572526.5	151376.6	54.5	10	7	13	6
7	DX	C7583	199-D5-101	SC5-4	EW	572942.8	151521.3	81.8	15	11	20	6
8	DX	C7591	199-D5-127	SC5-12	EW	572992.9	151428.7	54.5	10	7	13	6
9	DX	C7590	199-D5-130	SC5-11	EW	574039.4	151928.2	65.4	12	8	16	6
10	DX	C7601	199-D5-131	SC5-22	EW	573684.3	152007.0	54.5	10	7	13	6
11	DX	A4577	199-D5-20	—	EW	573240.0	152030.0	54.5	10	7	13	4
12	DX	C4185	199-D5-32	—	EW	573372.0	151903.0	54.5	10	7	13	6
13	DX	B8748	199-D5-39	—	EW	573142.0	151427.0	109.0	20	14	26	6
14	DX	C4583	199-D5-92	—	EW	573132.0	152010.0	136.3	25	18	33	6
15	DX	C7599	199-D7-3	SC5-20	EW	574151.4	152364.1	54.5	10	7	13	6
16	DX	C7611	199-D7-6	SC5-32	EW	574428.6	152980.2	54.5	10	7	13	6
17	DX	A4581	199-D8-53	—	EW	573889.0	152451.0	56.6	10	7	14	4
18	DX	A4582	199-D8-54A	—	EW	573781.0	152408.0	83.5	15	11	20	4
19	DX	A4585	199-D8-6	—	EW	573434.9	152061.0	32.7	6	4	12	4
20	DX	C3829	199-D8-72	—	EW	573571.0	152212.0	72.9	13	9	17	6
21	DX	C7091	199-D8-89	—	EW	573468.1	152246.4	109.0	20	14	26	6
22	DX	C7092	199-D8-90	—	EW	573948.7	152646.2	54.5	10	7	15	6
23	DX	C7093	199-D8-91	—	EW	574037.2	152741.3	81.8	15	11	21	6
24	DX	C7589	199-D8-95	SC5-10	EW	573611.8	152160.8	54.5	10	7	15	6
25	DX	C7603	199-D8-96	SC5-24	EW	573705.9	152152.6	81.8	15	11	20	6
26	DX	C7582	199-D8-97	SC5-3	EW	573859.6	152087.6	81.8	15	11	20	6
27	DX	C7602	199-D8-98	SC5-23	EW	574012.5	152122.7	54.5	10	7	13	6
28	DX	C7610	199-H1-5	SC5-31	EW	574849.4	153054.8	81.8	15	11	20	6
29	DX	C7595	199-H4-80	SC5-16	EW	575251.8	152553.1	54.5	10	7	13	6
30	DX	C7596	199-H4-81	SC5-17	EW	575241.2	153043.7	54.5	10	7	18	6
31	DX	C7609	199-H4-82	SC5-30	EW	574863.3	152693.9	81.8	15	11	20	6
32	DX	B8989	199-D4-38	—	EW	572671.0	151538.0	27.3	5	4	7	6
33	DX	B8990	199-D4-39	—	EW	572747.0	151651.0	81.8	15	11	20	6
34	DX	C3315	199-D4-83	—	EW	572859.0	151723.0	65.4	12	8	16	6
35	DX	C3316	199-D4-84	—	EW	572568.0	151434.0	43.6	8	6	10	6
36	DX	C3317	199-D4-85	—	EW	572486.0	151324.0	54.5	10	7	13	6
37	DX	B2773	199-D8-69	—	EW	573844.0	152552.0	76.3	14	10	18	6
38	DX	C4474	199-D8-73	—	EW	573389.0	152167.0	54.5	10	7	13	6
39	DX	C4536	199-D8-88	—	EW	573292.0	152141.0	54.5	10	7	13	6
40	DX	—	199-D5-104	—	EW	573265.48	151422.43	81.8	15	11	20	6"
41	DX	—	199-D8-68	—	EW	573711.67	152427.1	272.5	50	40	50	4"

This page left intentionally blank.

ITEM	PLANT	BOREHOLE	WELL	SC5 NO	PRIMARY FUNCTION	EASTING	NORTHING	PUMPING RATE	TARGET PUMPING RATE	MIN PUMPING RATE	MAX PUMPING RATE	WELL CASING DIA
(–)	(–)	(–)	(–)	(–)	(–)	(m)	(m)	(m^3/d)	(gpm)	(gpm)	(gpm)	(in)
1	DX	C7089	199-D2-10	—	IW	574470.7	153465.2	381.6	80	49	91	6
2	DX	C7090	199-D2-12	—	IW	574343.4	153300.8	381.6	80	49	91	6
3	DX	—	199-D5-44	—	IW	572993.6	151835.7	190.8	35	25	46	10
4	DX	B8752	199-D5-42	—	IW	573480.0	151623.0	257.8	47	33	61	6
5	DX	C7095	199-D8-93	—	IW	574191.2	153067.3	245.3	50	32	59	6
6	DX	C7096	199-D8-94	—	IW	574082.3	152920.2	232.7	53	30	56	6
7	DX	A4584	199-D8-55	—	IW	573621.0	152364.0	218.0	40	28	52	6
8	DX	C7592	199-D6-1	SC5-13	IW	574129.6	151691.5	163.5	35	21	39	6
9	DX	C7593	199-D8-99	SC5-14	IW	574006.3	152364.0	109.0	15	14	26	6
10	DX	C7594	199-D7-4	SC5-15	IW	574377.0	152369.5	190.8	35	25	46	6
11	DX	C7600	199-D5-129	SC5-21	IW	573743.8	151561.3	163.5	35	21	39	6
12	DX	C7607	199-D6-2	SC5-28	IW	574545.2	151970.6	218.0	40	28	52	6
13	DX	C7608	199-D7-5	SC5-29	IW	574434.2	152678.6	218.0	40	28	52	6
14	DX	C7612	199-D5-128	SC5-33	IW	573622.0	151237.1	354.3	36	36	85	6

a. Reference: DOE/RL-2006-52, Rev. 2, Decisional Draft
b. Coordinates are Washington State Pane Coordinate System (NAV88, meters)
c. Table values are as of 5/25/10
d. Four wells from the H-area have been temporarily assigned to the DX system.

This page left intentionally blank.

SGW-40243, Rev. 4

Distribution

Onsite

1	U.S. Department of Energy, Richland Operations Office	
	DOE Public Reading Room	H2-53
13	CHPRC	
	G. L. Hopkins	R3-50
	M. T. Bachand	H3-23
	R. S. Popielarczyk	R3-60
	C. L. Rambo	R3-50
	J. G. Riddelle	R3-50
	A. J. Rossi	R3-60
	F. H. Biebesheimer	R3-60
	W. R. Thackaberry	R3-60
	J. L. Smoot	R3-50
	R. W. Whitlock	R3-50
	J. C. Williams	R3-19
	J. A. Winterhalder	R3-60
	G.A. Edwards	R3-50
	P. W. McGuinness	R3-19
	W.F. Barrett	R3-19
1	Pacific Northwest National Laboratory	
	Hanford Technical Library	P8-55
1	Lockheed Martin Information Technology	
	Document Processing Center	H6-08

This page left intentionally blank.

S

SGW-43616
Revision 4

Functional Design Criteria for the 100-HX Pump and Treat System

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

SGW-43616
Revision 4

EDC #: ECR-11-000605

Functional Design Criteria for the 100-HX Pump and Treat System

D. Neshem
CH2M HILL Plateau Remediation Company

Date Published
May 2011

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

MAY 24 2011
DATE:
STA: 4
HANFORD RELEASE
27
ID:

Release Approval — Date 5/24/2011 — Release Stamp

Approved for Public Release;
Further Dissemination Unlimited

SGW-43616
Revision 4

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Total Pages: 70

CHPRC RECORD OF REVISION (ROR)	(1) Document Number SGW-43616	Page 1 of 1

(2) Title
Functional Design Criteria for the 100-HX Pump and Treat System

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release (5) DA/TA Date
1	Move 4 wells from HX to DX, and correction of well min-max *~a~l values Per PRC-EDC-10-44298	
2	Changed number of transfer buildings to 1, updated the amount 2 and type of water being transferred between HX and DX, and added a reference to document SGW-40 044. ECR-10-000454	
3	Added requirement to include temperature monitoring on HDPE lines to provide data to Operations during cold weather conditions. ECR-10-001388	G.G. Bergquist
RS 4	Updated wells associated with HX, corrected reference, updated environmental compliance sections, and removed requirement for temperature monitoring on HDPE lines.	~~J. G. Riddelle~~ D.O. NESHEIM

A-6004-786 (REV 1)

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 BACKGROUND 1-2
1.2 FACILITY TYPE 1-4
1.3 SCOPE, MISSION, AND PERFORMANCE SUMMARY 1-4
1.4 SITE LOCATION 1-6
1.4.1 Treatment Facility 1-6
1.5 PROJECT INTERFACES 1-8
1.5.1 Organizational and Physical Interfaces 1-8
1.6 ANTICIPATED DESIGN / CONSTRUCTION SCHEDULE 1-9
1.7 METHOD OF PERFORMANCE 1-9

2.0 FUNCTIONS 2-1
2.1 PROCESS PRODUCTION RATES AND CHEMICAL END STATES 2-1
2.2 OPERATIONAL EFFECTIVENESS REQUIREMENTS AND AVAILABILITY 2-2
2.3 PREFERRED TECHNOLOGY AND JUSTIFICATION 2-2
2.4 SAFETY 2-3
2.5 UNIQUE ENVIRONMENTAL PROTECTION REQUIREMENTS 2-3
2.6 WASTE ACCEPTANCE CRITERIA 2-4
2.7 TESTING AND INSPECTION REQUIREMENTS 2-4
2.8 DESIGN LIFE 2-5
2.9 SPECIAL OPERATION AND MAINTENANCE REQUIREMENTS 2-5
2.10 SPECIAL SAFEGUARDS AND SECURITY REQUIREMENTS 2-6
2.11 CHEMICAL STORAGE 2-6

3.0 PROJECT INPUTS 3-1
3.1 EXISTING SSCS TO BE MODIFIED 3-1
3.2 SYSTEM DESCRIPTION 3-1
3.3 SYSTEM OPERATION 3-2
3.4 SAFETY BASIS 3-2
3.5 DESIGN ASSUMPTIONS AND ASSOCIATED RISKS 3-2
3.6 CONSTRAINTS 3-3

4.0 DESIGN CRITERIA 4-1
4.1 GENERAL CRITERIA 4-1
4.1.1 Quality Assurance Requirements for Design 4-1
4.1.2 Additional Criteria 4-2
4.1.3 Flexibility and Future Expansion 4-4
4.1.4 Natural Phenomena Hazards Criteria 4-4
4.1.5 The Treatment Facility is expected to be a PC-1 facility. Materials of Construction and Protective Coatings 4-5
4.1.6 Human Factors 4-5
4.1.7 Fire Protection 4-5
4.1.8 Cleanliness and Foreign Material Exclusion 4-6

4.2 PROCESS DESIGN CRITERIA 4-7
4.2.1 Process Design and Operating Limits 4-7
4.2.2 Mechanical/Piping 4-8
4.2.3 Electrical 4-9
4.2.4 Process Control and Instrumentation 4-11
4.2.5 Process Data 4-14
4.2.6 Process System Structural 4-14
4.2.7 General Process Criteria 4-14
4.3 FACILITY DESIGN CRITERIA 4-15
4.3.1 General 4-15
4.3.2 Architectural and Civil/Structural 4-16
4.3.3 Heating, Ventilation and Air Conditioning 4-18
4.3.4 Utilities 4-19
4.4 GENERAL REQUIREMENTS 4-19
4.4.1 Equipment and Instrument Identification and Labeling 4-20
4.5 DECONTAMINATION AND DECOMMISSIONING 4-20

5.0 CODES AND STANDARDS 5-1
5.1 ARCHITECTURAL/CIVIL/STRUCTURAL 5-1
5.2 MECHANICAL 5-2
5.3 ELECTRICAL 5-3
5.4 WASHINGTON STATE CODES 5-3
5.5 FEDERAL CODES 5-4

6.0 REFERENCES 6-1

APPENDICES

Attachment A ..... A-i

FIGURES

Figure 1-1. Hanford Site 1-2

TABLES

Table 1-1. 100-HX Design Influent and Effluent Concentrations 1-5

TERMS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFDs	Adjustable Frequency Drives
AHJ	Authority Having Jurisdiction
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirement
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
AWWA	American Water Works Association
BOP	balance of plant
CAT	Construction acceptance test
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
CMAA	Crane Manufacturer's Association of America
COC	constituent of concern
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EIA	Electronic Industries Association
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FBR	fluidized bed reactor
FDC	Functional Design Criteria
FHA	Fire Hazards Analysis
FME	foreign material exclusion
FRP	fiber reinforced plastic
HC	Hazard Category
HDPE	high-density polyethylene

HMI	human-machine interface
HVAC	heating, ventilation, and air conditioning
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IMC	International Mechanical Code
IRM	interim remedial measure
ISA	Instrument Society of America
IX	ion exchange
MCL	maximum contaminant level
MNA	Monitored Natural Attenuation
NAAMM	National Association of Architectural Metal Manufacturers
NCP	National Contingency Plan
NCR	nonconformance report
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Agency
NPL	National Priorities List
NRTL	nationally recognized testing laboratory
OSHA	Occupational Safety and Health Administration
OTP	Operational test procedure
OU	Operable Unit
P&ID	process and instrumentation diagram
PC	Performance Category
PFHA	Preliminary Fire Hazards Analysis
PLC	programmable logic controller
PPE	personal protective equipment
PSIG	Pound per square inch
PVC	Poly(Vinyl Chloride)
QAPP	Quality Assurance Program Plan
RAM	reliability, availability and maintainability
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Revised Code of Washington

RD/RA	remedial design/remedial action
RFAR	Radio Fire Alarm Reporter
ROD	Record of Decision
RPO	Remedial Process Optimization
RTO	regenerative thermal oxidizer
S&GRP	Soil & Groundwater Remediation Program
SARA	Superfund Amendments and Reauthorization Act of 1986
SCMP	software configuration management plan
SDD	system design description
SDI	Steel Deck Institute
SGRP	Soil and Groundwater Remediation Project
SSC	structures, systems, and components
TAP	toxic air pollutant
T-BACT	toxics best available control technology
TCE	Trichloroethylene
TM	Technical Memorandum
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPS	uninterruptible power supply
USC	United States Code
WMA	Waste Management Area
WSDOT	Washington State Department of Transportation

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
Inches	25.40	millimeters	millimeters	0.0394	inches
Inches	2.54	centimeters	centimeters	0.394	inches
Feet	0.305	meters	meters	3.281	feet
Yards	0.914	meters	meters	1.094	yards
Miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	Ounces
pounds	0.454	kilograms	kilograms	2.205	Pounds
ton (short)	0.907	ton (metric)	ton (metric)	1.102	ton (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	Pints
fluid ounces	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts	0.946	liters	cubic meters	1.308	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Celsius	Celsius	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
Picocuries	37	millibecquerel	millibecquerel	0.027	Picocuries

This page left intentionally blank.

1.0 INTRODUCTION

This document is the Functional Design Criteria (FDC) for the new 100-HX Pump and Treat System for the 100-HR-3 Groundwater Operable Unit (OU), located adjacent to the Columbia River in the northeast corner of the Hanford Site in southeastern Washington State (Figure 1-1). This FDC provides the fundamental technical criteria and design requirements necessary for remedial design of this project to meet the cleanup goals established for the OU as specified in the *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units at the Hanford Site (Interim Remedial Action)* (referenced from here on out as the Interim Record of Decision [ROD]).

The three subsystems for the 100-HX Pump and Treat System addressed by this FDC are as follows:

1. The Treatment Facility, which is to be centrally located with respect to the location of the extraction and injection wells, will house all of the process treatment equipment as well as the control system for the project.

2. The injection and extraction wells.

3. The balance of plant (BOP) that includes the well pumps, network and associated Transfer Building with transfer pumps to pump the contaminated well water to the Treatment Facility. The Treatment Facility will then pump the treated water to the injection wells.

Criteria for design, drilling, and installation of the injection and extraction wells are not in the scope of this document beyond stating that each extraction well is designed to provide the nominal flow rates presented in Appendix A.

This FDC was prepared following the guidance of PRC-PRO-EN-8258, *Functional Design Criteria,* and PRC-GD-EN-8004, *Functional Requirements Document.* In addition, the 100-KR-4 and 100-KX & DX Expansion Project criteria, and experiences gained from those projects, provided the basis for design criteria used in this functional design criteria document.

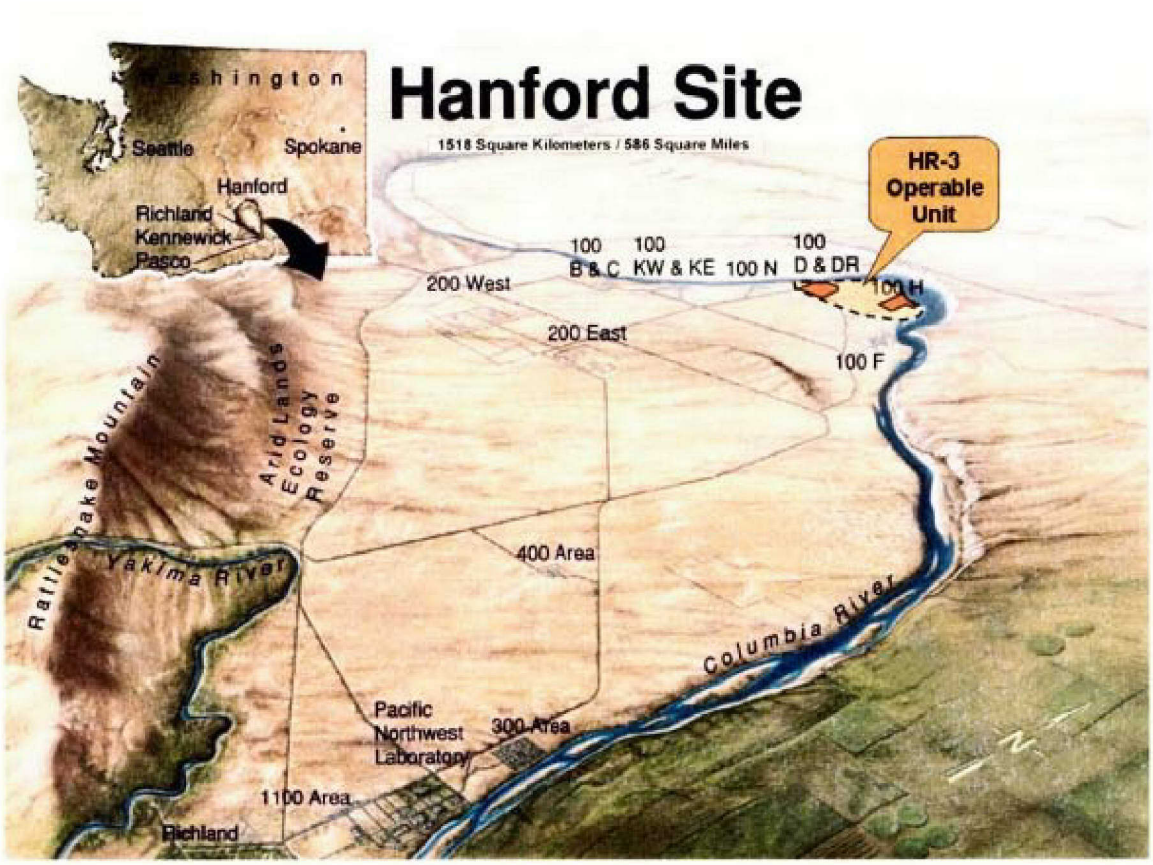
The use of "shall", "will", "should" and "may" in this document is as follows:

- Whenever the word "shall" appears, it shall be interpreted to mean that the requirements are binding.
- The words "will", "should" and "may", shall be interpreted as non-mandatory provisions.
- The word "will" is used to express declaration of purpose or simple futurity.
- The word "should" is used to express non-mandatory desired or preferred method of accomplishment.
- The word "may" is used to express an acceptable or suggested means of accomplishment.

1.1 BACKGROUND

The U.S. Department of Energy's (DOE's) Hanford Site is a 1,517-km^2 (586-mi^2) Federal facility located in southeastern Washington State along the Columbia River (see Figure 1-1). The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area commonly known as the Tri-Cities. This region includes the incorporated cities of Richland, Pasco, and Kennewick, as well as surrounding communities in Benton, Franklin, and Grant counties. For administrative purposes, the Hanford Site was divided into four National Priorities List (NPL) (Title 40, Protection of Environment, *Code of Federal Regulations* [CFR], Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan" [40 CFR 300], Appendix B) sites under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), one of which is the 100 Area. The CERCLA site identification number for the 100 Area is WA3890090076.

Figure 1-1. Hanford Site



The contaminated groundwater in the 100 Areas reactor sites has been grouped into five operable units (OU). One of these, the 100-HR-3 Groundwater OU includes the 100-D/DR and 100-H reactor sites. Hexavalent chromium (Cr[VI]) is the primary contaminant of concern in groundwater beneath the 100-H Area, which comprises the east part of the operable unit (100-HR-3-D). The 100-H Area encompasses the operating areas of 1 former DOE production reactor (the former H reactor). While the reactor was operational, large volumes of river water were treated with sodium dichromate (to inhibit corrosion of the reactor piping) and used as a coolant for the reactors. After a single pass through the reactor and before being discharged back to the river, the coolant water was sent to unlined retention basins to cool and so the short-lived radioactive contaminants would decay. This approach to reactor cooling led to the introduction of large volumes of process water contaminated with low concentrations of hexavalent chromium into the vadose zone, and ultimately into the groundwater aquifer and adjacent Columbia River. In addition, numerous leaks and spills of concentrated sodium dichromate stock solution over the lifetime of reactor operations led to higher concentrations of chromate in the vadose zone and ground water in localized areas. Chromium is distributed in north and southwest plumes and other contaminant plumes include tritium, nitrate, and sulfate in the same general area.

As a result of the discharge of groundwater from the operable units into the river, chromium, a metal that is toxic to aquatic organisms in low concentrations, poses a risk to aquatic organisms in the Columbia River adjacent to the 100-H. The most toxic form of chromium, hexavalent chromium, readily dissolves in water and, therefore, moves freely with groundwater. Hexavalent chromium has been detected in groundwater and in the groundwater/river interface where groundwater upwells into the river. Once discharged into the river, it is easily assimilated by aquatic organisms, some of which are adversely affected.

This document describes the functional design criteria for a new pump and treat system at 100-H area. The new system will provide 800 gpm of treatment capacity at a new facility to be called HX treatment facility to be located to the west of the existing HR-3 treatment facility. The design will include a transfer building (H1) on the east side of 100-H.

In order to mitigate the impacts of contamination at the 100-H Area to human health and the environment, ex situ remedial actions have been implemented in an attempt to achieve the following remedial action objectives (RAOs) specified in the Interim ROD:

- RAO #1: Protect aquatic receptors in the river bottom substrate from contaminants in ground water entering the Columbia River.
- RAO #2: Protect human health by preventing exposure to contaminants in the groundwater.
- RAO #3: Provide information that will lead to the final remedy.

Basis: Interim ROD Section VII.

1.2 FACILITY TYPE

1.2.1 Treatment Facility

Construction Type: Type IIB non-combustible
International Building Code (IBC), Section 602.2, Table 601)

Occupancy Classification (mixed use occupancy):

The Occupancy Classification of specific rooms of the Treatment Facility in accordance with IBC Chapter 3 will be determined during remedial design phase. The goal will be to arrange and manage chemicals in the facility to keep the Occupancy Classification as low as possible.

Special Purpose Industrial Occupancy, per National Fire Protection Agency (NFPA) 101, *Life Safety Code.*

1.2.2 Transfer Building

Construction Type: Type IIB non-combustible
IBC, Section 602.2, Table 601

Occupancy Classification:

The Occupancy Classification of the Transfer Building in accordance with IBC Chapter 3 will be determined during the design phase. The goal will be to arrange and manage chemicals in the facility to keep the Occupancy Classification as low as possible. The Transfer Building is not normally occupied.

Special Purpose Industrial Occupancy, per NFPA 101, *Life Safety Code.*

1.2.3 Facility Hazard Category

The 100-HX Pump & Treat Facility is expected to be categorized as less than *Hazard Category (HC)-3.* This includes all facilities and systems associated with 100-HX Pump & Treat. See FDC Section 3.4 (Safety Basis).

All facilities and systems will be General Service.

1.3 SCOPE, MISSION, AND PERFORMANCE SUMMARY

Contaminated groundwater in the 100-H Area is currently being treated by a pump and treat system (HR-3) and in situ by permeable redox manipulation barrier. The existing in situ and ex situ treatments are not significantly reducing the concentrations of hexavalent chromium reach the Columbia River. Therefore, the goal of this project is to accelerate remediation of the 100-H Area by adding pump and treat capacity for plume control and contaminant mass reduction. This

approach will help accelerate and achieve the remedial action objectives and remedial milestones summarized below:

- Immediately protect the river (aquatic receptors) by 2012.
- Clean up the bulk of the groundwater by 2020.

The objective of the groundwater treatment system is to reduce the effluent chromium concentrations to the maximum extent practicable. The ROD currently states that "The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 µg/L chromium will not be discharged." Current effluent chromium concentrations re-injected into the aquifer are typically below the Aquatic Water Quality Criteria (AWQC) of 10 µg/L and treatment is expected to be maintained at or below this concentration. Since AWQC are required to be met at the river, injection of groundwater in wells that are not located upgradient of the extraction wells need to meet these criteria. Therefore, injection wells that are not located upgradient of the extraction wells must reduce the effluent chromium concentrations to the maximum extent practicable, and not to exceed 20 µg/L (i.e. two times the AWQC of 10 µg/L). As indicated in the ROD, a dilution factor of 1:1 is expected before the injected treated groundwater would reach the aquatic receptor point of concern within the river substrate, ensuring that the AWQC of 10 µg/L in the river substrate will be met.

The 100-HX treatment system shall be designed to capture and treat contaminated groundwater to reduce the effluent concentration of the hexavalent chromium to less than 20 µg/L at compliance monitoring locations to achieve 10 µg/L at the river using the preliminary dilution factor of 1:1. **Basis**: Explanation of Significant Differences for the 100-HR-3 and 100-KR-4 Operable Units Interim Record of Decision (August 2009) that allows reinjection of treated groundwater in locations other than upgradient of the extraction wells.

The 100-HX Pump and Treat System will replace the existing HR-3 system.

Hexavalent chromium is the only constituent requiring removal. Although there is no requirement for the removal of co-contaminants for this interim action, monitoring and sampling to include potential co-contaminants will be performed to aid in final remedy selection.

The treated groundwater (meeting the preliminary cleanup level of Table 1-1) will then be returned to the aquifer through injection wells. **Basis**: Interim ROD

Table 1-1. 100-HX Design Influent and Effluent Concentrations

COC	Design Average Influent Concentration	Federal Drinking Water Standard MCL[1]	State[2] Water Quality Standards	Effluent Concentration
Non-Radionuclides				
Hexavalent chromium	500 µg/L	100 µg/L	10 µg/L	< 20 µg/L (at compliance

				wells) < 20 µg/L (at injection)
Nitrate (as Nitrogen)	< 10 mg/L	10 mg/L	N/A	< 10 mg/L
Radionuclides				
Strontium-90	6 pCi/L (very conservative assumption)	8 pCi/L	8 pCi/L	8 pCi/L
Technetium-99	12 pCi/L	900 pCi/L	900 pCi/L	900 pCi/L
Tritium	6,500 pCi/L	20,000 pCi/L	20,000 pCi/L	20,000 pCi/L
Uranium (total)	1.5 pCi/L	30 µg/L	30 µg/L	30 µg/L

NOTES:
1. 40 CFR 141 (Primary MCL = maximum contaminant level).
2. Water Quality Standards for Surface Waters of the State (chronic value).

The construction, startup and operation of the 100-HX Pump and Treat System will be done in a single phase. Depending on facility and well field performance, additional phases may be conducted to facilitate chromium removal, including well realignment, plant modifications to improve performance, incorporation of bioremediation, etc.

1.4 SITE LOCATION

1.4.1 Treatment Facility

The Treatment Facility will be centrally located with respect to the extraction and injection wells. The facility will house all the process treatment equipment as well as control systems for the project.

The site has not been selected. The final site location for the transfer buildings will be confirmed/determined during the early stages of the remedial design.

1.4.2 Wellfield

The results of the 100-HR-3RPO effort, SGW -40044, *100-HR-3Remedial Process Optimization Modeling Technical Memorandum, Rev 1*, recommended the installation of new extraction and injection wells to ensure maximized hydraulic capture of the dissolved hexavalent chromium plume and protect the river (aquatic receptors) by the year 2012.

Since the size and influence of the various 100 Area groundwater P&T remedies has increased through time, recent efforts have focused on the development of a single flow model that encompasses these various P&T remedies and can be used to support decisions at each of the 100-K, N, D and H Areas. The modeling is reported on separately for each OU. Basis: SGW-40044, *100-HR-3Remedial Process Optimization Modeling Technical Memorandum, Rev 1*.

Table A-1 in this FDC provides a comprehensive list of all existing and proposed wells with respect to the RPO design for HX; immediate goals related to system operation under the maximized capacity; and/or projected well operation for attainment of aquifer cleanup by 2020. Specifically, Table A-1 lists the following information:

a) The names and geographic coordinates of the HX wells;

b) Primary function (extraction/injection);

c) Pumping rates as determined for attainment of the 2012 RPO goals;

d) The well casing sizes;

The actual locations may need to be adjusted in the field to accommodate interference from utilities, roads, waste management units, buildings, on-going soil remediation activities, and other practical considerations and may also be adjusted based on numerical groundwater modeling as design and operations proceed. If further adjustment moves these wells outside the numerical model cell they were located in, then the numerical model shall be evaluated to confirm the location for its adequacy.

Monitoring shall be conducted to evaluate the performance of the 100-HX Pump and Treat System. Monitoring well locations are designed and operated to demonstrate whether or not the 100-HX Pump and Treat System is attaining aquifer cleanup goals.

Flow-path control is also required and shall be achieved by injecting the treated groundwater into the aquifer to the southeast and northwest of the groundwater contamination (see Table A-1 well locations) such that the treated injected water in these locations will slow the natural westward flow of most of the groundwater and, as a result, keep COCs within the capture zone, as well as increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

The output from extraction wells may be pumped to an Extraction Transfer Building(s), (as determined during remedial design by pipeline pressure limitation, pump performance or operational factors), for accumulation and pumping to the Treatment Facility. Also, depending upon well proximity to the Treatment Facility, some wells may be piped directly to the facility. The size, number, and location Transfer Buildings will be determined during remedial design with the goal being to minimize the total cost of pipe and pumping equipment. The output from the Treatment Facility will be split up and pumped directly to the individual injection wells.

1.5 PROJECT INTERFACES

Both organizational and physical interfaces are defined in the following subsection.

1.5.1 Organizational and Physical Interfaces

Organizational interfaces are defined in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System*. This document will be revised to include HX in the future.

Access Roads –

Existing roads shall be used in lieu of developing new roads, as practicable. Where new roads are required, such as to transfer buildings, wells, and the treatment facility, their layout shall minimize disturbance of the site.

Communications –

Communications shall be provided by and coordinated with Lockheed Martin Information Technology. Phone and Hanford Local Area Network (HLAN) services will be provided in the Treatment Facility. The SCADA system will be connected to the groundwater engineering network.

Electrical –

Tie-ins to existing electrical utilities shall be coordinated and approved by the site electrical utilities organization.

Site –

Where possible the Treatment Facility location and pipeline routes will be selected to minimize disturbance of existing plant life and wildlife resources. Coordination with cultural and natural resource management personnel shall be performed as part of site selection and excavation processes.

Existing Remediation Projects –

The 100-H Area has numerous remediation efforts currently underway. Coordination with 100-H Area project work from other Contractors shall be performed as part of the site selection process.

Coordination with the 100-DX Pump & Treat will be required for transfer of water between DX and HX facilities.

Other –

No connections to raw water, sanitary water or sewer systems are required.

1.6 ANTICIPATED DESIGN / CONSTRUCTION SCHEDULE

The project schedule for design and construction is contained in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System*. This document will be revised to include HX in the future.

1.7 METHOD OF PERFORMANCE

The method of performance for the project is contained in SGW-40524, *Project Execution Plan for the 100-DX Pump-and-Treat System*. This document will be revised to include HX in the future.

This page left intentionally blank.

2.0 FUNCTIONS

2.1 PROCESS PRODUCTION RATES AND CHEMICAL END STATES

Projected total groundwater extraction in 100-H Area is approximately 677 gpm, see Table A-1; however, to afford contingency for operations and system optimization, the remedial design shall include all the process unit operations required to treat a sustained flow of groundwater from the 100-H Area at a maximum rate of 800 gpm.

The actual production rate at each well will depend primarily on hydrogeologic factors, and to a lesser extent on well contruction. Each of the extraction and injection wells will have a minimum and maximum flow rate as shown in Table A-1. **Basis**: SGW-40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater in The 100-HR-3 Operable Unit In Support of Remedial Process Optimization*. Decisional Draft A, Received 4/10/09. **Basis**: To provide a basis for flexibility in pump sizing and operation of the treatment facility.

To account for future throughput (up to the 800 gpm), nine additional penetrations and influent connections on the influent tank shall be provided at the treatment facility; each line thereby capable of providing 20 gpm.

To compensate for system downtime for planned and unplanned maintenance, and to allow additional flexibility in the system, the treatment facility shall be designed with eight IX treatment trains (four IX vessels per train) with each train having a design maximum flow rate of approximately 100 gpm, to achieve a total peak production capacity of 800 gpm. **Basis**: SGW-40044, Appendix A, *Technical Memorandum on Numerical Modeling of Groundwater in The 100-HR-3 Operable Unit In Support Of Remedial Process Optimization.*

Each train shall be capable of operating continuously between 50 percent and 100 percent of maximum design flow rate (50 gpm to 100 gpm) to accommodate variations in well pump operation.

The minimum and maximum flow rates for injection wells are shown in Table A-1. Five injection well spares shall be provided in the treatment facility effluent piping manifold. The range of flows through the spare injection connections is 30 to 50 gpm.

The 100-HX treatment shall be designed to be able to deliver approximately 150 gpm of treated well water to 100-DX area for injection

Following treatment in the process facility, the water shall meet the preliminary cleanup level requirement of Table 1-1 prior to re-injection into the ground water through the injection wells. **Basis**: Interim ROD

A recirculation line shall be installed at the effluent tank such that treated groundwater that does not meet the preliminary cleanup level requirement of Table 1-1 prior to re-injection during start-up or system testing and optimization may be reprocessed. It is anticipated that this feature will be used during plant startup and during resolution of upset conditions. This line does not need to

be sized to flow the maximum flow rate of 800 gpm. **Basis**: Process design and the need to assure groundwater meets specifications prior to re-injection.

Treated water shall have neutral pH (6.5 to 8.5) and be essentially particulate-free and foulant-free to avoid scaling or plugging the injection wells. The treated injection stream shall be no lower than a pH of 6.5. **Basis**: Past project experience. WMP-30899, "Design Criteria for the 100-K Expansion Pump and Treat"

2.2 OPERATIONAL EFFECTIVENESS REQUIREMENTS AND AVAILABILITY

The extraction and treatment system shall be designed to run on a continuous basis such that routine procedures such as resin changes and mechanical maintenance can be conducted with minimal impact to system operations. **Basis**: ROD. The 100-HX Pump and Treat System will not incorporate redundancy, but equipment selection will be such to provide a high overall system availability goal without providing redundancy of all systems. However, transfer pumps within the facility shall have redundancy, e.g, two pumps running and one installed spare. **Basis**: Experience with current systems.

The 100-HX facility will operate twenty-four hours per day, seven days per week, unattended after start-up and stabilization, except during routine surveillance and operation cycles, effluent sampling, and maintenance.

2.3 PREFERRED TECHNOLOGY AND JUSTIFICATION

As stated previously in Section 1.3, the selected remedy for the 100-HR-3 Groundwater OU in accordance with the Interim ROD is, "Pump-and-Treat, Flow-Path Control, and Institutional Controls."

As recommended by the resin evaluation "Report on Resin Evaluations to Support DX Treatment System", SGW-41642, dated August 2009 the preferred technology will be based on an ion exchange process using a ResinTech SIR-700 granular or WBG30-B spherical disposable resin. The resin will be used for start-up, and the facility will be modified after start-up to optimize using this resin. In the unlikely event that the operational issues cannot be resolved for ResinTech SIR-700 during start-up phase, Purolite A500 with off-site regeneration will be used. To facilitate the capability of handling the SIR-700 resin or Purolite A500 resin with off-site regeneration in the future, the following will be accommodated in the design.

- Materials of construction capable of handling the pH range of either resin
- IX vessel diffusers capable of handling both types of resins
- Install points of connection for a system supporting the removal of the SIR-700 resin from the IX vessels
- Design overall pressure drops to accommodate both types of resin

- Install points of connection to allow the automated adjustment of pH prior to treatment and discharge to the influent wells and allowing sufficient space to accommodate the necessary tanks for the associated acid and caustic for pH adjustment

- Install points of connection to allow for injection of a reagent for reducing Cr(VI) to Cr(III) prior to removal from the IX vessels

The ion exchange vessels will be similar to existing columns in the DX facility. The vessels and facility will be designed to accommodate conversion to Purolite A500 resin in the future. All aspects of vessel conversion to Purolite A500 are to be addressed, including but not limited to materials of construction, instrumentation, distributor design etc. as described above.

Energy savings principles that apply executive order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, shall be incorporated into the design and shall be documented.

2.4 SAFETY

The 100-HX Pump and Treat System shall be assessed as to whether 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," requirements are applicable due to the presence of hazardous chemicals. If applicable, then the requirements shall be complied with. **Basis**: 29 CFR 1910.119.

Eye wash station(s) and safety shower(s) shall be located in the Treatment Facility where the eyes or body of any person may be exposed to injurious corrosive materials in accordance with 29 CFR 1910.151, "Medical Services and First Aid." Access to eyewash and showers shall be unrestricted. **Basis**: 29 CFR 1910.151

The design of the facility shall include fixed ladders, stairs, and platforms wherever possible to do so. Space shall be provided for scaffolding or rolling ladders around equipment to permit maintenance activities. Space the trains far enough apart to allow the rolling platforms to easily pass between trains. The design of the facility shall be such as to avoid the use of portable ladders during maintenance. **Basis**: CH2M-Hill Plateau Remediation Company (CHPRC) ladder policy.

Allow sufficient safe clearances for aisles, at loading docks, through doorways. Minimize overhead obstructions which could create head bumping hazards. Other Occupational Safety and Health Administration (OSHA) regulations shall be complied with as applicable in accordance with 29 CFR 1910.

2.5 UNIQUE ENVIRONMENTAL PROTECTION REQUIREMENTS

The project shall seek to minimize the impact of existing plant and wildlife resources through the site selection process. It is preferred that only previously disturbed habitat will be used for siting of structures, systems, and components (SSC) where possible. Where undisturbed habitat must

be used, the footprint will be limited and appropriate Biological, Ecological, and Cultural Resource Reviews will be conducted.

The S&GW program will coordinate and implement reviews of culturally sensitive sites through the site selection/evaluation process, which may result in relocation of some structures.

Basis: Interim ROD.

Construction and operation of the new Treatment Facility should not interfere with ongoing/future remediation of wastes sites in the vicinity. **Basis**: PRC-RD-EP-15332, *Environmental Protection Requirements,* and PRC-PRO-ER-15333, *Environmental Projection Processes*.

2.6 WASTE ACCEPTANCE CRITERIA

The Management of all wastes generated from this activity are prescribed in the Waste Management Plan for the 100 HR 3 and 100 KR 4 Operable Units. Treatment facility solid waste (sludge, spent ion exchange resin if disposable resin is used or resin is past its useful life, and miscellaneous solid waste) requiring ERDF disposal shall meet WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*. Additional criteria for smearable surface contamination fixed contamination, and activity levels are described in 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for the Environmental Restoration Disposal Facility*. **Basis**: Waste Management Plan for the 100 HR 3 and 100 KR 4 Operable Units.

Other wastes such as paint, epoxies and expired glues shall be managed in accordance with the Waste Management Plan for the 100 HR 3 and 100 KR 4 Operable Units. Treatment facility liquids generated from well surging, development, and sampling shall be disposed at the modular storage units or at the Effluent Treatment Facility (ETF), if acceptance criteria can be met. The ETF waste acceptance criteria is defined in HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*. **Basis**: Waste Management Plan for the 100 HR3 and 100 KR 4 Operable Units

Where possible, the treatment process should be designed so hazardous wastes and radioactive wastes are segregated (i.e., avoid generating mixed wastes). A regulator approved waste management plan shall be prepared before treatment facility waste generation activities are conducted.

2.7 TESTING AND INSPECTION REQUIREMENTS

Any unique or special testing requirements shall be identified by engineering as remedial design proceeds.

Factory acceptance tests (FATs) will be conducted as specified by engineering to ensure the systems, structures, and components (SSCs) and software meet certain requirements prior to shipment. FATs are conducted by the vendor and may be witnessed as desired by engineering or operations representatives, and/or an inspector.

Construction acceptance tests (CATs) will be conducted as specified by engineering to verify proper installation of SSCs and software. Typically, CATs include visual and other non-destructive examination, leak/pressure tests, cleanliness, electrical continuity tests, equipment alignment, motor rotation checks, and verification of component functionality. System functional checks may be specified in lieu of continuity checks. Pressure testing in compliance with ASME B31.3 of the piping and system internal to the facility will be conducted.

Construction acceptance testing is performed by the Construction Contractor in accordance with their procedures to ensure that the construction activities were properly performed in accordance with the design requirements, industry practices, codes and standards, and the quality requirements of the contract. These tests ensure the electrical and mechanical integrity of the new or modified SSCs, and ensure that all equipment was properly installed.

Basis: PRC-PRO-EN-286, *Testing of Equipment and Systems*.

A schedule of inspections shall be determined by engineering as required for facility safety – for example, anchor bolt inspection – as further detailed in General Criteria, Quality Assurance.

Operational testing will be conducted upon successful completion of any CATs and turn-over of the facility to Operations. Operational testing is performed by the Operator with items in their final in-service configuration to verify that functional, operational, and design criteria have been met.

Any additional unique or special testing requirements shall be identified by the design engineering organization as the design proceeds.

2.8 DESIGN LIFE

The design life for the 100-HX Pump and Treat System is 15 years. Replacement of equipment and piping during this period is allowed to meet this goal if life-cycle cost analysis shows it is the lowest cost option of meeting this criterion. **Basis**: Project experience.

2.9 SPECIAL OPERATION AND MAINTENANCE REQUIREMENTS

No special operation and maintenance requirements have been identified during the preparation of this Functional Design Criteria. (Nibco brand PVC valves NOT to be used. Hayward or Spears are acceptable.)

The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate.

Facility and equipment layout and design shall consider the provision of adequate space and means of access to perform maintenance, material handling, and operations. Design shall consider such items (but not be limited to) change out of ion exchange resin, changing of filters, access to instrumentation, access to valves, pump maintenance, air compressor maintenance, and other activities.

2.10 SPECIAL SAFEGUARDS AND SECURITY REQUIREMENTS

There are no special safeguards and security requirements identified for the 100-HX Pump and Treat System. Security to buildings will be maintained by coded (OMNI) locks. Safeguards and security personnel will participate in design reviews to determine if any additional security measures are required.

2.11 CHEMICAL STORAGE

Space within the facility shall be planned for chemical storage cabinets.

The process shall use acid and caustic. Maximum quantity in the facility at any time must not exceed fifty gallons. The use of acid and other chemicals in regard to concentration, container size, and quantity will be determined during the conduct of the Environmental Preparedness Review. An eye wash station and safety shower shall be provided and located adjacent to the acid work station. An outdoor safety shower shall be provided for the areas that need the acid and caustic tank connections/ delivery locations.

As discussed in Section 2.3, space and points of connection in the effluent and influent tanks will be provide for the future addition of necessary tanks, secondary containment, and associated systems to all for pH adjustment using acid and caustic to accommodate the SIR-700 resin.

.

3.0 PROJECT INPUTS

3.1 EXISTING SSCS TO BE MODIFIED

No existing SSCs will be modified by this project with the exception of tie-ins with existing wells, electrical utilities, roads, and communication systems described in Section 1.5.1.

3.2 SYSTEM DESCRIPTION

In order to reduce remedial design costs and expedite the installation of the 100-HX Treatment Facility, the design of the facility will be based, with necessary modifications, on the 600-gpm treatment facility at the 100-D Area (the 100-DX Pump and Treat) that will become operational in 2010. The 100-HX treatment system includes:

- Influent groundwater collection
- Acid pH adjustment including automated pH adjustment to reduce the groundwater pH to nominally 5.0.
- A minimum of three parallel process feed pumps (and transfer and injection boost pumps) shall be provided to transfer water to the IX column trains (and influent tanks and injection wells), and shall achieve a maximum flow rate of 800 gpm with one pump shutdown.
- Eight, skid-mounted ion exchange treatment trains with four columns/train; the flow through each train is 100 gpm at full system capacity. Refer to Section 2.3 for additional details.
- Ion exchange columns contain ResinTech SIR-700. Backwash and resin sluicing system, with resin tote sump load-in/load-out area to remove resins.
- Compressed air system to supply the tote sump diaphragm pump and for operational use throughout the process building
- Caustic addition and pH monitoring of effluent to prevent treated water from being injected into the groundwater if the pH is too low.
- Manual sampling and portable test kits for analysis are used to verify Cr(VI) concentrations on a scheduled basis.
- Treated water storage and AFD controlled injection well booster pumps
- Totes (40 ft^3 each) for resin storage and shipment
- Transfer building(s) to include transfer tank, AFD driven transfer pumps, filters, piping manifold and associated controls

- Extraction wells to include AFD driven well pumps, instrumentation and controls
- Injection wells with level instrumentation

3.3 SYSTEM OPERATION

Each IX skid is configured so that water can flow through any number of columns in any sequence. During normal operation, groundwater flows through the four columns in the following order: lead, lag 1, lag 2, polish. Before the Cr(VI) concentration in the effluent from the polishing column reaches 15 µg/L, the lead column is removed from service for resin replacement. At this time, the lag 1 column becomes the lead column, lag 2 column becomes the lag column, and the polish column remains as the polish column. After the resin has been replaced, the former lead column is returned to service as the polish column, the former lag 2 column becomes the lag 1 column, and the former polish column becomes the lag 2 column. Prior to resin removal, treated groundwater is used to backwash the depleted resin to remove fines and to sluice depleted resins into 40-ft^3 totes for shipment off-site. The backwash and sluicing water is collected in a sump and returned to the influent tank. The resin in the totes is sampled for radiological analysis and shipped off-site for regeneration.

3.4 SAFETY BASIS

The Hazard Category of the facility is based on DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. The HC is determined in accordance with PRC-PRO-NS-8366.

The 100-HX Pump & Treat Facility sum-of-fractions for the HC-3 threshold is well below unity; therefore, the facility is less than HC-3. This is documented in PRC-PRO-NS-8366, Form B and Form E, which are included in the hazard categorization document (SGW-46688) for HX.

3.5 DESIGN ASSUMPTIONS AND ASSOCIATED RISKS

It is assumed that the nominal flow rates indicated in Appendix A can be achieved from the extraction wells by increasing the open screen intervals, determining well packing based on the formation, and revised methods of well development. The risk of not meeting the capacity requirements is introduced by the lack of quantitative data on the ability of the aquifer to yield sufficient quantity of groundwater to the extraction wells. This information will not be available until the wells are drilled and tested after the completion of the design. The well design shall be in accordance with standard well completion practices, as well as meeting state requirements for well construction. Well field modifications may include but not necessarily be limited to pump motor size, well locations, number of wells needed to satisfy the operational objectives. These can be a combination of extraction, injection, and monitoring wells.

Well production numbers are estimated and needed for proper pump and pipe sizing. Over or under sizing could cause pipeline freezing or over pressurizing of the pipes. Wells with low production rates will be monitored and/or shut down during low temperature conditions to

minimize potential freezing. Changes to pumps or transfer lines may be required when actual well production is established.

It is assumed that the treatment technologies chosen will treat Cr(VI) at the design influent concentrations with sufficient efficiency to reduce them to the preliminary cleanup levels. Cr(VI) treatment using IX resins has proven successful at currently operational pump and treat facilities.

It is assumed that no backup power supply is required.

3.6 CONSTRAINTS

There will be constraints on the routing of piping and location of road crossings to and from wells, transfer and process facilities. Routing of pipelines will be resolved during remedial design.

Road crossings should be built up on existing roads to the extent possible so that excavation permits are not required. When building up crossings above grade, ensure that carbon steel pipe casings are sufficiently long to prevent sloughed back fill material from entering casing.

Low ambient temperature may require pump systems to be shut-down for a period of time due to potential for line freezing. It may be necessary to wait for higher temperatures to start-up.

This page left intentionally blank.

4.0 DESIGN CRITERIA

4.1 GENERAL CRITERIA

4.1.1 Quality Assurance Requirements for Design

The CHPRC QA Program is comprised of PRC-MP-QA-599, *Quality Assurance Program* and implementing documents. PRC-MP-QA-599 describes how CHPRC implements DOE O 414.1C *Quality Assurance* and 10 CFR 830 "Nuclear Safety Management". The design contractor was to implement a QA Program that addresses the criteria stated in PRC-MP-QA-599, as appropriate. Subsequent engineering, procurement and construction activity shall utilize PRC-MP-QA-599 as the primary Quality Assurance Planning document.

The CHPRC-00189, Environmental Quality Assurance Plan, Appendix C, *Soil and Groundwater Remediation Project Quality Assurance Project Plan*, describes a graded approach for applying quality levels to items and services on the Soil and Groundwater Remediation Program (S&GRP).

1. Utilize the approach to applying quality levels as outlined in PRC-PRO-QA-259, *Graded Approach*, Section 3, "Process".

2. Additional Items and Services in S&GRP that are Enhanced Commercial (General Service, Quality Level 3) include:

    a. Design and construction of critical elements.

    b. Testing of instruments used to demonstrate regulatory compliance.

    c. Procurement of services or standards used to calibrate instruments used to collect environmental data.

    d. Procurement of services to develop CERCLA and RCRA response action documents that include tasks requiring the use of computational and analytical software, including spreadsheets. Such tasks would include, but not be limited to vadose zone and groundwater contaminant fate and transport modeling and the conduct of human health, ecological, and protection of groundwater risk assessments. CERCLA and RCRA response action documents include the administrative and technical plans and reports developed to support the selection and implementation of removal and/or remedial actions.

    e. Procurement of selected items that are susceptible to counterfeiting as described in DOE G 414.1-3 *Suspect/Counterfeit Items Guide* (e.g., graded fasteners, circuit breakers, ratchet type tie downs and other items as determined by the Design Authority and QA). Purchase orders for such items shall include clauses or statements regarding procurement of potentially suspect or counterfeit items and shall require receipt inspection.

Some SSCs may be Enhanced Commercial (General Service, Quality Level 3) as described in PRC-PRO-QA-259, such as American Society of Mechanical Engineers (ASME) Code items (requiring independent verification), and procurement of items shown to be vulnerable to counterfeiting (requiring receipt inspection). Items will be specified and procured in accordance with the Codes and standards defined in Section 5.0.

Additional QA requirements for this project are listed below.

- Any materials or components that, due to economic constraints must be tolerated by design as a single point of failure with respect to safety of life, health and property, must appear in a suitable inspection plan, or in a submittal of an inspection report:
    - QA inspection plan (e.g., pressure vessels, ASME piping, NEC electrical inspection), and
    - Engineer's inspection report.
- Other material and components that are not single points of failure, yet may have some consequence with respect to safety of life, health and property; these will require individual engineering assessment of any risks remaining with partially redundant systems, throughout the course of design. Specifications, submittals, inspection plans, and reports are to be included, as appropriate.
- The design and construction of the system shall comply with the cleanliness and foreign material exclusion requirements of Section 4.1.8.
- Hydrostatic and in-service leak/pressure testing shall be conducted and documented by a qualified individual.

4.1.2 Additional Criteria

4.1.2.1. Radiological

Conduct radiological design reviews in accordance with PRC-PRO-RP-1622, *Radiological Design Review Process*. Goal shall be to maintain exposure levels below 0.05 mrem/hr at 30 cm, and as far below that as is reasonably achievable per 10 CFR 835, *Occupational Radiation Protection*.

It is desirable to contain the radionuclide constituents as much as possible in order to minimize exposure and the potential contact with radioactive material, especially if that would require the use of personnel protective equipment (PPE). The process system should avoid the used of ferric materials, where Tc-99 tends to plate out. Stainless steel, fiber reinforced plastic or polyvinyl chloride materials are preferable.

The facility should be designed to minimize the generation of radioactive material for storage or as waste.

4.1.2.2. Hazard Identification and Environmental Description

The 100-HX Pump and Treat System shall be assessed as to whether OSHA's Process Safety Management Standard, 29 CFR 1910.119 requirements are applicable due to the presence of hazardous chemicals. If applicable, then the requirements shall be complied with. **Basis**: 29 CFR 1910.119.

If a hazards analysis is required, it shall be performed in accordance with the guidance DOE-STD-1100, *Chemical Process Hazards Analysis*.

4.1.2.3. Environmental Compliance and Permitting

No permitting actions are necessary for this project, as the project is being conducted under the authority of CERCLA Section 121(e)(1), which exempts any response action conducted entirely on-site from having to obtain a Federal, State, or local permit. In lieu of permitting, substantive compliance with ARARs in state and federal codes and regulations will be achieved. The ARARs are fully identified in the Interim ROD, USDOE Hanford 100 Area, 100-HR-3 and 100-KR-4 Operable Units, Benton County, Washington. The new 100-HX Pump and Treat System will discharge treated groundwater to injection wells in the aquifer being remediated by this CERCLA remedial action. The ARARs and compliance strategy are summarized here.

Discharge to Groundwater

The final clean up levels for the 100-HR-3 OU groundwater are federal and state drinking water maximum contaminant levels (MCLs) and state groundwater cleanup standards (where more stringent than the MCLs) that are ARARs for the selected remedy. These cleanup levels define acceptable risk levels for potential beneficial use of the groundwater as drinking water. The final cleanup levels for the contaminants of concern in the 100-HR-3 OU groundwater were developed using federal MCLs. The preliminary cleanup levels are provided in Table 1-1.
Basis: Interim ROD,

Radiological Air Emissions

Radiological air emissions will be evaluated for the 100 HX pump and treat as WAC 173-480, 246-24, 42 United States Code 7401 et seq., 40 CFR 61 Subpart H are not ARAR for the interim action ROD for the 100 HR-3 and 100 KR-4 operable units.

Basis: Best management practice.

Nonradiological Air Emissions

Nonradiological air emissions will be evaluated for the 100 HX pump and treat as WAC 173-400 and WAC 173-460 are not ARAR to the interim action ROD.

Basis: Best management practice

4.1.2.4. Security

There are no special safeguards and security requirements identified for the 100-HX Pump and Treat System. Security to new buildings will be maintained by coded locks (OMNI Locks).

4.1.3 Flexibility and Future Expansion

Wells will be completed and started in phases as determined for attainment of the 2012 RPO goals, as well as to perform aquifer testing for optimization of well locations. **Basis**: SGW-40044.

The 100-HX Treatment Facility will be comparable to the 100-DX facility; however, provisions for the possible future installation of a pretreatment system to remove soluble iron and manganese species [Fe(II) and Mn(II)] shall be included in the remedial design. These ions have the potential to encourage bacterial growth or precipitate within the treatment system or in injection wells upon oxidation. Several methods are available for removing Fe(II) and Mn(II) from groundwater (Minnesota Rural Water Association, 2007). Processes to remove iron usually consist of oxidation to convert Fe(II) to insoluble Fe(III) hydroxide, followed by filtration. Manganese is not as easily removed by this process unless the pH is raised to at least 9.5 (National Drinking Water Clearinghouse. 1998). An alternative when Mn(II) is present is the use of pyrolusite (natural manganese dioxide) or manganese greensand; a filter medium in which the greensand is coated with manganese dioxide (Water and Wastes Digest, 2003). In this process, oxidation and filtration occur in a single step. Exhausted pyrolusite and greensand need to be re-oxidized, usually with potassium permanganate to restore iron and manganese removal capacity. **Basis**: In situ biological or chemical treatment of groundwater with elevated Cr(VI) concentrations is being considered for further implementation at the 100-D Area, which can introduce substantial levels of soluble iron and manganese.

The pretreatment system would be selected, sized, and located based on the composition and flow of water from the location of the in situ biological treatment zone. A pretreatment could be installed upstream of the influent feed tank and in close proximity and downstream of the extraction wells. An area of 40 feet x 40 feet shall be set aside in the 100-HX Treatment Facility for the allocation of the Fe (II) and Mn (II) pretreatment system.

4.1.4 Natural Phenomena Hazards Criteria

Natural Phenomena Hazard Criteria shall conform to the guidance in PRC-PRO-EN-097, *Engineering Design and Evaluation (Natural Phenomena Hazard)*, as modified below;

Design for Performance Category (PC) 1 and PC 2 will be per IBC 2006 for seismic and ASCE 7-05 for wind with the following parameters:

	PC2	PC1
WIND		
Wind Speed	38 m/s(85 mi/h)	38 m/s(85 mi/h)
Importance Factor (I)	1.15	1.0
Exposure Category	C	C
SEISMIC		
Site Class	D*	D*
S_s	0.46	0.46
S_1	0.15	0.15
Importance Factor (I_p)	1.5	1.0
* Site Class C may be used, if soil properties are known		

4.1.5 The Treatment Facility is expected to be a PC-1 facility. Materials of Construction and Protective Coatings

The Treatment Facility and Transfer Buildings will be pre-engineered steel structures. If high humidity, exposure to chemicals, or other corrosive environmental conditions are present, ferrous materials will receive a high-build epoxy coating. These facilities will be supported on reinforced concrete foundations.

The floors will be slabs on grade and shall be coated with an epoxy resin coating finish. An evaluation shall be conducted to determine if the floors should be coated with a non-slip epoxy resin coating finish or remain un-coated concrete.

Generally the piping will be non-metallic (HDPE, PVC, or fiber reinforced plastic), or stainless steel where applicable. Pipe supports will be of corrosion resistant materials. Galvanized steel or aluminum ductwork will be used for the HVAC applications.

Indoor process piping shall be PVC Schedule 80 as established by precedent, while outdoor transfer piping shall be HDPE.

4.1.6 Human Factors

The design should be consistent with the guidance of DOE-HDBK-1140, *Human Factor/Ergonomics Handbook for the Design for Ease of Maintenance*. **Basis**: PRC-PRO-EN-8258.

4.1.7 Fire Protection

Facilities shall conform to the fire resistance requirements of the International Building Code (IBC) (latest edition) in regard to the allowable floor area, building height limitations, and building separations.

Basis: DOE O 420.1B (Supplemented Rev. 4), Section B.1).a

Building construction related to egress and life safety shall comply with NFPA 101, *Life Safety Code*. Conflicts between the IBC and NFPA 101 related to fire resistance rating shall conform to the more restrictive body of requirements contained in either document.

Basis: DOE O 420.1B (Supplemented Rev. 4), Section B.1).a

The Hanford Fire Marshal's Office shall perform the following services:

Review and approve Acceptance Test Procedures
Review and approve site construction documents and shop drawings
Perform the initial review of the facility fire hazards analysis
Issue an Occupancy Permit for the facility

Basis: DOE O 420.1B (Supplemented Rev. 4), Section E.1), Subsections 1, 2, & 3

The fire alarm system (if required) shall comply with the requirements in NFPA 72, *National Fire Alarm Code*, and HNF-36174, *Hanford Chapter of the DOE Fire Protection Resource Manual.*

The installation of a Radio Fire Alarm Reporter (RFAR) shall be in compliance with the requirements of HNF-36174. The RFAR is only required if the fire suppression system and/or the fire alarm system is installed.

The Treatment Facility and Transfer Buildings shall be furnished with hand held portable fire extinguishers in approximate classes to effectively serve extinguishing purposes specific to the area (i.e., electrical room versus process or pump room). Units shall be spaced at distance intervals established by NFPA 10, and mounted in cabinets on the wall. The number and location shall be reviewed and approved by the Fire Marshal.

4.1.8 Cleanliness and Foreign Material Exclusion

Cleanliness and foreign material exclusion (FME) requirements throughout the project life-cycle (manufacturing, shipment, storage, installation, operation, and maintenance) shall be in accordance with HNF-PRO-33415, *Structures, Systems Components Cleaning/Cleanliness and Foreign Material Exclusion*. **Basis**: PRC-PRO-EN-8258.

During shipment and installation, precaution will be taken to keep foreign material out of all the piping, equipment, components, pumps, and vessels. These precautions include the following:

- Ensure the initial removal of any deleterious contaminants;
- Minimize the introduction of foreign materials into interior surfaces and spaces; and
- Ensure the cleanliness of SSC during/after installation, operation, maintenance, repair, or modification.

Extra precaution to prevent laying pipe against sharp objects is to be taken when installing the high-density polyethylene (HDPE) groundwater transfer pipe across the ground and through road crossing casings. **Basis**: Site experience. This has been accomplished by centering the HDPE pipe in the steel casing/sleeve and then filling the void with expanding foam.

4.2 PROCESS DESIGN CRITERIA

4.2.1 Process Design and Operating Limits

Design concentrations of the COCs at the Treatment Facility are based on numerical groundwater modeling and are provided in Table 1-1 for the ion exchange portion of the facility for hexavalent chrome treatment.

Range of outdoor temperatures is -23°F (February 1950) to +113°F (August 1961), as reported by Hanford Meteorological Station. Deviation can be approved by engineering management on a case-by-case basis.

Max design temperature for the SIR-700 IX resin is 180°F. Process shall be controlled to <130°F.

Additional process limits are to be determined during remedial design and explicitly stated in a System Design Description, as complete sets of limits and operating points:

- Physical Design Limit.
- Operating Limit, if different than physical design limit due to a margin of safety being provided.
- Maximum Operating set-point recommendation should be sufficiently inside of the Operating Limit to allow a reasonable margin of controller/operator overshoot as well as effective warning indications.

Provisions shall be made in transfer and/or treatment buildings for sampling individual extraction well influent flows, and treated water flows.

Acid shall be added to the flow upstream of the Ion Exchange process. The acid injection system shall be required to control pH to a set point. The acid injection system capacity shall be capable of maintaining a nominal 7.0 pH in continuous operation for A500 and a nominal 5.0 pH for SIR-700. **Basis**: Resin Performance Characteristics.

Overland conveyance piping shall not be fitted with any leak detection or double-containment system. Leak detection shall be by routine surveillance of the pipeline, and supplemented with low flow detection and/or flow balance monitoring systems.

4.2.2 Mechanical/Piping

Groundwater transfer piping shall be HDPE SDR 9 PE 3408/3608 or PE 4710, single wall, and designed in accordance with ASME B31.3, *Process Piping*. The piping service shall be Category D. The piping shall not to be restrained to provide flexibility to allow for expansion and contraction associated with ambient temperature changes. The pipe will be installed above grade and inspected on a periodic basis to meet the leak detection requirements of WAC 173-303-640, "Tank Systems". HDPE piping shall not be placed on sharp surfaces. The ends of metal pipe sleeves (for road crossings) shall be rounded smooth and/or a PVC sleeve will be added around the HDPE to prevent the steel pipe from cutting the HDPE pipe. Materials other than HDPE may be used on a case-by-case basis with the approval of the mechanical design authority. **Basis**: Current operating practice. HDPE piping shall be routed as close to access roads as possible, but with 8' minimum from edge to road, to aid in required inspection of piping. At road crossings HDPE piping and electrical cables will be routed within metal pipe sleeves under the road.

Pump impellers for centrifugal pumps driven by Adjustable Frequency Drives (AFD) shall not be trimmed except to limit deadhead pressure at maximum rated speed or to ensure that the pumps will operate at the proper place on the pump curve. All pumps that operate as a group, in parallel, shall be of the same size and capacity. In addition, pumps shall have a stable head/capacity curve that continuously rises from rated capacity to shut-off. **Basis**: Current operating practice, necessary for process control of pumps operating in parallel.

The transfer pumps, feed pumps and injection (booster) pumps shall each be a scalable set of pumps sized so that the process may continue at peak capacity upon loss of one individual pump out of the set. Preferred pumps are a vertical inline pump similar to existing facilities. This facilitates maintenance since the facility craft are familiar with these pumps. **Basis**: Current operating practice to maintain flow.

Transfer station intake and discharge manifolds, and tanks, shall be sized to provide for a minimum of two (2) spare connections. Tanks shall be sized considering the maximum expected extraction well flow and an influent flow rate of 15 gpm per each spare connection. **Basis**: To provide contingency for optimization.

Outdoor piping velocity (and flow rate) is critical to prevent overheating and freezing. Optimum line sizing shall be calculated to minimize freezing potential and to minimize solar heating of the water. **Basis**: Current operating practice.

Motor drivers shall be sized for at least 125% of the maximum operating set-points. **Basis**: Necessary for process control.

Well level sensing and pump discharge pressure shall be available at the remote monitoring location. Extraction well heads are to be insulated and heat traced for freeze protection. Piping connections, wiring and insulation shall be arranged to allow removal of the extraction well pump without 100 percent removal of all the heat trace and discharge piping, etc. There will be no backup protection in the form of an automatic line drain back into the well upon shut down other than removal of the extraction well pump foot valve to allow drain back into the well.

Individual extraction flow streams shall be controlled by adjustable frequency drives on the extraction pumps. Extraction well flow rate settings shall be manually controlled as the master set point for overall system flows.

An air compressor station shall be provided in the Treatment Facility for operating diaphragm operated pumps used for resin transfers and flushing. The compressor shall be nominally 35 CFM @ 175 psi, with an ASME receiver tank with nominal capacity of 120 gallons. The system shall deliver 100 psig to the plant. Additionally, compressor shall be sized to accommodate resin SIR-700 air requirement.

Piping containing acid (if acid is used) shall be double-contained in appropriate clear plastic tubing/or other appropriate manner. (hose-in-hose).

The new facility shall utilize high quality long life materials for gaskets, and shall utilize mechanical seals for pumps.

4.2.3 Electrical

Electrical power shall be supplied from existing 13.8 kV power lines.

There will be no combined neutral circuits (Edison circuits). **Basis**: NEC 2008 compliance.

It is preferred that each well head shall have an electrical rack with a main disconnect, an AFD, a remote input/output process controller interface, panelboard with step down transformer, heat trace controller, and a 120 V convenience outlet.

Electrical service design, and any required extension of utilities distribution system, shall be compliant with Hanford Electrical Utilities organization and engineering standards, the *National Electrical Safety Code* (Institute of Electrical and Electronics Engineers [IEEE] C2) and the *National Electrical Code* (NFPA 70).

All circuit breakers shall be provided with a permanently attached lock-out provision.

Arc-flash calculations for distribution components and loads, starting with the service transformer primary fuse, are required and shall be performed in accordance with IEEE 1584, *Guide for Performing Arc-Flash Calculations*.

All electric driven pumps and motorized equipment greater than 1/2 HP shall be 480 VAC, and all motors greater than 1/4 HP shall be three phase to minimize motor maintenance. **Basis**: Cost of motor maintenance.

All control systems equipment and wiring shall be 24 VDC. **Basis**: Worker safety and Hanford lock and tag implementation.

Power supplies fed by 120 VAC and all other circuits more than 50 V shall be located in separate cabinets from the process control sensing and control and communication equipment. **Basis**: Current operating practice and Hanford hazardous energy control implementation.

Outdoor electrical enclosures shall be outdoor rated and dust-tight. **Basis**: NEC compliance and site experience.

All electrical panelboards shall have approximately 20% spare capacity for future expansion.

All electrical equipment installed or used on the Hanford Site must be approved by the AHJ for the *National Electrical Code* (NFPA 70). Electrical equipment is approved, and, therefore, acceptable for use, under the following conditions.

1. If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by an Occupational Safety and Health Administration-recognized nationally recognized testing laboratory (NRTL) as indicated by an NRTL label applied by the manufacturer; or

2. If it has been labeled by an NRTL representative following an NRTL field evaluation; or

3. With respect to an installation or equipment that does not comply with Item 1 or 2 listed above, and for which written justification for the non-compliance is provided to the AHJ prior to installation and energization, it may be approved if it is inspected or tested, using the Non-NRTL Electrical Equipment AHJ Approval Report Checklist, by a Technical Representative designated by the AHJ.

Basis: PRC-RD-SH-11827, *Hanford Electrical Safety Program Requirements*.

Adjustable Frequency Drives (AFDs)

Adjustable Frequency equipment with AFDs is the preferred method of providing pump speed/flow control rather than throttling valves. **Basis**: To meet energy management goals, reduce cost of maintenance, reduce cost of control system engineering, and reduce operating costs.

AFDs shall be located at their motors to comply with NFPA work-safety requirements for proximity of motors, motor controllers and disconnects.

No motor disconnect, circuit breaker, power supply, or any other device shall be enclosed in the same cabinet with an AFD. Expressly for electrical work safety, motor disconnect switches shall disconnect the source of power to the AFD housing, rendering the entire AFD housing energy free. NEMA 1 factory-supplied housing will be appropriate unless intended to be purposely washed down, or located outdoors.

AFDs operator interface will be as manufactured integral to the AFD and of quality appropriate for use by operations personnel (i.e. user friendly).

AFDs shall include PROFIBUS communication adaptors having full access to all configuration parameters and operating status from the PLC.

AFDs located at the wellhead, shall be oriented facing north and sun shades shall be provided to protect the unit from exposure to sunlight.

The PLC and human-machine interface (HMI) software shall accommodate loading of all relevant parameters for every AFD in the facility with a single button push. Motors and AFDs shall be sized so as to:

- Minimize the number of spares required for one or two odd sized motors or AFDs.
- Assure that there is at least 25% spare motor capacity beyond the estimated steady-state operation design load for effective control of process transitions into steady-state operation.

Electric motors shall have a minimum efficiency of that specified in Section 1437 of WAC 51-11. **Basis**: WAC 51-11, Section 1510.

4.2.4 Process Control and Instrumentation

The industrial control system network shall be PROFIBUS standard for compatibility with existing PLC and HMI systems of Supervisory Control and Data Acquisition (SCADA).

The SCADA system, PLCs, HMIs, and distributed control systems (DCS) components of the control system shall be Siemens S7. **Basis**: To be consistent with existing systems and thereby reduce spares, maintenance and operator training, and engineering tool costs.

All treatment and normal process systems and equipment shall be remotely operable from centrally located SCADA stations. All treatment and normal process warning indications and alarms shall be remotely visible and acknowledgeable. All relevant treatment and normal process measurements and status indications shall be visible remotely.

The control system physical design and equipment shall accommodate remote controls to be implemented using HMI and PLC, accommodating as a minimum: basic "manual" start/stop control of each device, and also process measurements, set-point controllers and regulators which assists the operator to specify desired flows and/or levels for wells and tanks.

Flows for each extraction well shall be independently adjustable with insignificant interaction between wells. If adjustment of flow and/or levels is required to achieve proper process performance, then further remote controls should also be accommodated as appropriate.

Measuring instruments and transmitters, shall be provided sufficient to remotely control each process variable (i.e. each flow stream, each pump discharge pressure, each tank or vessel level, each throttle valve position, and any other process attribute to be controlled, such as temperature or pH).

Process control actuators (i.e. Adjustable Frequency Pump Drives, Motor Operated Throttling Valves, Solenoid or Air Powered Valves, Motor Controllers, and other actuators) shall be provided sufficient to remotely control each process variable. **Basis**: Required support for remote control systems, operation efficiency and economic productivity.

Measuring instruments, transmitters, valves, etc. shall be located indoor to the maximum extent possible. **Basis**: Required to support maintenance activities.

Control room shall be network ready so as to facilitate Ethernet (PROFINET) connection among PLC, communications room backboard, and control room desktop HMI, using cabinet or rack mounted Ethernet switch and flush mounted Ethernet receptacle. **Basis**: Option to provide network connectivity to evaluate/restore plant operation from other locations if problems occur during unattended operation.

A flow indicating transmitter will be required for each extraction well (at the final discharge of its conveyance piping) and for each injection well. **Basis**: Mandatory point of process control.

Sampling locations at the treatment facility and at the transfer building(s) shall be provided to sample influent and effluent streams.

A level transmitter in each well will be positioned at the discharge of the pump for extraction wells and at a level to be determined for injection wells. **Basis**: Current operating practice.

Remote control throttle valves shall be installed in the piping to individual injection wells. The valves may be controlled via the PLC. **Basis**: Injection flows are often siphoning, requiring throttle valves to control injection rates. Injection flow distribution control is sufficiently complex—given the size of the piping and valve network--as to be implausible without remote control of the valves and monitoring of the flow distribution given by the PLC. Cannot effectively control flow distribution by hand manipulation on the valves themselves due to the large number of flow interactions and adjustments to make in too short of time.

All motorized equipment shall be both remotely and locally operable and have a local Remote-Off-Local switch. AFD's have built-in local/remote function.

All control interlocks and alarms required to assure safety of life, health, and property, including environment, shall be mechanical or hard wired electrical. Electrical interlock and alarm status shall also be visible remotely.

Unless economically justified by a complete life-cycle cost analysis, no active safety system shall be permitted in the design—safety of life, health and property shall be arranged using passive, non-energized systems—all systems and equipment shall be designed to fail safe on loss of any energy source or communication link. **Basis**: Commercial grade software controls are not sufficiently reliable for protection of life, health and property.

Software systems shall be commercial grade. The economic advantage of the software, in terms of flexibility and adaptability, shall be restricted from imposition of more conservative duties than targeted by commercial grade software process controls industry. **Basis**: Protect the economic value of the software from unrealistic cost burdens of reliability.

Software controls shall exclude any safety-related protective functions, and shall be limited to two specific purposes:

1. Additional protection of equipment and systems from excessive wear and tear or avoidable damage; and

2. Productivity enhancements and measures to optimize cost performance, avoiding design boundaries of operation and facilitating unattended operation performance.

If economical, instrument transmitters shall include local indicators, and their display configuration shall be locally accessible without special communication or programming devices.

Any instrument transmitter that is required to support a mechanized approach to performance monitoring, data acquisition for release beyond the boundaries of engineering and operations organizations, as defined by the RD/RA work plan, shall be provided with a local indicator, and engineered statement of accuracy requirements and calibration check interval. **Basis**: Required for operations verification of data acquisition and reporting accuracy and reliability.

Gravity flow into tanks or other open vessels shall be controlled to prevent overflow, and any requirements for tank headroom (i.e., surge capacity) shall be clearly defined in a system design description (SDD) document.

Floor low-point (or sump) leak detection shall be provided in the transfer buildings and the treatment facility. **Basis**: WAC-173-303-640

4.2.4.1. Operating Assumptions

The facility will be typically be unattended by operating personnel, and shall be designed for continuous operation 24 hrs/day, 7 days/wk. During an unexpected shutdown, the control system shall have an automated calling system to notify responsible personnel to begin recovery operations. **Basis**: Unattended operation provides considerable operational cost savings.

Planned outages for maintenance should be performed during the normal work day, with the system restored to operation by the end of the shift. It is expected that, where possible, the system design will allow maintenance activities without shutting down the (entire) plant. For example, with parallel pumps or trains, one could be taken down for maintenance with only a reduction in plant throughput. **Basis**: Current experience and planned pump-and-treat system availability.

4.2.4.2. Operating Provisions

The system shall shut down on loss of site power, and shall not restart without operator initiation. The need for a master shut down control shall be determined during remedial design.

All operator instruments or adjustments shall be designed for ergonomic access from the operating floor level, or shall be provided with suitable permanent access platforms.

4.2.5 Process Data

All input values, alarms and process control events shall be archived for information and analysis. Current and historical data shall be available in real-time at the control station or by authorized remote logons. **Basis**: Needed for engineering trending.

4.2.6 Process System Structural

Design criteria for the supports and attachments of nonstructural components (pipe supports, electrical equipments and other items) shall be per IBC 2006, as outlined in Section 4.1.4. Expansion anchors shall use any industry standard wedge-type expansion anchor having capacities published by the International Code Council Evaluation Service (ICC-ES) and approved for resistance to wind and seismic loading.

4.2.7 General Process Criteria

Piping and instrumentation diagrams (P&IDs) shall show all process equipment, instruments and physical interlocks or governances. Inasmuch as practicable, P&IDs should include system and process materials, design limits, ratings, interlock set points, software interlocks and controls, and elements appearing in recent ISA Standards for P&IDs, but only where those can be shown consistently throughout the design, or in limited scope of such information is clearly identified in a P&ID cover sheet.

Design of electrical overcurrent and fault protection shall be made to accommodate ease of illustrating and tabulating electrical loads, wire sizing and protection requirements.

Loop diagrams shall not be acceptable for electrical wiring unless actually illustrating a bona-fide current loop through three or more devices in series and the rare example of such a circuit that cannot be reasonably illustrated on electrical ladder diagrams. Loop diagrams may still be developed but not in place of appropriate wiring diagrams or ladder diagrams.

Ladder diagrams shall include all electrical control wiring, DCS inputs and outputs, Motor control elementary diagrams, with:

- Organization by electrical enclosure, clearly showing the boundaries of the topic enclosure and every source of energy into or out of that enclosure
- Every circuit load and short protective device in the enclosure or otherwise dedicated to the enclosure
- Distinct wire terminal identification for each item of equipment. These may be generic if manufacturer is unknown, and as-built by end of construction
- DCS module terminals should be designed for direct landing of field wiring without auxiliary field-terminal blocks. Land wires directly on all control-device terminals if

possible. If field terminal blocks cannot be avoided, use a different termination symbol for field-terminals than for control-device terminals.

- Node based wire identification for all wires, usually by fuse number or signaling device tag, for class 2 control circuits feeding externally mounted transmitters or switches
- Standard motor control elementary, if applicable, to be included in the elementary ladder diagrams
- Cross reference among sheets showing destination/source of wiring leaving/arriving an enclosure
- Standard ladder logic cross reference for location of contacts belonging to relays.

4.3 FACILITY DESIGN CRITERIA

4.3.1 General

The following is a list of design requirements that have been developed from the recently completed 100-KX Pump and Treat Facility and the 100-DX facility design. These requirements shall be incorporated into the 100-HX remedial design.

- Resin tank access ports shall be on the bottom of vessels
- Use moveable power rack (Hoffa boot concept) at well pads
- Identify component model numbers on drawings to facilitate maintenance
- Install ground rods a minimum of 6-inches below grade
- Electronic readouts at eye level with horizontal orientation
- Lighting lined up between trains to provide access for rolling platform access
- When penetrating a wall with piping leave a minimum of four feet between the wall and any panel or access restriction so as to support maintenance.
- Provide access to safely change filter media at main and transfer buildings
- On the perimeter apron have no backup hazards or slopes near by
- No overhead hazards or sharp edges for workers
- Provide safety caps on structural channel (uni-strut)
- Keep piping and conduit - if mounted on the floor, close to the equipment
- Brace long horizontal and vertical runs of pipe to stabilize, protect from vibration, and in personnel contact that could compromise the pipe
- Maintain minimum flow to any online pumps to ensure proper pump bowl cooling capacity
- Design supply and discharge manifolds to equalize supply and discharge pressures among all parallel pumps throughout entire range of process flows.
- For pumps operating in parallel, prohibit individual pump flow-pressure curves that show indeterminate flow at any given pressure (prohibit multiple flow possibilities for any one

pressure, prohibit 'humped' flow-pressure curve, prohibit range of decreasing flow with decreasing pressure.)

- Install flow meter, pressure gauge, etc. with interlocks on pump to ensure that that minimum flow is occurring, and if not, shut the pump down.
- Provide epoxy coating on floors
- Provide an uninterrupted power supply for the control room Human Machine Interface workstation/server
- Vent lines on IX vessels shall allow for drainage
- Filter drains shall have drain valve and pipe to allow for drainage to bucket

4.3.2 Architectural and Civil/Structural

The facility is General Service, Performance Category (PC) 1, it shall be designed in accordance with the IBC 2006 and ASCE 7-05 as outlined in Section 4.1.4.

The facilities shall be a pre-engineered metal building with the following requirements;

- Roof slope - 1 in 12
- Roof Live Load – 20 psf
- Collateral Load – 10 psf
- Ground Snow Load – 15 psf

Both analysis and drawings shall be stamped by Professional Engineer licensed in the state of Washington who is experienced in this work.

Access and egress shall be provided in accordance with the requirements of the IBC and NFPA 101.

Roadway and parking shall be designed in accordance with Washington State Department of Transportation (WSDOT) M41-10, *Standard Specifications for Road, Bridge and Municipal Construction*, or approved equivalent.

A 100-ft asphalt concrete pavement (ACP) shall be provided around the treatment building for operation of fork-lifts and trucks and to provide storage of totes, drums, equipment, etc.

Fences, if required, shall be designed in accordance with WSDOT M41-10, or approved equivalent.

Storm drainage water shall be managed by appropriately sloping paned areas to cause drainage away from the facilities to the surrounding low lying area for infiltration into the native soil.

Steel design, fabrication, and installation shall be in accordance with the American Institute of Steel Construction (AISC) M 011, *Manual of Steel Construction – Allowable Stress Design*, 9th edition.

Welding shall comply with the applicable American Welding Society (AWS) standards.

Concrete design and installation shall be in accordance with American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete*.

In addition, the facilities shall comply with building Construction Specifications developed during design.

The Treatment Facility and Transfer Buildings shall house as much of the equipment and instrumentation as reasonable to minimize exposure to weather and increase the efficiency of maintenance.

Treatment Facility:

- Shall house the process equipment described in Section 3.2, System Description.
- Where ion exchange columns are housed, overhead roll-up doors (12-ft wide x 14-ft high) spaced along building sides located as required for service/equipment access, hollow metal personnel doors located for function/access and per code (egress) requirements.
- Control Room: houses SCADA HMI with view window(s) to process room and facility entrance, access to entry area (off small lobby/viewing hall) and process area.
- Electrical equipment shall be located within the main process area and in close proximity to the process equipment.
- HVAC (wall exhauster, space heater(s)) as required to control the process area environment.
- HVAC to control the control room area environment.

Transfer Buildings:

Pre-engineered metal buildings, with low-maintenance sloped metal roofing, accommodating the following equipment and requirements:

- Pump/Tank Room: for housing equalization tank and transfer pumps, with overhead roll-up doors (possibly a double door) spaced along building sides located as required for service/equipment access, hollow metal personnel doors located for function/access and per code (egress) requirements.
- Electrical/panelboards, AFD's, control cabinets and equipment.
- HVAC (wall exhauster, space heater) as required to control building environment.
- Sampling station

Unrestricted access shall be provided at rollup doors to permit fork truck operations into/out of the process building.

Parking around the Treatment Facility shall be provided for 10 vehicles without obstructing facility operations.

4.3.3 Heating, Ventilation and Air Conditioning

The HVAC design shall comply with the WAC 51-11 and the *International Mechanical Code* (IMC).

Heating and cooling load calculations shall be performed in accordance with the IMC, Section 312, "Heating and Cooling Load Calculations." Heating and cooling system design loads for the purpose of sizing systems, appliances and equipment shall be determined in accordance with the procedures described in the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) *Handbook of Fundamentals.* Heating and cooling loads shall be adjusted to account for load reductions that are achieved when energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE Handbook – *HVAC Systems and Equipment.* Alternatively, design loads shall be determined by an approved equivalent computation procedure, using the design parameters specified in Chapter 3 of the *International Energy Conservation Code* (IECC). **Basis**: IMC, Section 312.

A building that is designed to be both heated and cooled shall meet the more stringent of the heating or cooling requirements as required in this Code when requirements of the exterior envelope differ. **Basis**: WAC 51-11, Section 301.2.

Indoor design temperatures for the 100-HX Pump and Treat System shall be as follows:

Treatment Facility:

- Process Room: 55°F for heating, no cooling*.
- Control Room: 70°F for heating and 78°F for cooling.

Transfer Buildings:

- 55°F for heating, no cooling*.

* Areas that do not require mechanical cooling shall have ventilation provided by exhaust fans and filtered inlet dampers to provide temperature moderation.

Basis: WAC 51-11, Section 302.2.1 for all areas normally manned or used frequently. For the Process Room, and Transfer Buildings, these spaces are infrequently occupied so 55°F was chosen as a minimum to keep processes and equipment above 50°F, ventilation is provided to maintain the high temperature at or near ambient.

The heating or cooling outdoor design temperatures shall be selected from 0.6% column for winter and 0.5% column for summer from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE." (See also *Washington State Energy Code Manual.*) **Basis**: WAC 51-11, Section 302.1

The building envelope requirements of WAC 51-11, Chapter 5, "Building Design by Component Performance Approach," shall be followed.

HVAC systems shall not use supply or return ducting. **Basis**: Current operating practice.

4.3.4 Utilities

Utilities provided by the project include:

Air – Instrument air shall be provided for the Treatment Facility. The air shall meet the requirements of ISA 7.0.01, *Quality Standard for Instrument Air.*

Chemicals –Storage solutions shall provide for secondary containment in accordance with WAC 173-303-640.

As discussed above, space will be provided for approximate 3,500 to 5,000-gal storage tanks for acid and caustic to accommodate the future use of SIR-700.

Communications – Phone and HLAN connections will be provided in the Treatment Facility and the Transfer Buildings. Connection to groundwater engineering network shall be provided at the Treatment Facility.

Electrical – 13.8 kV overhead power lines that are present and in the vicinity will be tapped and extended to provide power to the transfer building and treatment facility.

4.4 GENERAL REQUIREMENTS

Process control set points, interlocks, and behavior of process regulators shall be documented in a System Design Description (SDD) as the definitive configuration control document for the process control system, in addition to the information on the P&ID.

Measurements shall be in English units. Any exceptions shall reflect the most common industry practices for:

- The subject materials and equipment,
- The involved construction organizations, and
- The responsible operations and maintenance organization.

For portability, systems shall not use physical well numbers. Well numbers shall appear only on site plans and on the physical well symbol of the P&ID. **Basis**: Current operating practice.

In addition to industrial safety codes and standards, equipment layout shall provide for most safe and economical maintenance of equipment. **Basis**: Current operating practice.

Routing of piping into and out of buildings shall allow clearances for access by emergency equipment and a minimum 30 ft fire buffer zone free of weeds. **Basis**: Current operating practice.

In addition to *National Electrical Safety Code* (NESC IEEE C2) clearance requirements, layout of 13.8 kV distribution and structural guying shall be arranged to be conspicuous, avoiding blind spots, and out of the way of any interference with safe pedestrian or vehicular traffic, parking and access for loading and unloading. **Basis**: Current operating practice.

All aspects of the outdoor design shall compliment the special requirements to protect cultural resources, wildlife activities and habitat, and environment and any special requirements as identified in the Ecological/Cultural Resource Review. This will be implemented through compliance with PRC-PRO-SH-090, *Excavating, Trenching, and Shoring*, which requires these reviews as part of the excavating permit process. **Basis**: Current operating practice.

Outdoor wiring and signal circuits shall be protected by markers where off road, and by barriers within 5 ft of vehicular traffic. Barriers shall not be designed as vehicular crash barriers. **Basis**: Current operating practice, PRC-PRO-SH-090.

Outdoor piping, electrical cables, and instrument cables shall be marked/protected from vehicular damage in areas with the potential for vehicular traffic.

4.4.1 Equipment and Instrument Identification and Labeling

Unique identification tags are required for all equipment meeting any of these conditions:

- Subject to failure and replacement, or
- Manually operable, or
- Has a purpose in, or is the object of safety lock-out, or
- Valve manifolds for line-up of flow through series of treatment stages.

A project-specific labeling scheme for systems, equipment, instruments, wiring, and piping shall be developed and approved by the 30% design review and shall take into consideration existing schemes developed for existing pump-and-treat systems. **Basis**: DOE O 5480.19, chg 2, Chapter XVIII, *Equipment and Pipe Labeling*.

4.5 DECONTAMINATION AND DECOMMISSIONING

Design of systems and equipment shall consider that all SSCs installed will ultimately be removed and disposed of at the end of their useful life.

Materials that come in contact with hazardous materials should consider the ease with which it can be decontaminated to acceptable levels.

The facility shall be designed for decontamination by use of protective coatings on the floor.

5.0 CODES AND STANDARDS

The following Codes and Standards are applicable to the design of the 100-HX Pump and Treat system and shall be applied as appropriate.

5.1 ARCHITECTURAL/CIVIL/STRUCTURAL

STANDARD NUMBER/REFERENCE	TITLE
American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 350.3-06	Seismic Design of Liquid-Containing Concrete Structures and Commentary
American Institute of Steel Construction (AISC)	
AISC M021	AISC Manual of Steel Construction – Allowable Stress Design, 9th Edition
AISC 360-05	Specification for Structural Steel Buildings
American Welding Society (AWS)	
AWS A 2.4	Weld Symbols
AWS D1.1	Structural Welding Code—Steel
AWS D1.2	Structural Welding Code—Aluminum
AWS D1.3	Structural Welding Code—Sheet Steel
AWS D1.4	Structural Welding Code—Reinforcing Steel
AWS D1.6	Structural Welding Code—Stainless Steel
AWS D9.1	Structural Welding Code—Sheet Metal
AWS QC-1	Guide to AWS Welding Inspector Qualifications and Certification
American Society of Civil Engineers (ASCE)	
ASCE 7	Minimum Design Loads for Buildings and Other Structures
American Society for Testing and Materials (ASTM)	
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 74	Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM C 39/C 39M	Standard Test Methods for Compressive Strength of Cylindrical Concrete Specimens
American Water Works Association (AWWA)	
	AWWA Cross-Connection Control Manual
D100	Welded Carbon Steel Tanks for Water Storage
International Code Council (ICC)	
IBC 2006	International Building Code
IFC 2006	International Fire Code
IMC 2006	International Mechanical Code
IPC 2006	International Plumbing Code
IFGC 2006	International Fuel Gas Code
IECC 2006	International Energy Conservation Code
National Association of Architectural Metal Manufacturers (NAAMM)	
MBG531-00	Metal Grating Manual
MBG532-00	Heavy Duty Metal Grating Manual
Steel Deck Institute (SDI)	
SDI 31	Design Manual for Composite Decks, Form Decks and Roof Decks

5.2 MECHANICAL

STANDARD NUMBER/REFERENCE	TITLE
American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B&PV Code	Boiler and Pressure Vessel Code, Section III, and Section VIII
ASME B16.3	Malleable iron threaded fittings class 150
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ through NPS 24
ASME B16.34	Valves Flanged, Threaded and Welding End
ASME B31.2	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist
American Society of Testing and Materials (ASTM)	
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A182	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM D2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
American Water Works Association (AWWA)	
M55	PE Pipe--Design and Installation
Crane Manufacturers Association of America (CMAA)	
CMAA 70	Single Girder Cranes
CMAA 74	Multiple Girder Cranes
DOE/RL-92-36	Hanford Hoisting and Rigging Manual

5.3 ELECTRICAL

STANDARD NUMBER/REFERENCE	TITLE
Electronic Industries Association (EIA)	
EID/TIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces.
Institute of Electrical and Electronics Engineers (IEEE)	
IEEE 1584	Guide for Performing Arc-Flash Calculations
International Society of Automation (ISA)	
ISA 5.1	Instrumentation Symbols and Identification
ISA 5.4	Instrument Loop Diagrams
ISA 7.0.01	Quality Standard for Instrument Air
ISA RP12.06.01	Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety
National Electrical Manufacturers Association (NEMA)	
NEMA 250	Enclosures for Electrical Equipment (1,000 V Maximum)
NEMA AB1	Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA C12.1	Code for Electricity Metering
NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 5	Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA KS 1	Enclosed and Miscellaneous Distribution Switches (600 V Maximum)
National Fire Protection Agency (NFPA)	
NFPA 70	National Electrical Code
Underwriters Laboratories, Inc. (UL)	
UL 98	Standard for Enclosed and Dead-Front Switches
UL 248	Standard for Low Voltage Fuses
UL 486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
UL 489	Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
UL 508A	Standard for Industrial Control Equipment
UL 943	Standard for Ground-Fault Circuit-Interrupters
UL 1059	Standard for Terminal Blocks
UL 1479	Fire Tests of Through-Penetration Fire Stops
IEEE C2	National Electrical Safety Code (NESC)
NFPA 101	Code for Safety to Life from Fire in Buildings and Structures
NFPA 780	Illuminating Engineering Society of North America (IES) Lighting Handbook

5.4 WASHINGTON STATE CODES (ARARs)

STANDARD NUMBER/REFERENCE	TITLE
WAC 173-160	Minimum Standards for Construction and Maintenance of Wells
WAC 173-218	Underground Injection Control
WAC 173-303	Dangerous Waste Regulations
WAC 173-303-640	Tank Systems

WAC 173-304	Minimum Functional Standards for Solid Waste Handling
WAC 173-340	Model Toxics Control Act - Cleanup
WAC 173-350	Solid Waste Handling Standards
WAC 173-400	General Regulations for Air Pollution Sources
WAC 173-460	General Regulations for New Sources of Toxic Air Pollutants
WAC 173-480	Ambient Air Quality Standards and Emission Limits for Radionuclides
WAC 246-247	On-site Sewage Systems
WSDOT M22-01	Washington State Department of Transportation Design Manual
WSDOT M44-10	Standard Specification for Road, Bridge and Municipal Construction

5.5 FEDERAL CODES (ARARs)

NUMBER	TITLE
10 CFR 835	Occupational Radiation Protection
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 141	National Primary Drinking Water Regulations
40 CFR 268	Land Disposal Restrictions
40 CFR 300.430	Remedial Investigation/Feasibility Study and Selection of Remedy
DOE 0 420.1B	Facility Safety
DOE-STD-1066-99	Fire Protection Design Criteria
DOE STD-1021-93	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
DOE-RL-92-36	Hanford Site Hoisting and Rigging Manual
DOE-HDBK-1132-99	Design Considerations
15 U.S.C. 2601	Toxic Substances Control Act of 1976
16 U.S.C. 470 Section 106	National Historic Preservation Act of 1966
16 U.S.C. 469aa-mm	Archeological and Historic Preservation Act of 1960
16 U.S.C. 1531	Endangered Species Act of 1973
25 U.S.C. 3001	Native American Graves Protection and Repatriation Act
42 U.S.C. 103	Superfund Amendments and Reauthorization Act of 1986
42 U.S.C. 2011	Atomic Energy Act of 1954
42 U.S.C. 6901	Resource Conservation and Recovery Act of 1976
42 U.S.C. 7401	Clean Air Act of 1990
42 U.S.C. 9601	Comprehensive Environmental Response, Compensation and Liability Act of 1980
10 CFR 851	Worker Safety and Health Program

6.0 REFERENCES

10 CFR 830, "Nuclear Safety Management," Code of Federal Regulations, as amended.

10 CFR 835, "Occupational Radiation Protection," Code of Federal Regulations, as amended.

29 CFR 1910.119, Process "Safety Management of Highly Hazardous Chemicals," Code of Federal Regulations, as amended.

29 CFR 1910.151, "Medical Services and First Aid," Code of Federal Regulations, as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Code of Federal Regulations, as amended.

40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities."

42 USC 7401, et seq., *Clean Air Act of 1990* and Amendments, as amended.

ACI 318, *Building Code Requirements for Structural Concrete*, American Concrete Institute, Farmington Hills, Michigan.

AISC M 011, *Manual of Steel Construction – Allowable Stress Design*, 9th edition, American Institute of Steel Construction, Chicago, Illinois.

ANSI/IEEE 1016, *IEEE Recommended Practice for Software Design Descriptions,* New York, New York.

ANSI/ISA S5.5, *Graphic Symbols for Process Displays,* American National Standards Institute, /Instrument Society of America, Washington, D.C.

ASCE 7, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineering

ASHRAE Handbook – *HVAC Systems and Equipment,* American Society of Heating, Refrigeration, and Air Conditioning Engineers

ASHRAE *Handbook of Fundamentals,* American Society of Heating, Refrigeration, and Air Conditioning Engineers

DOE O 420.1B, *Facility Safety,* U.S. Department of Energy, Washington, D.C.

DOE O 414.1c, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

DOE G 414.1-3 *Suspect/Counterfeit Items Guide*, 2004, U.S. Department of Energy, Washington, D.C.

DOE-HDBK-1140, *Human Factor/Ergonomics Handbook for the Design for Ease of Maintenance*, 2001, U.S. Department of Energy, Washington, D.C.

DOE-O-5480.19, *Equipment and Pipe Labeling, 2001, U.S. Department of Energy*

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, 1992, U.S. Department of Energy, Washington, D.C.

DOE-STD-1066, *Fire Protection Design Criteria*, 1999, U.S. Department of Energy, Washington, D.C.

DOE-STD-1100, *Chemical Process Hazards Analysis*, 1996, U.S. Department of Energy, Washington, D.C.

DOE-TSL-1-2007, *Department of Energy Standards Index*, 2007, U.S. Department of Energy, Washington, D.C.

EPA 816-F-00-002, *Implementation Guidance for Radionuclides*

Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*

Handbook of Fundamentals, 2005, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

Hanford Federal Facility Agreement and Consent Order Action Plan.

CHPRC-00189, Environmental Quality Assurance Plan, Appendix C, *Soil and Groundwater Remediation Project Quality Assurance Project Plan*, CHPRC, Richland, Washington.

HNF-36174, *Hanford Chapter of the DOE Fire Protection Resource Manual*, Richland, Washington

PRC-GD-EN-8004, *Functional Requirements Document*, Project Hanford Management System, Richland, Washington.

PRC-MP-QA-599, *Quality Assurance Program*, Rev. 0, CHPRC, Richland, Washington.

PRC-PRO-EN-097, E*ngineering Design and Evaluation (Natural Phenomena Hazard)*, 2006, Project Hanford Management System, Richland, Washington.

PRC-PRO-ER-15333, *Environmental Projection Processes*, Rev. 12, Project Hanford Management System, Richland, Washington.

PRC-PRO-RP-1622, *Radiological Design Review Process,* Rev. 1, Project Hanford Management System, Richland, Washington.

PRC-PRO-QA-259, *Graded Approach,* Rev. 11, Project Hanford Management System, Richland, Washington.

PRC-PRO-IRM-309, *Computer Software Management,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-PRO-EN-8258, *Functional Design Criteria,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-PRO-NS-8366, *Facility Hazard Categorization*, Rev. 6, Project Hanford Management System, Richland, Washington.

HNF-PRO-33415, Structures, Systems Components Cleaning/Cleanliness and Foreign Material Exclusion, Project Hanford Management System, Richland, Washington.

PRC-RD-SH-11827, *Hanford Electrical Safety Program Requirements,* Rev. 6, Project Hanford Management System, Richland, Washington.

PRC-RD-EP-15332, *Environmental Protection Requirements*, Rev. 8, Project Hanford Management System, Richland, Washington.

*HVAC Systems and Equipmen*t, 2008, American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

IEEE 1016, Recommended Practice for Software Design Descriptions, 1998, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE 1584, *Guide for Performing Arc-Flash Calculations*, 2002, Institute of Electrical and Electronics Engineers, New York, New York.

IEEE C2, *National Electrical Safety Code,* Institute of Electrical and Electronics Engineers, New York, New York.

International Building Code, 2006, International Code Council.

International Energy Conservation Code, 2006, International Code Council.

International Mechanical Code, 2006, International Code Council.

ISA 5.1, *Instrumentation Symbols and Identification*, 1984 (R1992), Instrument Society of America, Research Triangle Park, North Carolina.

ISA 7.0.01, *Quality Standard for Instrument Air,* 1996, Instrument Society of America, Research Triangle Park, North Carolina.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 30, *Flammable and Combustible Liquids*, 2003, National Fire Protection Association, Quincy, Massachusetts.

NFPA 58, *Liquefied Petroleum Gas Code*, 2004, National Fire Protection Association, Quincy, Massachusetts.

NFPA 70, *National Electric Code,* 2008*,* National Fire Protection Association, Quincy, Massachusetts.

NFPA 72, *National Fire Alarm Code*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 101, *Life Safety Code*, 2006, National Fire Protection Association, Quincy, Massachusetts.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2008, National Fire Protection Association, Quincy, Massachusetts.

RCW 70.94, "Washington Clean Air Act," Revised Code of Washington, as amended.

*Record of Decision,USDOE Hanford 100 Area, 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County.*U.S. Department of Energy, Richland Operations Office, Richland, Washington.

SGW-40524, *Project Execution Plan for the 100-DX Pump and Treat System*, Rev. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-40044, 2009, *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum,* Rev. 1, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-46688, *Initial Hazard Categorization for the 100 HX Pump and Treat System*, Rev. 0-A, CH2M Hill Plateau Remediation Company, Richland, Washington.

Uniform Building Code, 1997, International Council of Building Organizations.

WAC 51-11, "Washington State Energy Code," *Washington Administrative Code*, Olympia, Washington, as amended.

WAC 173-303-640, "Tank Systems," *Washington Administrative Code*, Olympia, Washington, as amended.

WAC 173-340, "Model Toxics Control Act – Cleanup," Washington Administrative Code, as amended.

WAC 173-400, "General Regulations for Air Pollution Sources," Washington Administrative Code, as amended.

WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," Washington Administrative Code, as amended.

WAC 246-247, "Radiation Protection – Air Emissions," Washington Administrative Code, as amended.

WAC 246-272, *On-site Sewage Systems*, Washington Administrative Code, Olympia, Washington.

WAC 246-290, "Public Water Supplies," Washington Administrative Code, as amended.

WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," Washington Administrative Code, as amended.

WAC 246-272, *On-site Sewage Systems*," Washington Administrative Code, as amended.

WMP-30899, *Design Criteria for the 100-K Expansion Pump and Treat*, Rev. 0, Fluor Hanford Inc., Richland, Washington.

WSDOT M41-10, *Standard Specifications for Road, Bridge and Municipal Construction,* 2008, Washington State Department of Transportation, Olympia, Washington.

This page left intentionally blank.

Attachment A

100-HX Well LOCATIONS

This page left intentionally blank.

Table A-1. 100-HX Well Locations[a]

ITEM	PLANT	BOREHOLE	WELL	SC5 NO	PRIMARY FUNCTION	EASTING	NORTHING	PUMPING RATE	PUMPING RATE	MIN PUMPING RATE	MAX PUMPING RATE	WELL CASING DIA
(--)	(--)	(--)	(--)	(--)	(--)	(m)	(m)	(m^3/d)	(gpm)	(gpm)	(gpm)	(in)
1	H	C7478	199-H1-25	—	EW	576279.2	154069.9	109.0	20	14	26	6
2	H	C7480	199-H1-27	—	EW	576403.9	154023.6	109.0	20	14	26	6
3	H	C7100	199-H1-32	—	EW	576767.0	153766.0	109.0	20	14	26	6
4	H	C7105	199-H1-33	—	EW	576833.0	153716.0	109.0	20	14	26	6
5	H	C7108	199-H1-34	—	EW	576883.0	153667.0	109.0	20	14	26	6
6	H	C7106	199-H1-35	—	EW	576958.7	153627.6	109.0	20	14	26	6
7	H	C7102	199-H1-36	—	EW	576885.2	153486.8	109.0	20	14	26	6
8	H	C7099	199-H1-37	—	EW	577107.0	153642.0	109.0	20	14	26	6
9	H	C7098	199-H1-38	—	EW	577159.3	153562.1	109.0	20	14	26	6
10	H	C7109	199-H1-39	—	EW	577224.0	153533.0	136.3	25	18	33	6
11	H	C7104	199-H1-40	—	EW	577294.7	153489.5	136.3	25	18	33	6
12	H	C7107	199-H1-42	—	EW	577127.0	153385.0	109.0	20	14	26	6
13	H	C7492	199-H1-43	—	EW	577228.0	153366.7	109.0	20	14	26	6
14	H	C7477	199-H1-45	—	EW	577239.4	153062.6	109.0	20	14	26	6
15	H		199-H4-15	—	EW	577906.0	153052.0	109.0	20	14	26	6
16	H	C7485	199-H4-69	—	EW	578011.0	152686.5	109.0	20	14	26	6
17	H	C7483	199-H4-70	—	EW	578003.7	152646.5	83.0	15	11	20	6
18	H	C7581	199-H1-3	SC5-2	EW	576141.1	153358.4	163.5	30	21	39	6
19	H	C7584	199-H1-2	SC5-5	EW	576413.9	153372.0	109.0	20	14	26	6
20	H	C7585	199-H1-1	SC5-6	EW	576693.7	153374.4	109.0	20	14	26	6
21	H	C7587	199-H4-76	SC5-8	EW	576750.7	152975.4	54.5	10	7	13	6
22	H	C7597	199-H4-75	SC5-18	EW	577211.8	152704.7	54.5	10	7	13	6
23	H	C7604	199-H1-4	SC5-25	EW	575786.0	153358.9	163.5	30	21	39	6
24	H	C7605	199-H4-77	SC5-26	EW	576332.9	152982.0	81.8	15	11	20	6
25	H	C7606	199-H1-6	SC5-27	EW	576037.6	153783.0	109.0	20	14	26	6
26	H	A4613	199-H3-2C	—	EW	577632.1	152750.3	218.0	40	28	52	6
27	H	B2779	199-H3-4	—	EW	577544.3	152293.2	436.0	80	56	104	6
28	H	A4630	199-H4-4	—	EW	578060.9	152854.0	38.2	7	5	9	6
29	H	A4618	199-H4-12C	—	EW	578011.8	152919.8	109.0	20	14	26	6
30	H	B2776	199-H4-63	—	EW	578185.8	152665.5	98.1	18	13	23	6
31	H	B2777	199-H4-64	—	EW	577946.1	153010.6	65.4	12	8	16	6

ITEM	PLANT	BOREHOLE	WELL	SC5 NO	PRIMARY FUNCTION	EASTING	NORTHING	PUMPING RATE	PUMPING RATE	MIN PUMPING RATE	MAX PUMPING RATE	WELL CASING DIA
(--)	(--)	(--)	(--)	(--)	(--)	(m)	(m)	(m^3/d)	(gpm)	(gpm)	(gpm)	(in)
1	H	C7113	199-H1-20	—	IW	575705.7	154184.4	310.7	57	40	74	6
2	H	C7111	199-H1-21	—	IW	575896.6	154163.2	490.6	90	63	117	6
3	H	C7110	199-H3-25	—	IW	577408.5	152989.7	109.0	20	14	26	6
4	H	C7115	199-H3-26	—	IW	577440.9	152846.3	54.5	10	7	13	6
5	H	C7114	199-H3-27	—	IW	577566.8	152810.8	54.5	10	7	13	6
6	H	A4628	199-H4-18	—	IW	578020.0	152755.0	109.0	20	14	26	6
7	H	C7487	199-H4-71	—	IW	578004.6	152583.5	54.5	10	7	13	6
8	H	C7488	199-H4-72	—	IW	578036.0	152500.3	54.5	10	7	13	6
9	H	C7484	199-H4-73	—	IW	577940.6	152370.0	109.0	20	14	26	6
10	H	C7489	199-H6-2	—	IW	577886.2	152193.2	109.0	20	14	26	6
11	H	C7586	199-H4-79	SC5-7	IW	575652.6	152158.0	327.1	60	42	78	6
12	H	C7588	199-H4-78	SC5-9	IW	576184.8	152161.0	218.0	40	28	52	6
13	H	C7598	199-H4-74	SC5-19	IW	577225.1	152169.4	109.0	20	14	26	6
14	H	A4620	199-H4-14	—	IW	577803.7	152752.4	452.4	83	60	107	6
15	H	A4627	199-H4-17	—	IW	577779.2	153037.6	256.2	47	33	61	6

IW = Injection Well
EX = Extraction Well

a. Reference: DOE/RL-2006-52, Rev. 2, Decisional Draft
b. Coordinates are Washington State Pane Coordinate System (NAV88, meters)
c. Table values are as of 4/10/09
d. Four wells from the H-area have been temporarily assigned to the DX system.

Distribution

Onsite

1	U.S. Department of Energy, Richland Operations Office	
	DOE Public Reading Room	H2-53
	CHPRC	
	G. L. Hopkins	R3-50
	M. T. Bachand	H3-23
	R. S. Popielarczyk	R3-60
	C. L. Rambo	R3-50
	J. G. Riddelle	R3-50
	A. J. Rossi	R3-60
	F. H. Biebesheimer	R3-60
	W. R. Thackaberry	R3-60
	J. L. Smoot	R3-50
	R. W. Whitlock	R3-50
	J. C. Williams	R3-19
	J. A. Winterhalder	R3-60
	G.A. Edwards	R3-50
	D.O. Neshem	R4-24
	W.F. Barrett	R4-23
1	Pacific Northwest National Laboratory	
	Hanford Technical Library	P8-55
1	Lockheed Martin Information Technology	
	Document Processing Center	H6-08

This page left intentionally blank.