SECOND PERIODIC REVIEW

L-BAR SITE
Cleanup Site ID# 88
Facility Site ID# 762

Prepared by
Washington State Department of Ecology
Eastern Regional Office
Toxics Cleanup Program
Spokane, WA

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EXECUTIVE SUMMARY

This document is the second periodic review of compliance monitoring data gathered from 2012–2017 to evaluate the effectiveness of the remedial actions and institutional controls for the L-Bar Site located at Highway 395, Chewelah, Washington, 99109 in Stevens County (Site).

The purpose of periodic reviews is to determine the long-term effectiveness of the implemented cleanup actions at sites where residual contamination is still present above the Site cleanup levels (CULs).

Remedial actions were implemented at the Site from 2001 to 2004. Earlier interim removal actions were also conducted from 1997 to 2000. The cleanup actions implemented at the Site included source material removal, natural attenuation, closure of one of the drainage ditches, and long-term monitoring.

Previous source removal actions were effective at eliminating the primary contaminant release mechanisms that allowed source-related contaminants to move into soil, sediments, shallow groundwater, and surface water at the Site.

Site CULs have not been met, although some improvements to groundwater and surface water quality have been demonstrated since the last periodic review. Primary indicator hazardous substances (IHSs) (chloride, ammonia, and total dissolved solids) in surface water and shallow groundwater are still elevated compared to their established CULs. Concentrations of secondary IHSs (trace metals, nitrate, nitrite, and pH) exceed CULs at selected locations.

CULs are still being exceeded at the Site. However, as long as the existing Restrictive Covenant is active and remains effective in protecting human health and the environment from exposure to hazardous substances, no further action is required beyond the compliance monitoring.

IHS concentrations in groundwater are expected to decline over time, due to natural attenuation.

TABLE OF CONTENTS

Contents

LIST OF ACRONYMS

Ammonia-N – Nitrogen as ammonium ions or free ammonia
CAP – Cleanup Action Plan
CMP – Compliance Monitoring Plan
CSID No. – Dept. of Ecology Cleanup Site Identification Number
COC – Constituent of Concern
CUL – Cleanup Level
DCAP – Draft Cleanup Action Plan
FCAP – Final Cleanup Action Plan
FSID No. – Dept. of Ecology Facility Site Identification Number
FB/FBR – Flux bar/Flux bar residue
FSQV – Freshwater Sediment Quality Values
FS – Feasibility Study
IHS – Indicator Hazardous Substances
MTCA – Model Toxics Control Act
N – Nitrogen
NPDES – National Pollution Discharge Elimination System
NWA- Northwest Alloys, Inc.
RI – Remedial Investigation
SCCD – Stevens County Conservation District
SWBU – Shallow Water Bearing Unit
TDS – Total Dissolved Solids

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The Washington State Department of Ecology (Ecology) completed this second periodic review of compliance monitoring data from 2012 – 2017 to evaluate the effectiveness of the remedial actions and institutional controls at the L-Bar Site (Site). Site periodic reviews are required for sites with institutional controls in accordance with Washington Administrative Code (WAC) 173-340-420(2)(a). Site remedial actions were completed from 1996 to 2004 under the Model Toxics Control (MTCA) Cleanup Regulation, Chapter 173-340 WAC.

Cleanup levels (CULs) for the Site are based on the following:

- Method B for groundwater
- Method C industrial for soils
- Method B for the surface water in the West Ditch, which is discharging to the Colville River
- Method C for the surface water in the Main Ditch which currently does not discharge to the Colville River
- Method C industrial levels for soils and sediments that are protective of surface water in the West Ditch and the Main Ditch

Past cleanup actions at this Site were carried out in accordance with the requirements of Agreed Order No. DE 00TCPER-984 dated June 12, 2000, entered into between Northwest Alloys, Inc. (NWA) and Ecology. NWA implemented the remedial actions from 2001 to 2004 in accordance with the L-Bar Material Removal and Compliance Monitoring Work Plan (CH2M, 2001a) and as required by the Ecology's June 2000 final Cleanup Action Plan (CAP). Earlier interim removal actions were also conducted from 1997 to 2000 under Agreed Order No. DE 94TC-E104. The cleanup actions implemented at the Site included source material removal, natural attenuation, closure of one of the drainage ditches (Main Ditch), and long-term monitoring.

1.1 PURPOSE OF THE FIVE-YEAR REVIEW

The purpose of periodic reviews is to determine the long-term effectiveness of the implemented cleanup actions at sites as described in WAC 173-340-120(5)(b) and WAC 173-340-420, where residual contamination is still present above Site CULs.

This document includes the following information to support the evaluation of the long-term effectiveness of the cleanup actions implemented at the Site:

- A brief description of the site background, including property ownership, regulatory applicability, feasibility study, cleanup levels, remedial actions, and recent supplemental activities/data collection.

- A brief description of the current status of the compliance monitoring program (CMP) groundwater and surface water monitoring programs.

- A summary of current surface water and groundwater contaminant levels.

- A summary of apparent changes in surface water and groundwater contaminant levels since the previous (2012) periodic review was completed.

- An evaluation of areas where CULs have been attained in response to previous source removal actions and ongoing natural attenuation processes.

- A trend analysis that includes all the CMP groundwater wells and constituents to assess relative changes in groundwater concentration to document progress toward achieving CULs.

- A focused predictive analysis for indicator groundwater constituents and wells located within the residual magnesite pile to provide insight on remedy progress and an indication as to whether CULs may be achieved within a 20- to 40-year restoration period.

- An estimate of the remaining restoration period using calculated chloride groundwater flux and surface water discharge data.

- Recommendations (as needed) to (1) address potential data gaps, (2) further optimize remedial action performance, and (3) amend the existing CMP to improve the effectiveness and efficiency of existing monitoring and reporting requirements.

2.0 SUMMARY OF SITE CONDITIONS

2.1 SITE DESCRIPTION

The Site is located on the west side of Highway 395 two miles south of Chewelah in the Colville River Valley of Stevens County (Figure 1.1).

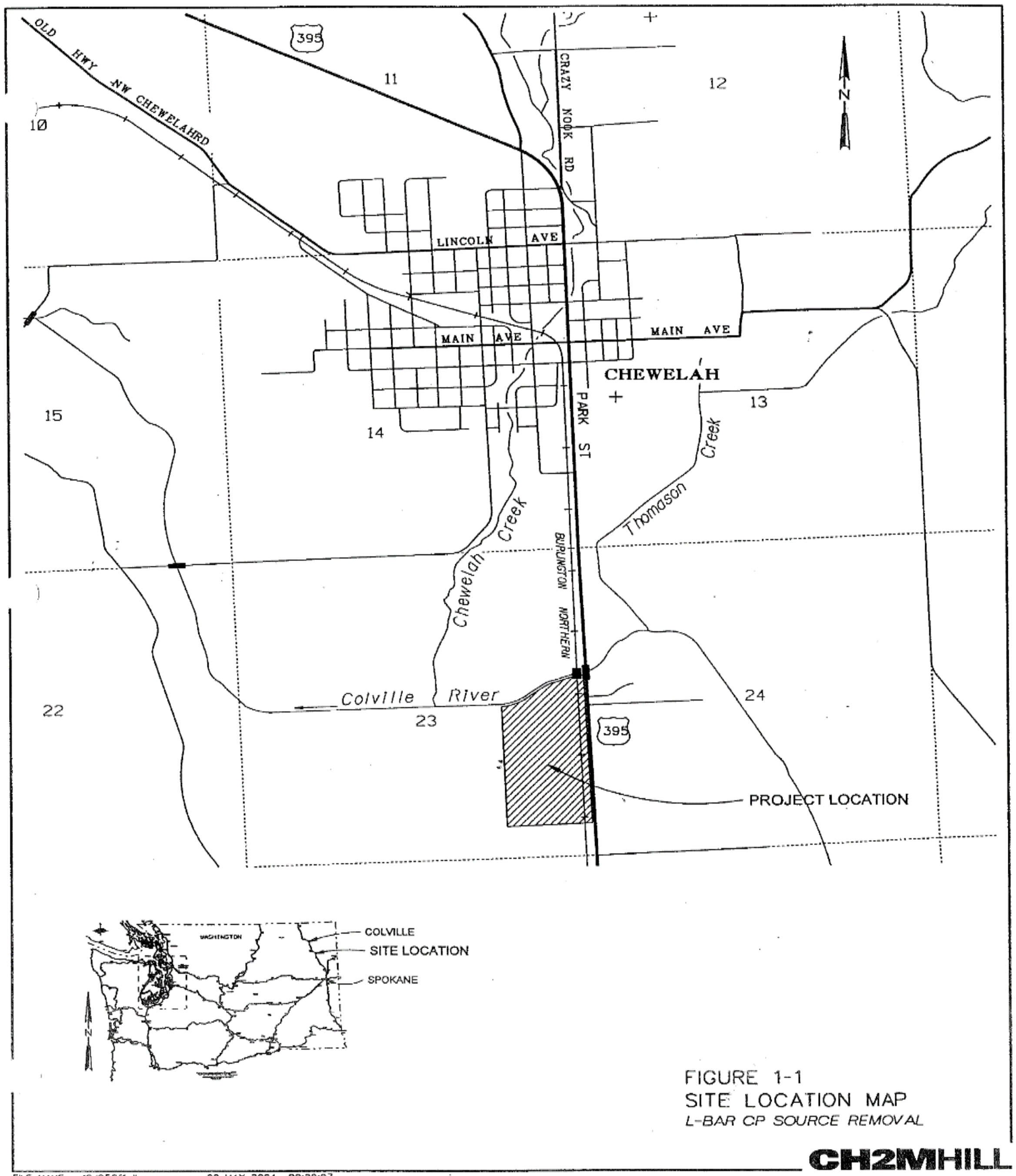


Figure 2.1 Site Location Map (CH2M, 2017)

The Site occupies approximately 67 acres of industrial and agricultural land. The industrial area covers approximately 50 acres. An adjoining 17-acre agricultural field (the North Field) lies between the industrial area and the Colville River. The Site layout is described as follows (Figure 2.2):

- The Magnesite Residue Pile covers nearly 17 acres within the southwest quadrant of the Site. The magnesite residue materials represent mining/milling byproducts from an earlier era of Site industrial operations (Northwest Magnesite), and are not subject to cleanup due to L-Bar's past on-Site operations.

- The West Ditch provides drainage for the western part of the Site and continues to discharge to the Colville River.

- The former Main Ditch provided drainage from the interior part of the Site and had previously discharged to the Colville River. In 1994, a dam was constructed to stop further the discharge to the river. In summer 2003, the ditch was covered and closed.

- Two high-density polyethylene- (HDPE) lined storage ponds, the Evaporation Pond and the Holding Pond, were part of the water management system during L-Bar's operating years. These ponds are still present on the Site; however, the Evaporation Pond is no longer in use and does not support current remedial actions at this site. The Holding Pond continues to be used for collection and storage of storm water that originates primarily as runoff from paved portions of the main plant area.

- Excess water from the Holding Pond discharges into the Colville River via a HDPE-lined drainage ditch that runs parallel to the former Main Ditch.

- The Former Covered Flux Bar Residue Pile was removed as part of the cleanup actions.

- Former Flux Bar and Flux Bar Residue that was on top of the southern portion of the Magnesite Pile was removed during an interim cleanup action.

- The former plant buildings.

- A HDPE-lined Sanitary Lagoon formerly used for on-site sewage waste management (currently inactive).

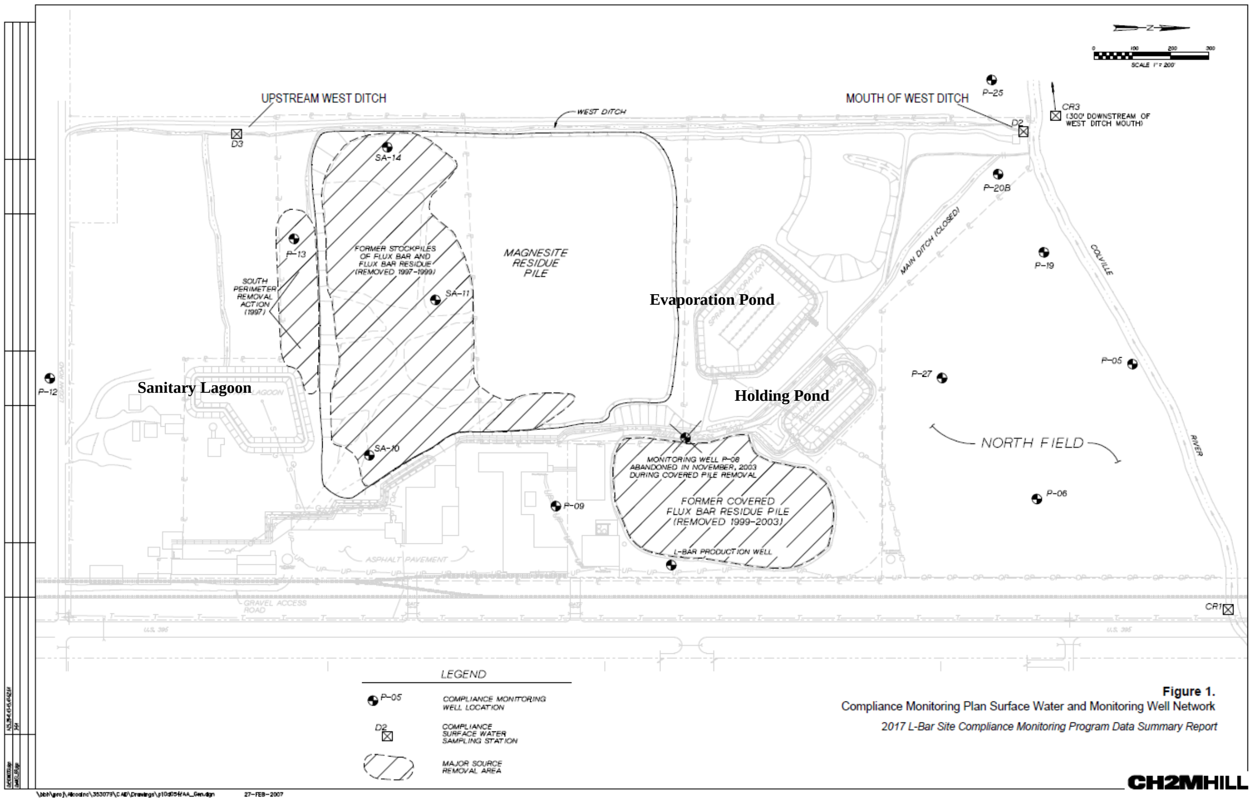


Figure 2.2 Site Map (CH2M 2017)

2.1.1 Current Site Ownership

The Site consists of six parcels: Stevens County Parcel Nos. 2600000, 2601080, 2600700, 2600800, 2600900, and 2600500.

Parcel 2600000 forms the northern portion of the Site and includes approximately 19.05 acres. The parcel is currently owned by Chewelah Properties LLC. The parcel consists of grass meadows (the North Field in Fig. 2.2) that are bounded by Colville River to the north and the railroad right-of-way/Highway 395 to the east. The North Field commonly floods during the late winter/early spring season.

Parcel 2601080 forms the eastern and north-central part of the Site and includes approximately 27.25 acres. Chewelah Properties LLC currently owns the parcel. The former magnesite and flux bar (FB) processing buildings were located on this parcel, as well as the Former Covered Flux Bar Pile (Figure 2.2). The Holding Pond and the former Evaporation Pond are also located within this parcel. The lined ditch draining the Holding Pond runs along the boundary of this parcel and Parcel 2600000 toward the Colville River. A portion of Parcel 2601080, including much of the Former Covered Flux Bar Pile footprint, is currently used for an agricultural enterprise.

Parcel 2600700 encompasses the southern portion of the magnesite residue pile and includes approximately 10.70 acres. Several piles of FB used to be stored within the parcel. These FB piles were removed as part of the interim Site cleanup action as described in subsection 2.5 of this document. The parcel is currently owned by Mr. William H. Brauner.

Parcel 2600800 forms the very southeastern corner of the Site and includes approximately 0.42 acres. This parcel is occupied by three elevators and storage bunkers that were used to store processed magnesite product. The parcel is currently owned by Chewelah Properties LLC.

Parcel 2600900 forms the northern portion of the magnesite residue pile and includes approximately 11.08 acres. The parcel is currently owned by Mr. William H. Brauner.

Parcel 2600500 forms the western boundary of the Site, bordering the Magnesite Residue Pile, and is approximately 80.00 acres. The parcel is currently agricultural land. Contaminated groundwater occurs under the northeastern corner of this parcel. The current owner of this parcel is Mr. Henry L. Hagen.

Until 2005, the Site (except for Parcel 2600500) was under the ownership and control of NWA. In late 2005, NWA sold the five parcels described above to the Ernie Smith Trust. As part of the sales agreement, NWA (currently Alcoa) and its representatives retain access rights to the Site (and the five parcels) for CMP in support of MTCA cleanup activities. Alcoa has permission from the property owner to enter Parcel 2600500 and sample well P-25.

2.1.2 Site Surroundings

The Site is bounded to the north by the Colville River. The land beyond the river to the north is currently agricultural with a strip of wetland meadows along the river. The Site is bounded to the east by Highway 395 and the BNSF Railway right-of-way. Across the highway to the east, Stevens County owns the land, which includes agricultural fields and a road maintenance/ vehicle equipment yard southeast of the Site. The City of Chewelah owns a cemetery northeast of the Site across Highway 395.

The Site is bounded to the south by an active industrial/commercial operation (White Stone Calcium Properties) that processes rock for decorative purposes. Large piles of aggregate material currently are stockpiled throughout the White Stone Calcium property. A closed asphalt works is located to the west of the rock processing facility. The west side of the Site is bounded by agricultural fields irrigated with water from the Colville River.

2.2 SITE HISTORY

2.2.1 Former Operations and Cleanup Activities

The Site has been associated with magnesium processing since the 1930s. Large quantities of magnesite ore for magnesium oxide production were processed and stockpiled at the Site until 1967. In the mid-1970s, the facility was converted to recover magnesium from FB, a magnesium processing byproduct. NWA supplied FB primarily from their magnesium plant near Addy, Washington, and sold it to the facility owners. The magnesium recovery facility was owned and operated by Phoenix Resources Recovery, Inc. from 1977 to 1986. L-Bar Products, Inc. operated the facility from 1986 to 1991 when it closed down due to insolvency.

The magnesium recovery process involved crushing raw FBs and screening the crushed materials to recover metallic magnesium granules. The remaining material was called flux bar residue (FBR). Magnesium, magnesium oxide, magnesium chloride, potassium chloride, calcium chloride, and lesser amounts of magnesium nitride and magnesium fluoride were the primary constituents of FBs and FBR. These materials were very reactive with water; the reactions were exothermic and had caused several fires at the Site during the plant’s operating years. The reaction of magnesium nitride with water releases ammonia. The magnesium and potassium chloride salts were highly soluble in water and easily leached from these materials into groundwater. These materials also designated as “state-only dangerous waste” due to fish toxicity.

When the plant closed in December 1991, predominantly raw FB with some FBR was stored on top of the southern half of the Magnesite Residue Pile in several separate uncovered piles (CES, 2001). The Magnesite Residue Pile is not vegetated, is uncovered, and has steep side slopes. Processed FBR was stockpiled in a large HDPE-covered pile to the north of the plant’s main processing area.

Ecology issued several enforcement orders and penalties to L-Bar for violations of air quality, water quality, and dangerous waste regulations while the plant was in operation. Some emergency actions and plant rehabilitations were undertaken to address the orders. However, when the plant closed, an estimated more than 100,000 tons of FB and FBR materials (under the covered pile, on top of the magnesite pile, and in buildings) were left on Site. Past operating practices and inadequate storage of FB and FBR resulted soluble components leaching from the materials into soil, groundwater, and surface water.

The formal MTCA cleanup process began in 1994. NWA entered into an agreed order with Ecology in 1995 that included provisions for conducting interim actions, a remedial investigation (RI), and a feasibility study (FS). The RI/FS included further site investigations and sampling, and evaluating cleanup alternatives for the Site. CH2M completed the RI in 1998 and the FS in 1999. Interim actions under this agreed order performed from 1996 to 1999 included removing FB and FBR from the top of the Magnesite Residue Pile, and removing additional FB and FBR from the plant’s main processing area (CH2M, 2001).

Ecology issued a draft CAP in April 2000; after public review and comment, the final CAP was issued in June 2000 as part of Agreed Order No. DE 00TCPER-984. Cleanup actions included removing the covered FBR pile north of the processing area and closing the Main Ditch, which took place from 2000 through 2004 (CH2M, 2001a and CH2M, 2012a). On-Site operations that occurred before L-Bar's ownership generated the magnesite pile, which was not subject to cleanup actions under the agreed order.

2.3 PHYSICAL SITE CHARACTERISTICS

2.3.1 Site Geology

The Site is located near the center of the Colville River Valley. The uppermost soils underlying the Site represent a mixture of naturally deposited sediments and artificially placed fill as identified in the RI (CH2M, 1998). These soil units can be grouped into four lithologically distinct deposits:

- Fill/magnesite residue
- Recent alluvium
- Volcanic ash
- Glacial silt and clay

Fill deposits, predominantly magnesite pile residue, are found in the southern portion of the Site, in the L-Bar plant area, in areas around the Holding Pond and Evaporation Pond, and along the eastern side of the former Main Ditch. Recent alluvial sediments consisting of silty sand, silt, and intermittent organic-rich layers up to several feet thick underlie the North Field. Volcanic ash was frequently encountered in the northern half of the Site at depths ranging from 3 to 6 feet below grade and typically lies atop a thick (>100 feet) sequence of silt and clay deposited in a glacial lake. A very stiff-to-hard clayey silt up to 10 feet thick underlies the L-Bar Site and represents the uppermost member of the glacial lake sediments.

2.3.2 Surface Water Hydrology

Primary surface water features associated with the L-Bar Site historically have included the following:

- Main Ditch
- West Ditch
- Colville River

The Main Ditch was a man-made drainage feature that extended diagonally across a large portion of the Site. The ditch ran from the southeast corner of the site to near the northwest corner (mouth) where it formerly discharged to the Colville River (Figure 2.2). The Main Ditch provided an important drainage function for the Site. This ditch captured both surface water runoff and shallow groundwater discharge and routed these waters to the river. The Main Ditch was filled with granular soil material in 2003 as part of the final Site cleanup actions.

The West Ditch runs along the western Site margins. This man-made ditch collects surface water runoff from areas immediately south of the Site and from adjacent agricultural fields west of the Site. The West Ditch also captures shallow groundwater from along the west side of the Magnesite Residue Pile. Water in the West Ditch (when present) discharges directly into the Colville River.

Discharge from the West Ditch typically ranges from being dry, typically during the summer to early fall, and peaks generally in the range of 0.1 to 0.2 cubic feet per second (cfs) during the spring seasonal highs. Discharge in the West Ditch is influenced by seasonal precipitation events and an influx from shallow groundwater along its length. During seasonal flooding of the Colville River, river flow can back-up into the lower reaches of the West Ditch and interrupt typical drainage conditions.

The Colville River forms the northern Site boundary. The river's current course near the Site has been influenced to some degree by historical channelization and realignment. The Colville River serves as the primary hydrologic feature influencing surface water and shallow groundwater flow at the Site.

The discharge measured at the Colville River stations typically ranges from a seasonal low of approximately 20 to 30 cfs (typically July through August), and peaks in the range of 250 to 450 cfs during spring snow melt seasonal highs (typically late March through early May). The Colville River discharge data was based on monthly readings from 2000 to 2006. Surface water sampling intervals were reduced from monthly to semi-annual after 2006.

Further discussion of the latest surface water discharge data is in Section 5, Compliance Monitoring Results.

2.3.3 Groundwater Hydrology

Groundwater at the Site is present in three units:

- SWBU – a thin, unconfined, locally discontinuous water-bearing zone, generally 1 to 3 feet thick that maintains a water table at or near land surface under normal seasonal conditions, approximately 1 to 8 feet below the ground surface. However, during periods of intermittent drought, these shallow water-bearing zones may be discontinuous or locally absent. The average hydraulic conductivity, based on slug tests in select wells, is 4.6 feet per day (CH2M, 1998).
- Intermediate Aquifer – confined, locally developed water-bearing zone at a depth of approximately 70 to 80 feet below ground surface (bgs) that averages about 50 feet of thickness. This zone is separated from the SWBU by a clay aquitard. A strong upward vertical gradient exists between this deeper confined aquifer unit and the SWBU.
- Deep Aquifer – confined, regionally distributed sand and gravel aquifer encountered at a depth ranging from 190 to 360 feet bgs.

Groundwater levels typically fluctuate 2 to 4 feet seasonally. Seasonal highs typically occur in February, and seasonal lows typically occur in October. In the North Field, shallow groundwater

(1 to 8 feet bgs) locally occurs at or near the ground surface during the wet season. Seasonal flooding of the North Field has occurred over the years.

Groundwater from either the intermediate or deep aquifer is the primary source of potable drinking water for rural residents and commercial operations near the Site. Current on-Site agricultural operations are supplied from a well (L-Bar in Fig 2.3 and 2.4) that is screened in the intermediate aquifer. No known water supply wells are within the SWBU in the immediate vicinity of the Site (CH2M, 1998).
Groundwater in the SWBU flows in a general northwesterly direction toward the Colville River under an average site-wide hydraulic gradient of 0.003 to 0.005 feet. Shallow groundwater flow in the North Field is slow because of the low permeability of the alluvial sediments (consisting of silty sand, silt, and intermittent organic-rich layer) and volcanic ash in the area.

A more expanded discussion of current hydrologic conditions is presented in Section 6, Compliance Monitoring Results.

2.4 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of contamination as presented in the CH2M 1998 RI Report.

2.4.1 Magnesite Residue Pile

During the RI, a distinct chloride and/or ammonia-leaching front was evident at approximately 7 to 15 feet below the interface between the magnesite residue and the raw FB and FBR material. The depths are based on field screening results for chloride and ammonia. Trace metal and metalloid concentrations in the FB materials below the leaching front were similar to those above the front demonstrating little potential leaching or mobilization of metals/metalloids.

2.4.2 Unsaturated Zone Soils

Several unsaturated zone soil samples collected from the North Field and main plant areas contained elevated concentrations of chloride and nitrogen as ammonia. The elevated concentrations in the main plant area were found in areas where source material stockpiling occurred. In the North Field, elevated levels of chloride and ammonia as nitrogen in the unsaturated soils likely resulted from seasonal saturation of the soils by high groundwater generated near the covered pile and/or surface water seeping from the Main Ditch into the SWBU.

2.4.3 Saturated Zone Soils

The RI investigation discovered that chloride and ammonia had penetrated into the clay beneath the SWBU at least 10 feet bgs. Chloride concentrations up to 4,650 milligrams per kilogram (mg/kg) and 216 mg/kg of ammonia were detected. Over 1,000 mg/kg of chloride was still detected at 10 feet bgs and approximately 4 feet into the clay beneath the SWBU.

2.4.4 Groundwater

Groundwater in the SWBU has been contaminated by chemicals that leached from FB and FBR. In contrast, the intermediate and deep aquifers do not show evidence of chemical impacts from FB or FBR.

Based on RI data, the following contaminants of concern (COCs) were identified as indicator hazardous substances (IHS) to establish cleanup requirements in the CAP (Ecology, 2000) within the SWBU:

- Chloride – This contaminant is found as an anion (negatively charged ion). Chloride in shallow groundwater is primarily sourced from the FB and FBR materials, which contain various metal salts. Chloride is a primary tracer that helps delineate areas of residual contamination caused by FB and FBR.

- Total Dissolved Solids (TDS) – TDS is a measure of the dissolved mineral content of water and commonly includes carbonates, chlorides, sulfates, nitrates, sodium, potassium, calcium, and magnesium.

- Ammonia-N (as nitrogen [N]) – The FB and FBR materials both contain ammonia that occurs as a byproduct of the magnesium smelting and refining process. Ammonia-N can be toxic to certain aquatic organisms.

- Nitrate-N (as N) – Nitrate is an anion that is often associated with biological activity, including waste byproducts. At the Site, the primary source of nitrate is from biological oxidation of ammonia into nitrite and then into nitrate (nitrification).

- Nitrite-N (as N) – Nitrite is an anion in groundwater. Nitrite typically forms as a short-lived, intermediate byproduct of ammonia nitrification.

- pH – The pH value of groundwater was influenced by various source materials and naturally occurring geochemical processes at the Site. The chemical composition of the L-Bar source materials and Magnesite Residue Pile tended to create slightly to moderately basic (alkaline) groundwater conditions (pH values >7.0 but <10.5).

- Metals and Metalloids – The L-Bar source materials contained various metals and metalloids including barium and manganese. Other metals such as selenium and thallium also were detected at slightly elevated concentrations in shallow groundwater. Chemical changes in the magnesite pile caused by L-Bar source materials may have influenced selenium, thallium, and possibly other trace metals to become slightly enriched in shallow groundwater at the Site.

2.4.5 Surface Water

Some of the IHS were also found in surface water.

- Before the Main Ditch was closed and covered in 2003, elevated chloride, ammonia, and TDS concentrations were observed throughout the length of this man-made drainage feature.

- Elevated chloride and ammonia concentrations were observed throughout the West Ditch, from the southwest corner of the Magnesite Residue Pile to the mouth. Vegetation growth along the banks of the ditch may help selectively remove some source-related contamination, such as ammonia and/or nitrate during portions of the year.

- A slight increase from upstream to downstream chloride and ammonia concentrations was observed routinely in the Colville River; however, none of the concentrations exceeded the surface water criteria.

2.5 INTERIM ACTIONS

Agreed Order No. 94TC-E104 provided for interim actions that would address water management and removal of on-site materials. An interim action involving the removal and off-site disposal of materials piled around and on top of the Magnesite Residue Pile began in June 1997 and was completed in 1999. The interim action focused on characterizing and removing weathered FB and FBR materials.

These FB and FBR materials were characterized as “special wastes” or solid wastes under WAC 173-303, Dangerous Waste Regulations. The 68,000 tons of material on top of the Magnesite Residue Pile were transported by railcars to an Ecology-approved solid waste disposal facility (Columbia Ridge Landfill, Arlington, Oregon) between May 1997 and December 1999. About 5,000 tons of prilled FBR material was removed from one of the process buildings and applied as a fertilizer product on fields in Eastern Washington and Oregon (CH2M, 2001b).

3.0 CLEANUP ACTION PLAN

Ecology issued the final CAP in June 2000 and entered into an agreed order with NWA to implement the identified cleanup actions.

3.1 REMEDIAL ACTION GOALS

The remedial action goals for the Site are to:

- Protect beneficial uses of the Colville River
- Reduce concentrations of contaminants in soil, SWBU, and ditches to identified CULs (Table 3.1) at the designated points of compliance
- Prevent or minimize leaching of contaminants from materials to the environment

3.2 CLEANUP STANDARDS

The two primary components of cleanup standards are cleanup levels and points of compliance.

3.2.1 Cleanup Levels

CULs determine the concentration at which a particular hazardous substance does not threaten human health or the environment. Site CULs were developed as follows:

- Groundwater: Method B CULs were based on protection of drinking water, surface water, and irrigation water.

- Soils: Method C industrial CULs were used for direct contact. Soil CULs that are protective of groundwater were established at 100 times the groundwater cleanup. Since Method C CULs were used, a restrictive covenant was required.

- Surface Water:
  - West Ditch – Method B CULs protective of drinking water, surface water, and irrigation (since this ditch discharges to the Colville River) were used.
  - Main Ditch – The Main Ditch did not discharge to the River. Method C industrial CULs for groundwater were used. This ditch was covered and closed in 2003; therefore, cleanup levels for this ditch are no longer applicable.

- Sediments:
  - West Ditch – CULs were based on Method C industrial for soils, protection of ditch water, and the Freshwater Sediment Quality Values in Washington State (Ecology, 1997).
  - Main Ditch – No CULs were set because this feature was covered and closed in 2003.

Table 3.1 lists applicable Site CULs. The CMP Workplan Addendum No. 1 (CH2M, 21012a) divided the IHS into primary and secondary categories. Primary IHS are sampled and analyzed twice per year, whereas secondary IHS are sampled and analyzed twice every other year.

Table 3.1 Site Cleanup Levels (CULs)

	CULs							
	GW, mg/l (except for pH)		**Soil, mg/kg**		**West Ditch**			
					SW, mg/l		**Sediments, mg/kg**	
INDICATOR		Basis		Basis		Basis		Basis
Primary COCs								
Chloride (Cl)	230	AWQC	23,000	Protection of GW	230	AWQC	N/A	N/A
Ammonia	0.13	WAC 173-201A	13	Protection of GW	0.13	WAC 173-201A	13	Protection of SW
Total dissolved solids	1092	Background	N/A	N/A	500 (250 Cl)	SMCL and irrigation	N/A	N/A
Secondary COCs								
pH	8.5 units	SMCL, AWQC	N/A	N/A	N/A	N/A	N/A	N/A
Nitrate	10	MCL, AWQC	N/A	N/A	N/A	N/A	N/A	N/A
Nitrite	1	MCL	N/A	N/A	N/A	N/A	N/A	N/A
Barium	1	AWQC	100	Protection of GW	N/A	N/A	N/A	N/A
Manganese	0.44	Background	44	Protection of GW	N/A	N/A	N/A	N/A
Selenium	0.0082	Background	0.82	Protection of GW	N/A	N/A	N/A	N/A
Thallium	0.00112	Method B formula	0.112	Protection of GW	N/A	N/A	N/A	N/A

Notes: AWQC – U.S. Environmental Protection Agency Ambient Water Quality Criteria, COC – contaminant of concern, GW – groundwater, MCL – Maximum Contaminant Level*, mg/kg – milligrams/kilogram, mg/l – milligrams/liter, N/A – not applicable, SMCL- Secondary Maximum Contaminant Level*, SW – surface water, WAC – Washington Administrative Code
* WAC 246-290-310

3.2.2 Points of Compliance

For groundwater, the point of compliance is throughout the Site. Where the affected groundwater flows into the Colville River, a conditional point of compliance located within the surface water as close as technically possible to the point or points where groundwater flows into surface water may be approved under the requirements listed in WAC 173-340-720(6)(d).

For soil, the point of compliance is throughout the Site down to the groundwater table.

The point of compliance for the West Ditch is the point of discharge to the Colville River. For sediments in the West Ditch, the point of compliance is everywhere in the ditch.

3.3 SITE CLEANUP ACTION

The Site's selected cleanup actions identified in the final CAP included the following:

- Removal and off-site disposal of FBR source materials in the covered pile.
- Monitoring of groundwater to demonstrate compliance with CULs.
- Monitoring of surface water to demonstrate compliance with CULs.
- Institutional controls to set restrictions on the Site to maintain the integrity of cleanup actions undertaken.

4.0 CLEANUP ACTION AND FOLLOW-UP ACTIONS

4.1 MATERIALS REMOVAL AND OFF-SITE DISPOSAL

Full-scale source removal activities involving the covered pile and FB/FBR materials in plant buildings were conducted between 2000 and 2004. Over 133,000 tons of FB-related materials were excavated or removed and disposed at an approved waste disposal facility. The amount of source material removed from the covered pile area was approximately 129,000 tons. Clean, granular fill material was placed into the footprint of the former covered pile area following excavation and removal of the source materials (CH2M, 2004).

4.2 ADDITIONAL ACTIONS

- During summer 2003, the Main Ditch was filled with clean, granular fill material and graded to match the existing grades along the perimeter of the ditch (CH2M, 2004).

- The West Ditch continues to discharge to the Colville River. This discharge was required to meet all substantive requirements of a National Pollutant Discharge Elimination System (NPDES) until June 2006 when the requirements were terminated.

- In April 2006, Ecology approved terminating the NPDES Permit discharge-limit monitoring.

- When cleanup construction was finished, NWA implemented a CMP to gauge the effectiveness of the cleanup action and to comply with the conditions set forth in the CAP (CH2M, 2001a).

4.3 INSTITUTIONAL CONTROLS

The Restrictive Covenant for the L-Bar properties was recorded in 2001. This Restrictive Covenant limits certain activities and land uses until CULs at the Site have been met.

4.4 FIRST PERIODIC REVIEW IN 2012

Ecology conducted the first periodic review in 2012 to evaluate the effectiveness of the cleanup action. The review had the following key conclusions:

- Site CULs have not been met, although some improvements to groundwater and surface water quality have been shown. Chloride, ammonia, and TDS concentrations are still elevated compared to their CULs.

- Concentrations of indicators in the North Field area east of the former Main Ditch do not indicate a clear trend during this assessment period. Elevated concentrations or increases have been observed along with seasonal variations. These appear to be the delayed effects of excavation-related disturbances that occurred during removal of materials from the covered FBR pile. The observed concentration response was thought to be influenced by the characteristically fine-grained nature of the alluvial soils and the low groundwater flow rates in the SWBU.

- Shallow groundwater in the North Field discharges to the Colville River. Although indicators in this groundwater exceeded CULs, continued monitoring of the Colville River upstream and downstream of the Site did show that impacts from this groundwater are negligible. Surface water standards have not been exceeded in the river.

- CULs are still being exceeded at the Site, although some improvements to groundwater and surface water quality have been shown. In a few wells, such as SA-10 (located on the Magnesite Residue Pile), concentrations appeared to be increasing. However, the existing Restrictive Covenant is active and effective in protecting human health and the environment from exposure to hazardous substances, and protecting the integrity of the cleanup actions.

- Residual flux bar residue may be present at the Site in the vicinity of well SA-10 based on the observed increase in contaminants in the well.

- A restoration time frame of 20 to 30 years was considered likely, in part because shallow groundwater flow is relatively slow within the fine-grained North Field soils (), thereby limiting the natural attenuation processes that help reduce residual contaminant concentrations over time.

Based on these conclusions, the review recommended the following:

- Continue groundwater and surface water monitoring in accordance with the following frequencies: (1) Yearly semi-annual monitoring for field parameters (temperature, pH, conductivity) and indicators (chloride, ammonia-N, and TDS); and (2) semi-annual monitoring for indicators (nitrate-N, nitrite-N, barium, manganese, selenium, and thallium) with less elevated concentrations should be conducted two times per year, every other year.

- The method detection limit (MDL) for thallium analysis should not exceed two times the CUL. If this is not achievable, the next periodic review should take into consideration the current cleanup level in relation to its practical quantitation limit (PQL)/MDL.

- A supplemental site investigation in the area of well SA-10 should be carried out to determine if source materials are still present and to conduct additional materials removal, if necessary.

4.5 SUPPLEMENTAL SITE INVESTIGATION AT WELL SA-10

NWA and their consultants conducted a supplemental site investigation at the southern end of the Magnesite Residue Pile in response to Ecology's recommendation to assess Site conditions in the area around well SA-10. The supplemental site investigation work was performed in two successive phases from 2012 to 2013, and was conducted to determine if residual FB and/or FBR source material was present in areas where former source removal actions had been conducted.

The field activities, investigation methods, data summaries, and key findings from these supplemental investigations have been documented in two reports:

- *Data Summary Report for the Supplemental Geophysical Survey Work Conducted at the L-Bar Site near Chewelah, Washington* (CH2M, 2012b)
- *Focused Site Investigation Data Summary Report for the L-Bar Site near Chewelah, Washington* (CH2M, 2014)

The first report (CH2M, 2012b) summarizes on-Site geophysical work using electromagnetic equipment to map soil conductivity and the presence of buried metallic objects. The purpose of this geophysical study was to determine whether residual FB/FBR materials were remaining in the Magnesite Residue Pile. The second report outlines the work and results addressing the recommendations set forth in the geophysical site investigation report.

From the first phase of the investigation mapping soil conductivity, areas were identified where residual FB/FBR could be present. The geophysics report recommended installing soil vapor probes in these areas to test for ammonia to confirm the presence of FB/FBR. The geophysics report also recommended testing shallow (<6 inches) soil to the south and east of the Magnesite Residue Pile for electric conductance to determine if residual FB material potentially was present.

The second phase of the investigation (CH2M, 2014) was carried out in accordance with the recommendations from the geophysics investigations; the soil vapor probes were installed and sampled, and shallow soils were tested for electric conductance. Several key findings and conclusions from this supplemental site investigation work are summarized below:

- Some areas of elevated soil conductivity were observed in the southeastern quadrant of the magnesite residue pile, and likely correlate with former FB stockpile areas.
- Shallow soil samples (i.e., soil/water slurry) did not show elevated electrical conductivity values that would indicate the likely presence of residual FB or FBR. The investigators concluded that elevated levels of chloride, TDS, and ammonia in groundwater at well SA-10 likely are not caused by an ongoing release of residual contaminants from the upper few feet of the Magnesite Residue Pile materials.
- No elevated ammonia vapors were detected in soil vapor probes installed 6 feet bgs within the southeastern quadrant of the Magnesite Residue Pile. All reported ammonia concentrations were <5 parts per million by volume, indicating little residual ammonia in the upper 6 feet of the Magnesite Residue Pile.
- Potentiometric information from two new piezometers installed near the southeast corner of the Magnesite Residue Pile helped refine the understanding of seasonal groundwater flow conditions in the area between well SA-10 and the former Main Ditch.

4.6 MONTHLY GROUNDWATER MEASUREMENTS 2015–2016

Monthly groundwater level measurements were collected from January 2015 until December 2016 at all CMP wells. This information helped refine the understanding of seasonal changes in water level fluctuations and apparent groundwater flow direction throughout the site.

5.0 SITE COMPLIANCE MONITORING NETWORK AND PROCEDURES

Beginning in November 2000, routine groundwater and surface water monitoring transitioned to compliance monitoring under the *L-Bar Material Removal and Compliance Monitoring Work Plan* (CH2M, 2001a).

NWA prepared an amended CMP Workplan implementing the recommendations from the first five-year review (CH2M, 2012a). This section briefly describes the current CMP.

5.1 SURFACE WATER COMPLIANCE MONITORING

The primary objective of the surface-water monitoring program for the Site is to document surface water quality in the West Ditch and the adjacent Colville River. On behalf of NWA, the Stevens County Conservation District (SCCD) administers and performs the routine compliance surface water monitoring as outlined in the CMP Addendum No. 1 (CH2M, 2012a). Four surface-water monitoring stations are included as part of the current CMP surface-water monitoring program shown in Figure 5.1:

- Station D3 – upstream in the West Ditch (upstream of station D2)
- Station D2 – mouth of the West Ditch (direct discharge to Colville River)
- Station CR1 – Colville River at the Highway 395 Bridge (upstream of the Site and West Ditch mouth)
- Station CR3 – Colville River (approximately 300 feet downstream from the West Ditch mouth)

Routine field sampling methods, quality control, and data management for the compliance surface-water monitoring program are presented in the CMP Addendum No. 1 (CH2M, 2012a).

5.2 GROUNDWATER COMPLIANCE MONITORING

The CMP groundwater monitoring network consists of 13 sampling locations, including 12 shallow resource-protection groundwater monitoring wells and one deep production well (see Figure 5.1). Groundwater monitoring is conducted semi-annually (CH2M, 2001a; CH2M, 2012a). The 12 wells monitor the SWBU and the intermediate, confined, alluvial water-bearing zone. Wells in the Site groundwater-monitoring network are grouped into the following categories:

- Site Background: Represented by well P-12, and the production well (L-Bar) completed in the deeper, confined aquifer.
- Source Removal Areas: Represented by well P-13, located immediately south of the Magnesite Residue Pile, and wells SA-10, SA-11, and SA-14 located atop the Magnesite Residue Pile and in locations where former source removal actions have been completed.
- Site Interior: Represented by well P-09, located within the former operations area east of the Magnesite Residue Pile and south of the covered FBR pile.

- North Field: Represented by wells P-05, P-06, P-19, P-20B, P-25, and P-27.

The groundwater monitoring analytical suite, test methods, and preliminary CULs are presented in CH2M's 2017 report. CH2M (2012a) provides additional details on groundwater sampling procedures, quality control, and data management. Primary indicator parameters (ammonia, chloride, and TDS) are sampled twice per year, while the secondary parameters are sampled twice per year every other year (during even numbered years). Thus, the most recent groundwater data evaluated in this report are the primary parameters collected in 2017 and the secondary parameters collected in 2016.

5.2.1 Overview of 2017 CMP Groundwater Data Evaluation

Groundwater analytical data through 2017 were used to perform an expanded evaluation and analysis of existing groundwater quality conditions at the Site [Jacobs, 2017]. The 2017 CMP report specifically included additional statistical analysis and data presentation approaches that support this Periodic Review and the overall assessment of cleanup progress at the Site. A brief summary of these supplemental statistical analyses included in the 2017 CMP report is presented below.

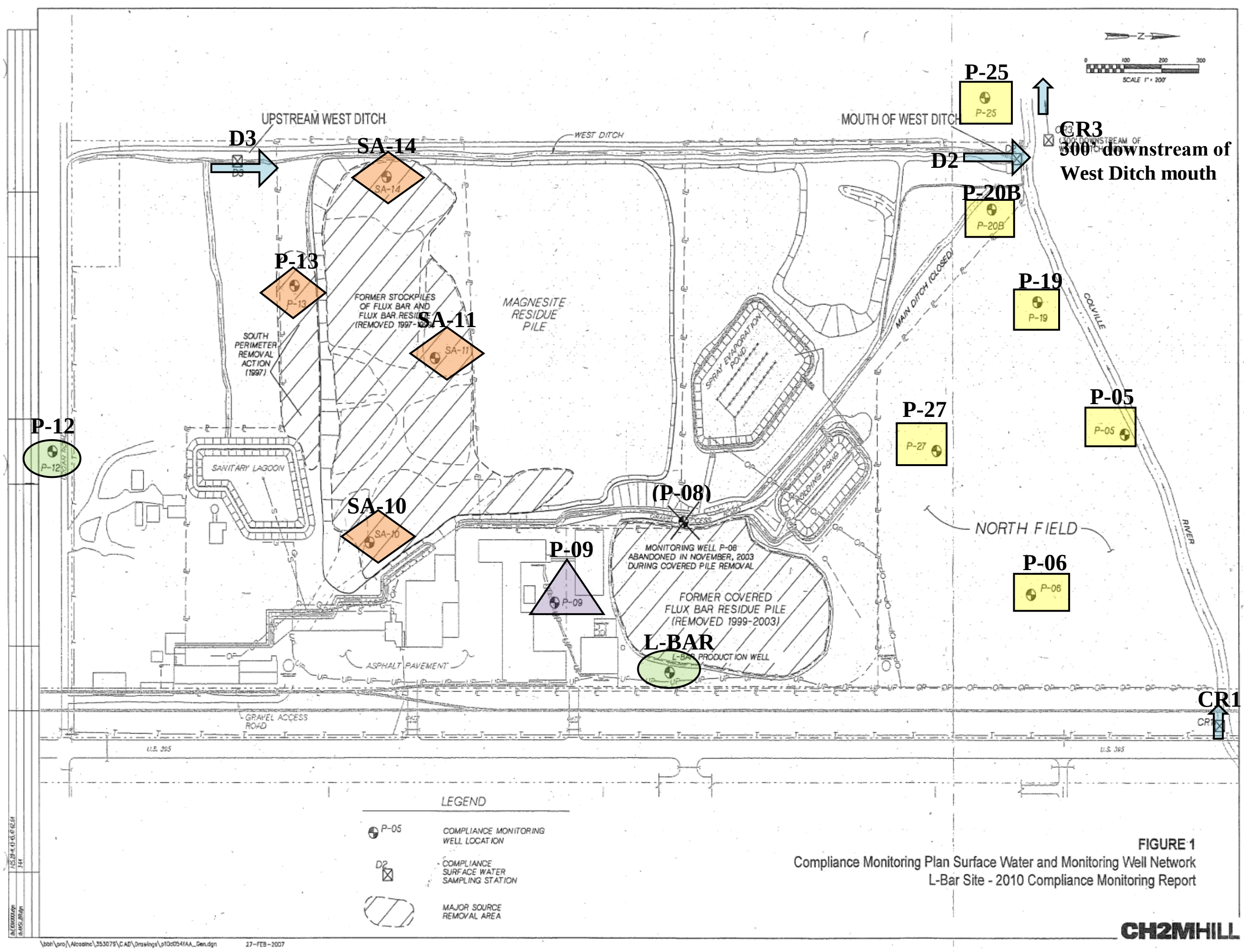
5.3 DATA ANALYSIS

Evaluation of site monitoring data (Jacobs, 2017) includes (1) a comparison to site cleanup levels, (2) evaluation of statistically significant trends, and (3) a linear regression predictive analysis to assess likely timeframes to achieve compliance with cleanup levels.

5.3.1 Comparison to Site Cleanup Levels

WAC 173-340-410 describes compliance monitoring requirements for cleanup sites. Performance monitoring [WAC 173-340-410(a)] is performed to confirm that the cleanup action has attained cleanup standards. For this current periodic review, groundwater quality data from 2016 to 2017 were compared to the Site CULs (Table 3.1) to assess the effectiveness of the implemented cleanup actions.

Figure 5.1 Compliance Monitoring Well and Surface Water Network



North Field Wells
Magnesite Residue Pile Wells
Plant Interior Wells
Background Well (P-12) and Production Well (L-Bar)
Surface Water Sampling Location

5.3.2. Trend Analysis

Trend analyses for the Site have been performed in prior annual CMP reports to assess relative changes (improvements) in groundwater quality following source removal actions and progress toward achieving CULs. For the 2017 CMP annual report, trend analyses were performed using the Mann-Kendall method. Groundwater monitoring data from spring 2008 through fall 2017 were used to perform the analysis.

Backup data and output documentation generated in support of this trend analysis are presented in Appendix D of the CMP 2017 Monitoring report (Jacobs, 2017).

5.3.3. Data Regression Analysis

A predictive (regression) analysis was conducted (Jacobs, 2017) to complement the Mann-Kendall trend analysis and to provide a general indication of whether groundwater conditions are showing progress toward achievement of groundwater CULs within or by the anticipated restoration period. Key assumptions for this predictive analysis are summarized as follows:

- The wells selected to perform the predictive analysis are P-13, SA-10, SA-11, and SA-14 located within or adjacent to the Magnesium Residue Pile and the former uncovered FBR piles. These wells were selected since the highest contaminant concentrations were found in these wells and showed increases in IHS concentrations when removal actions were implemented and subsequent IHS concentration declined afterward.
- The primary indicator parameters (ammonia, chloride, and TDS) were included for the regression analysis.
- The analysis included data from 1996 until the last sampling event in 2017.
- The predictive analysis included a standard spreadsheet-based application of linear regression trend lines to the time-series concentration data. The estimated trend lines were extrapolated out beyond 2017 to 2034 and beyond. For all plots, the 2034 end-point was selected to illustrate 30 years following completion of source removal actions in 2004. The analysis assumed linear trends; therefore, it did not adjust for the asymptotic flattening of the time-concentration curve that commonly occurs in non-linear trends.

6.0 COMPLIANCE MONITORING RESULTS

6.1 HYDROLOGIC CONDITIONS 2012–2017

6.1.1 Surface Water Flow Data

Surface water flow in the Colville River typically ranged from 30–95 cfs from October to November and 13–228 cfs in late March through late May. Surface water flow measurements collected since 2012 show general similarity to the flow values prior to 2012 (SCCD, 2018).

Surface water discharge in the West Ditch ranged from little to no observable discharge during the summer to early fall to flows up to 0.24 cfs in November 2015. During intermittent seasonal flooding of the Colville River, flood waters temporarily can back up the West Ditch and preclude the ability to monitor flow within this drainage feature (SCCD, 2018).

6.1.2 Groundwater Elevation and Flow

No long-term temporal trends in groundwater elevations are evident. A site hydrograph showing monthly measurements from November 2014 to December 2016 for all the CMP wells and the two piezometers (PZSP and PZEP) near the Magnesium Residue Pile is presented in Figure 6.1.

Groundwater elevations ranged from approximately 1,642 to 1,644 feet above mean sea level (amsl) at upgradient site locations (south end of site) to approximately 1,634 to 1,636 feet amsl at wells located closer to the Colville River. Groundwater from the SWBU generally flowed north-northwesterly beneath the site and discharged either into the West Ditch or the Colville River. Some losses due to evapotranspiration are likely to occur in the North Field as well.

Figure 6.2 presents March 2016 groundwater elevation contours (potentiometric surface map) and the inferred groundwater flow direction. Groundwater conditions depicted in Figure 6.2 represent seasonal high groundwater elevations, which coincided with peak surface water discharge in the Colville River during 2016. Figure 6.3 presents October 2016 groundwater elevation contours and the inferred groundwater flow direction. Groundwater conditions depicted in Figure 6.3 represent dry season hydrologic conditions and coincide with seasonal low flow conditions in the Colville River.

An apparent radial flow pattern away from well SA-10 occurs in groundwater beneath the Magnesite Residue Pile during the dry season as shown in Figure 6.3. This partly reflects the water retention capacity of the fine-grained Magnesite Residue Pile materials versus the more free-draining characteristics of the native SWBU soils. Little upgradient migration of groundwater from the vicinity of well SA-10 to the south or southeast likely occurs during these late summer periods. The bulk movement of site contaminants within the SWBU (including areas beneath the Magnesite Residue Pile) is predominantly to the north and northwest.

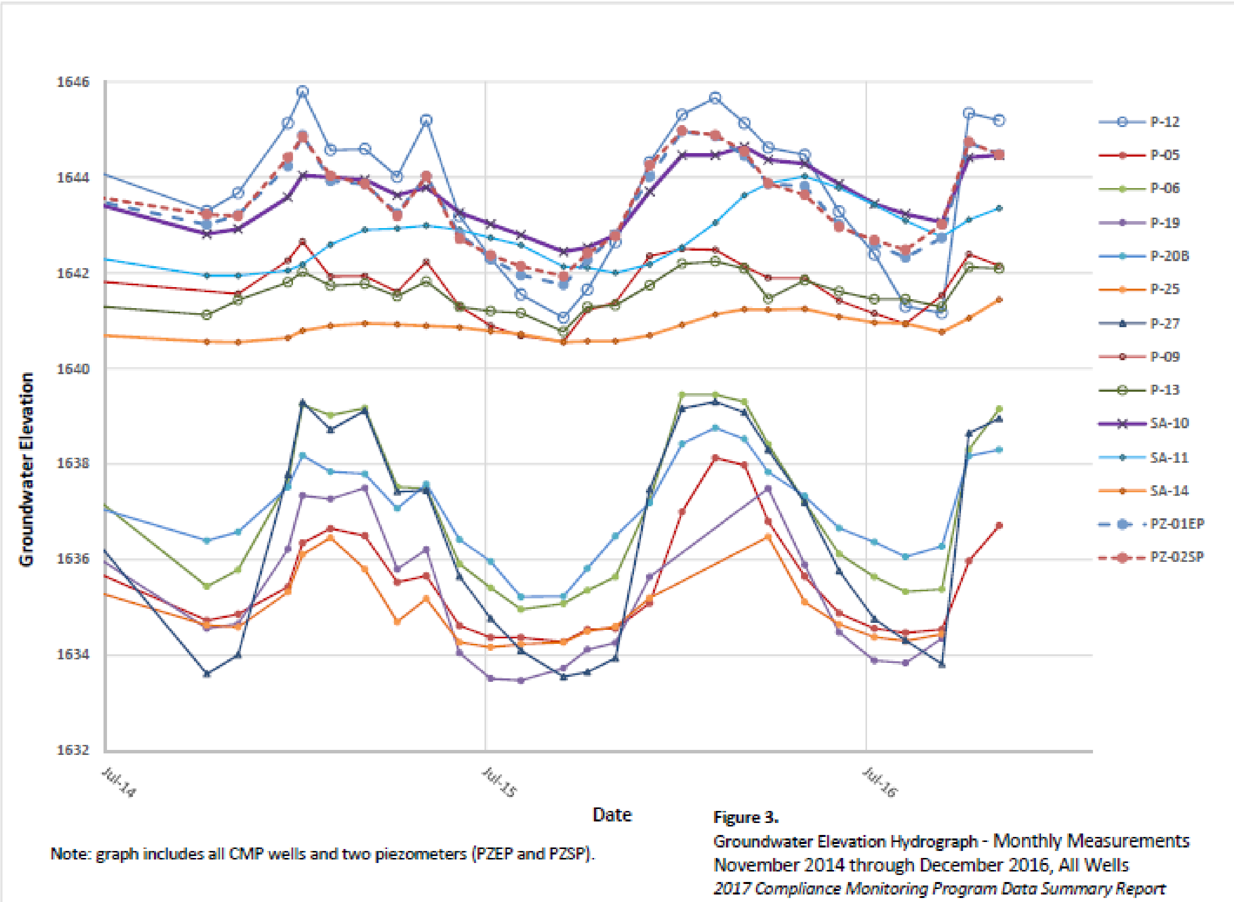


Figure 6.1 Groundwater Elevation Hydrograph Monthly Measurements (Jacobs, 2017)

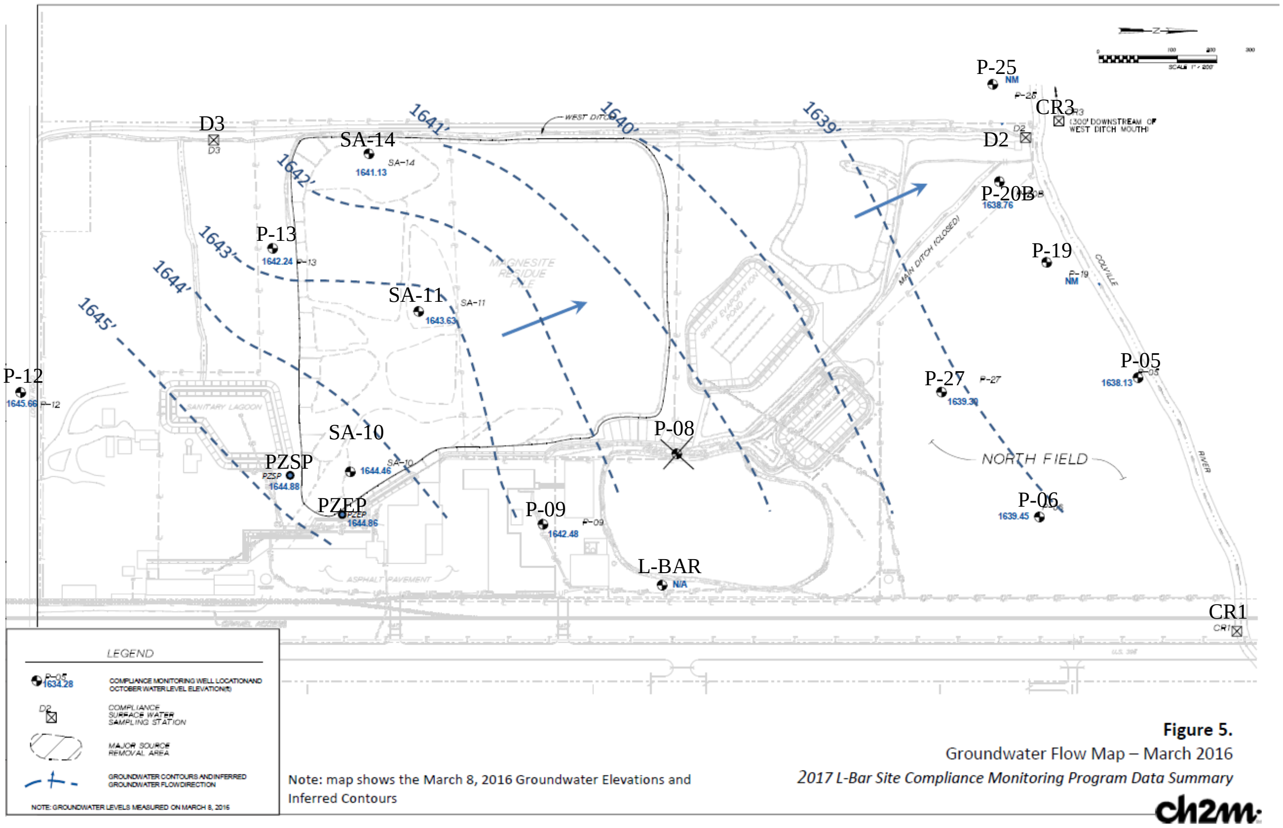


Figure 6.2 Groundwater Flow Map, March 2016 (CH2M, 2017)

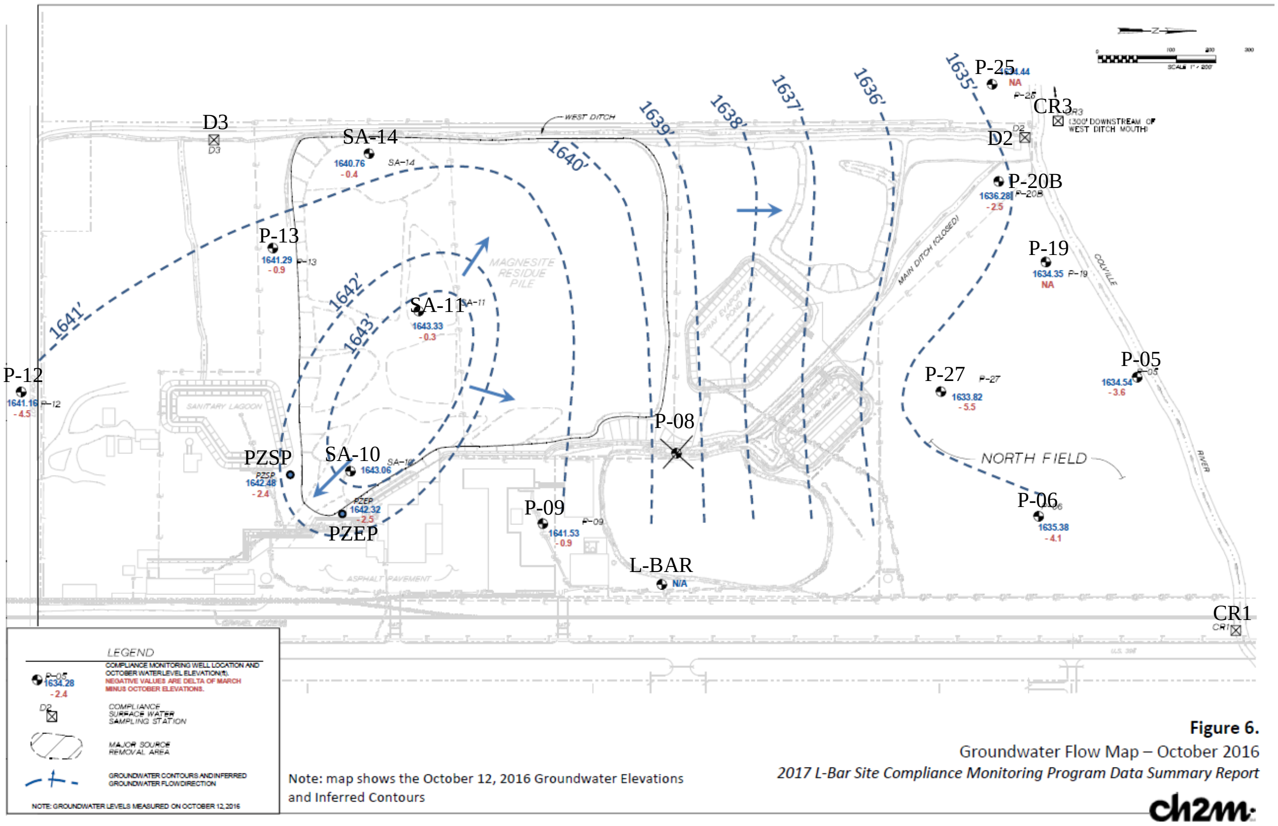


Figure 6.3 Groundwater Flow Map, October 2016 (CH2M, 2017)

6.2 WATER QUALITY CONDITIONS 2012–2017

6.2.1 Surface Water Quality Results

SCCD monitors surface water quality (SCCD, 2018) at the four locations described in Section 5.1. This includes two stations on the West Ditch (D2 and D3) and two stations on the Colville River (CR1 and CR3). Surface water monitoring parameters include:

- pH
- Temperature
- Dissolved oxygen
- Specific conductance
- Chloride
- Ammonia
- TDS (Station D3 only)

Table 6.1 below summarizes the range of surface water quality conditions observed over this approximate 6-year period.

Table 6.1. Summary of Surface Water Quality Monitoring Results (2012–2017)

Parameter	West Ditch Mouth (D2)	Upper West Ditch (D3)	Colville River Upstream (CR1)	Colville River Downstream (CR3)
pH	7.0 – 8.8	7.2 – 8.9	7.5 – 8.4	6.8 – 8.2
Temperature (degrees F)	5.0 – 18.0	3.9 – 18.3	3.5 – 17.3	3.4 – 17.3
Specific Conductance (µS/cm)	2,040 – 7,090	980 – 9260	270 – 420	280 – 420
Dissolved Oxygen (mg/l)	1.3 – 10.0	NM	6.5 – 13.2	6.0 – 12.4
Chloride (mg/l)	490 – 1,750	50 – 490	1.5 – 5.0	2.0 – 6.1
Ammonia as NH3-N (mg/l)	3.8 – 62.4	0.05 – 11.1	<0.02 – 0.19	<0.02 – 0.31
Total Dissolved Solids (mg/L)	NM	420 – 1,990	NM	NM

NM – not measured

The data from Table 6.1 demonstrate that concentrations of chloride and ammonia, associated with the former FB and FBR source materials remain elevated in the West Ditch surface water, as compared to concentrations measured in the Colville River. While the West Ditch discharge (station D2) contains elevated concentrations of these constituents, the relatively small discharge from the West Ditch into the Colville River results in only a small net increase in the concentration of these parameters between stations CR1 (upstream) and CR3 (downstream).

6.2.2 Surface Water Quality Trends 2012–2017

6.2.2.1 West Ditch

Surface water quality has shown some degree of measureable improvement as compared to the conditions documented by the previous periodic review (2005–2011). Table 6.2 summarizes the observed changes in chloride and ammonia concentrations and specific conductance at station D2 (mouth of West Ditch). The values presented in the table represent the observed high and low measurements during these selected intervals. These data indicate that cleanup progress attributable to the earlier source removal actions and ongoing natural attenuation processes is occurring.

Table 6.3 provides a more refined snapshot of water quality changes. Specifically, Table 6.3 presents a comparison of average chloride and ammonia concentrations and specific conductance field measurement during the start (May 2012 to October 2013) and the end (April 2016 to October 2017) of this current periodic review cycle. The data indicate that water quality in the West Ditch has shown measurable improvement. These decreases demonstrate positive progress toward achieving CULs.

Table 6.2. Comparison of Water Quality Conditions at West Ditch Station D2: 2005–2011 (First Periodic Review) vs. 2012–2017 (Second Periodic Review)

Parameter	Observed Range (2005–2011)	Observed Range (2012–2017)
Specific Conductance (µS/cm)	2,230 – 11,800[1]	2,040 – 7,090
Chloride (mg/l)	320 – 2,270	490 – 1,750
Ammonia (mg/l)	2.5 – 59.8	3.8 – 62.4

Notes: µS/cm – micro Siemens per centimeter, mg/l – milligrams per liter
[1] Excludes measurements during seasonal flooding of Colville River.

Table 6.3. Comparison of Water Quality Conditions at West Ditch Station D2: 2012–2013 vs. 2016–2017 (Start and End of Second Periodic Review)

Parameter	Average Concentration (May 2012–October 2013)[1]	Average Concentration (April 2016–October 2017)[2]
Specific Conductance (µS/cm)	5,950	3,300
Chloride (mg/l)	1,360	600
Ammonia (mg/l)	38.4	6.0

Notes: µS/cm – micro Siemens per centimeter, mg/l – milligrams per liter
[1] Includes monitoring data from 5/14/12, 11/27/12, 5/8/13 and 10/7/13.
[2] Includes monitoring data from 4/26/16, 11/15/16, 5/31/17 and 10/30/17.

6.2.2.2 Colville River

Water quality conditions within the Colville River have not changed measurably. Water quality at Colville River station CR3 continues to meet state and federal surface water quality standards.

6.2.3 West Ditch Loading Rates 2012–2017

Chloride and ammonia loading rates at station D2 further demonstrate a progressive decline in contamination levels at the Site. Table 6.4 summarizes the estimated range of chloride and ammonia loading (pounds/day) that was discharged to the Colville River from the West Ditch during the 2005–2011 and the 2012–2017 periods. Table 6.4 indicates an overall decline in the mass of chloride being discharged to the river from the ditch. The mass flux of ammonia also appears to be showing a measurable decline. Along with the apparent decreasing trends in contaminant concentrations (Tables 6.2 and 6.3), the loading data provide additional evidence indicating progress is being made toward achieving Site cleanup goals.

Table 6.4 Comparison of Contaminant Loading Rates at Station D2: 2005–2011 vs. 2012–2017

Parameter	Calculated Range (2005–2011)	Calculated Range (2012–2017)
Chloride Load (pounds/day)	0[1] – 1,760	70 – 640
Ammonia Load (pounds/day)	0 – 26	0.8 – 6.7[2]

[1] Zero value reflects an absence of flow (dry) in the West Ditch during late summer conditions.
[2] Flow measurements were not obtained in 2012 or early 2013.

6.2.4 Groundwater Quality Conditions 2016–2017

Groundwater samples are collected from the 13 wells depicted on Figure 5.1. Table 6.5 summarizes the groundwater analytical results for 2016 and 2017 as presented in the 2017 CMP report. The values highlighted in red in Table 6.5 indicate groundwater concentrations that exceed Site CULs. Table 6.6 presents the CUL factor of exceedance for each non-background well and each primary indicator parameter.

6.2.4.1 Site Background Wells

The concentration of primary COCs in the L-Bar production and P-12 wells is below the established CULs for the Site based on samples collected in 2017. The secondary parameter concentrations for these background wells also are below the established CULs based on samples collected in 2016. The location of the wells and the groundwater quality data itself continue to justify the use of these two wells for general background comparison purposes.

6.2.4.2 Non-Background Wells

The 2017 concentration of primary COCs continues to exceed established CULs throughout the Site, including wells located in the vicinities of the Magnesite Residue Pile, plant interior, North Field, and West Field (P-25). Table 6.6 summarizes the overall degree to which COC concentrations for chloride, ammonia, and TDS exceed their respective cleanup levels.

Table 6.5 2016/2017 Groundwater Sampling Results for Primary and Secondary Contaminants of Concern
[Source: 2017 CMP Monitoring Report (Jacobs, 2017)]

				Site Background		*Former Source Area / Magnesite Residue Pile*				*Site Interior*	*North Field*					
Analyte[b]	Date	Units	Cleanup Level[c]	P-12	PROD. WELL	P-13	SA-10	SA-11	SA-14	P-09	P-05	P-06	P-19	P-20B	P-25	P-27
Ammonia-N*	May 18, 2017	mg/L	0.13	0.058	ND	36.3	347	60.6	23.3	1.99	ND	0.478	1.15	13.3	1.7	ND
	September 28, 2017			ND	0.0689	22.8	812	71.7	21.5	0.426	ND	0.374	0.539	71.7	0.365	ND
Chloride*	May 18, 2017	mg/L	230	110	0.792	1,200	9,540	4,410	995	713	2,920	262	6,210	1,360	816	6,940
	September 28, 2017			10.3	1.12	1,250	7,130	6,270	930	523	3,120	92.3	8,150	1,980	720	7,390
TDS*	May 18, 2017	mg/L	1,092.4	878	241	4,120	22,400	10,600	3,710	1,700	3,850	842	11,700	2,980	1,510	11,800
	September 28, 2017			810	234	5,320	21,300	14,000	3,620	1,260	4,500	570	7,140	4,490	1,960	12,400
pH	April 28, 2016	none	6.5-8.5	7.81	8.03	7.56	7.51	8.39	9.69	7.57	7.25	7.61	6.78	7.78	6.59	7.10
	October 12, 2016			7.61	7.90	7.28	7.59	8.45	9.86	8.40	7.05	7.24	6.68	7.13	6.72	6.91
Conductivity	April 28, 2016	µmhos/cm	NA	1,373	412	6,680	34,100	12,540	5,820	2,990	7,220	1,214	21,640	6,340	2,630	24,400
	October 12, 2016			1,239	435	7,450	32,900	14,200	5,900	2,360	7,700	892	16,000	8,030	4,220	24,000
Nitrate-N	April 28, 2016	mg/L	10	0.758	ND	0.479	ND	ND	ND	ND	ND	ND	ND	15.2	ND	ND
	October 12, 2016			0.547	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrite-N	April 28, 2016	mg/L	1	ND	ND	ND	ND	0.136	ND	ND	ND	ND	ND	ND	ND	ND
	October 12, 2016			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	April 28, 2016	mg/L	1	0.043	0.0839	0.0551	0.0593	0.0283	0.0137	0.274	0.542	0.198	0.146	0.0605	0.061	4.02
	October 12, 2016			0.044	0.0784	0.0639	0.057	0.0395	0.014	0.0983	0.59	0.317	0.0969	0.0807	0.0781	3.49
Manganese	April 28, 2016	mg/L	0.44	0.00136	0.0286	4.2	5.83	0.13	0.00911	1.23	0.0185	1.85	2.39	0.816	7.5	0.00338
	October 12, 2016			ND	ND	4.31	5.14	0.251	0.00628	0.179	0.73	1.39	2.35	0.945	8.44	0.00942
Selenium	April 28, 2016	mg/L	0.0082	ND	ND	0.00186	0.017	0.0195	0.0259	ND	0.00187	ND	0.00503	0.00346	ND	0.00247
	October 12, 2016			ND	ND	ND	ND	0.0111	0.0268	ND	ND	ND	ND	ND	ND	ND
Thallium	April 28, 2016	mg/L	0.0002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	October 12, 2016			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
[a] The most recent available data shown - primary parameters for 2017 and secondary parameters for 2016.
[b] Primary indicator parameters indicated with '*'.
[c] Cleanup Levels as listed in the *L-Bar Cleanup Levels Development and Feasibility Report* (CH2M HILL 1999).
ND = The result is a non-detect
TDS = Total Dissolved Solids
BOLD font are values which exceed respective cleanup levels.

Table 6.6. Cleanup Level Factor of Exceedance Values for Groundwater Monitoring Wells (2017) – Primary Indicator Parameters from Jacobs (2017).

Well	P-13	SA-10	SA-11	SA-14	P-09	P-05	P-06	P-27	P-19	P-20B	P-25
Site Area	Magnesite Residue Pile				PIA	North Field and West Field					
CUL FOE Ammonia	230	4,500	510	170	9.3	N/A	3.3	N/A	6.5	330	7.9
CUL FOE Chloride	5.3	36	23	4.2	2.7	13	N/A	31	31	7.3	3.3
CUL FOE TDS	4.2	20	11	3.4	1.4	3.8	N/A	11	8.6	3.4	1.6

Notes: CUL – cleanup level, FOE – factor of exceedance, N/A – not applicable, PI = plant interior area, TDS – total dissolved solids

For the secondary indicator parameters (sampled in 2016), cleanup levels for pH, manganese, barium, and selenium are exceeded at selected wells:

- Manganese is exceeded at eight wells (P-13, SA-10, P-09, P-06, P-19, P-20B, and P-25)
- Selenium is exceeded at three wells (SA-10, SA-11, and SA-14)
- Barium is exceeded at one well (P-27)
- pH is exceeded at one well (SA-14)

6.2.5 Groundwater Quality Trends 2012-2017

Table 6.7 presents trend results from the Mann-Kendall method and includes data from spring 2008 through fall 2017. Trends were identified as statistically significant at a 95 percent (or higher) confidence level. Of the total 143 possible well-constituent combinations tested (13 wells and 11 constituents), 43 cases were found to be statistically significant; of these, a total of 8 were increasing trends, 35 were decreasing trends, and the rest were not statistically significant (Jacobs, 2017).

Decreasing trends are expected in response to the previous remedial actions conducted at the site. Ongoing natural attenuation (dispersion for chloride and oxidation of ammonia) processes also are expected to produce a progressive reduction in the concentration of residual contaminants in Site soil and groundwater over time. Lack of a declining trend, or in some cases increasing trends, primarily indicate ongoing, transient conditions following the earlier stage of source removal. Residual contaminants are still being flushed and mobilized from former source areas.

Table 6.7 Mann-Kendall Method Trend Analysis Results [Source: 2017 CMP Monitoring Report (Jacobs, 2017)]

	Chloride		Ammonia-N		TDS		pH		Conductivity		Nitrate-N		Nitrite-N		Barium		Manganese		Selenium		Thallium	
Well	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig	Trend	Sig
P-12	Inc	***	-	-	Inc	***	---	---	Inc	***	---	---	-	-	---	---	Dec	*	-	-	-	-
PRODWELL	---	---	---	---	---	---	---	---	---	---	---	---	-	-	---	---	---	---	-	-	-	-
P-13	---	---	---	---	Inc	*	---	---	---	---	---	---	---	---	Inc	*	---	---	-	-	-	-
SA-10	Dec	**	Dec	***	Dec	***	Dec	**	Dec	*	-	-	---	---	---	---	Dec	*	-	-	-	-
SA-11	Inc	***	Dec	***	---	---	Dec	***	---	---	-	-	Dec	*	Inc	*	Inc	**	Dec	***	-	-
SA-14	Dec	***	Dec	***	Dec	***	---	---	Dec	***	-	-	Dec	**	---	---	Dec	*	Dec	***	-	-
P-05	---	---	Dec	*	Dec	*	---	---	Dec	**	---	---	-	-	---	---	---	---	-	-	-	-
P-06	---	---	---	---	---	---	---	---	---	---	---	---	-	-	---	---	---	---	-	-	-	-
P-09	Dec	*	Dec	*	Dec	*	---	---	Dec	*	---	---	-	-	---	---	---	---	-	-	-	-
P-19	Dec	**	---	---	Dec	***	---	---	Dec	**	---	---	---	---	Dec	**	---	---	Dec	*	-	-
P-20B	---	---	---	---	---	---	---	---	---	---	Dec	*	---	---	---	---	---	---	Dec	**	-	-
P-25	---	---	---	---	---	---	---	---	---	---	-	-	-	-	---	---	---	---	-	-	-	-
P-27	Dec	*	-	-	Dec	***	---	---	---	---	Dec	***	---	---	---	---	---	---	-	-	-	-

Notes:
Trend tests performed using semi-annual groundwater sampling results from April 2008 through September 2017 (the most recent 20 rounds of sampling)
- For indicator parameters (chloride, ammonia, and TDS) and source area wells (P-13, SA-10, SA-11, and SA-14) trend tests performed on same data used for predictive analysis
Tests performed for parameter-well pairs with at least 50% detected results.
Trend Results:
"Dec" = decreasing trend
"Inc" = increasing trend
" --- " = neither increasing nor decreasing trend at 95% or better confidence level
" - " = trend test not performed because parameter-well pair had fewer than 50% detected results
Sig (statistical significance):
*** = 99.9 percent confidence level (alpha = 0.001)
** = 99 percent confidence level (alpha = 0.01)
* = 95 percent confidence level (alpha = 0.05)
Refer to Appendix C for time-series plots; refer to Appendix D for a summary of all trend evaluations.

6.2.5.1 Site Background

At well P-12, increasing concentration trends were identified for chloride, TDS, and conductivity, and a decreasing concentration trend was identified for manganese. For the increasing trends, these data were reviewed and confirm a natural variation in background concentrations over time. Existing concentrations of these indicator parameters are relatively low compared to the corresponding Site CULs.

Well P-12 is located next to Logan Road at the south end of the Site. Logan Road provides local access to commercial/light industrial operations located immediately south of the Site. Increasing trends for background well P-12 may be caused by changes in local land use, agricultural practices, and/or expanded use of road salt during winter months. These apparent changes in background groundwater quality should be tracked and monitored carefully in future CMP monitoring evaluations. These observed changes could indicate a shift in groundwater quality in the SWBU that potentially could affect groundwater quality in monitoring wells.

No significant trends were identified for the production well (L-Bar), which exhibits relatively low concentrations for all constituents.

6.2.5.2 Magnesite Residue Pile Wells

Noteworthy concentration trends have been observed at the four magnesite residue monitoring wells (P-13, SA-10, SA-11, and SA-14), including:

- Chloride shows a strong *increasing* trend at SA-11 and a moderate to strong *decreasing* trend at SA-10 and SA-14
- Ammonia shows a strong *decreasing* trend at SA-10, SA-11, and SA-14
- TDS shows a strong *decreasing* trend at SA-10 and SA-14 and a slight *increasing* trend at P-13
- Specific conductance shows a strong *decreasing* trend at SA-14
- Barium shows a slight *increasing* trend at SA-11 and P-13
- Selenium shows a strong *decreasing* trend at SA-11 and SA-14

6.2.5.3 Site Interior Well P-09

Trend results for Site interior well P-09 and North Field wells show either no trends or non-significant decreasing trends (chloride, ammonia, TDS, and conductivity).

6.2.5.4 North Field and West Field Wells

The Mann-Kendall test did not detect any increasing trends in the North Field Wells. Noteworthy concentration trends have been observed at the five North Field monitoring wells (P-05, P-06, P-19, P-20B, and P-27) and West Field well P-25, including:

- Chloride shows a weak to moderate *decreasing* trend at P-19 and P-27
- Ammonia shows a weak *decreasing* trend at P-05
- TDS shows a strong *decreasing* trend at P-19 and P-27 and a weak d*ecreasing* trend at P-05
- Specific conductance shows a moderate decreasing trend at P-05 and P-19
- Nitrate shows a strong decreasing trend at P-27
- Barium shows a moderate decreasing trend at P-19
- Selenium shows a weak to moderate *decreasing* trend at P-19 and P-20B

6.1.5 Predictive Analysis Results

Table 6.8 presents the results from a linear regression analysis of anticipated timeframes to achieve Site-specific CULs based on recently observed concentration trends. This predictive analysis concentrated on four wells (P-13, SA-10, SA-11, and SA-14) located on or near the Magnesite Residue Pile.

The predictive analysis indicates that CULs (primary COCs) for wells SA-10 and SA-14 could be achieved by 2034. This date corresponds with the original 30-year cleanup timeframe given source removal actions were completed in 2004.

However, the predictive analysis showed no trends for chloride and ammonia in well P-13, as well as for TDS in SA-11. An increasing trend for chloride was observed in well SA-11. Consequently, no predictions for chloride and ammonia in well P-13 and TDS in well SA-11 can be provided at this time; therefore, the cleanup timeframe for groundwater in wells P-13 and SA-11 may extend beyond 2034.

7.0 PERIODIC REVIEW

WAC 173-340-420(2) requires that:

"When evaluating whether human health and the environment are being protected during periodic review, the factors the department shall consider include:

(a) The effectiveness of ongoing or completed cleanup actions;
(b) New scientific information for individual hazardous substances or mixtures present at the site;
(c) New applicable state and federal laws for hazardous substances of mixtures present at the site;
(d) Current and projected site use;
(e) Availability and practicability of higher preference technologies; and
(f) The availability of improved analytical techniques to evaluate compliance with cleanup levels.

The department [Ecology] shall publish a notice of all periodic reviews in the site register and provide an opportunity for public comment."

7.1 EFFECTIVENESS OF COMPLETED CLEANUP ACTIONS

7.1.1 Implemented Removal Action and Effect on Current IHS Trends

The completed cleanup actions primarily involved removing uncovered source materials (FB/FBR) from atop the magnesite pile, removal of FB/FBR materials stored within on-Site buildings and structures, and removal of FBR contained within the covered FBR pile. The Main Ditch was also eliminated as a primary site drainage feature. Vegetative uptake of selected IHS, in particular ammonia and nitrate, is an ongoing, cleanup process in portions of the Site, most notably the North Field area. These past cleanup actions and ongoing contaminant reduction processes have resulted in the following:

- Cleanup of the main plant area, removal of materials from the buildings and Magnesite Residue Pile, and closing the Main Ditch have resulted in decreasing trends for chloride, ammonia-N, TDS, and manganese. However, IHS concentrations (in particular chloride) in shallow groundwater still exceed CULs; the rate of decline in IHS concentrations at plant interior monitoring well P-09 has been relatively slow since the removal actions were completed.
- Monitoring wells located within the Magnesite Residue Pile (SA-10, SA-11, and SA-14) have shown different concentration trend patterns following removal of the FB/FBR source materials from this area. The trend analysis indicates increasing, decreasing, and non-evident concentration trends depending on the well and the monitoring parameter under consideration (Tables 6.7 and 6.8). The current trend analysis suggests that groundwater CULs for some primary IHS may not be achieved in this portion of the Site by 2034.

- Downward concentration trends for chloride, TDS, and nitrate (Table 6.7) are evident at several North Field monitoring wells including P-05, P-19 and P-27. Ammonia-N concentrations remain highest at well P-20B, located closest to the former Main Ditch. Ammonia concentrations at the other North Field wells are 10 to 100 times lower than concentrations at P-20B, and are slowly approaching the Site-specific CUL. The CUL for barium is exceeded at well P-27, with no current indications of a statistically significant downward concentration trend. Similarly, the CUL for manganese is exceeded at wells P-06, P-19, P-20B, and P-25 with no current indications of a statistically significant downward concentration trend. Residual IHS concentrations at several North Field wells may not achieve CULs by 2034 based on existing trends and observed concentrations.
- Decreasing chloride and ammonia-N concentrations and mass loading has been observed at the lower West Ditch station D2 since the last periodic review in 2012. A similar concentration trend for chloride and ammonia also is evident at upstream West Ditch station D3. These declining trend observations (concentration and mass loading) are attributed largely to source material removal actions completed from 1997–2004.

The CAP anticipated a restoration time frame of 20 to 30 years (2024–2034) from the time of the completion of the CAP that occurred in 2004. This projected restoration time frame may not be achievable for all primary and secondary IHS, based on the current predictive trend analyses performed. However, by removing the source materials, maintaining existing (or similar) land use practices into the foreseeable future, and ensuring that the Restrictive Covenant provisions are followed, overall risk to human health and the environment will remain low.

7.1.2 Expected Origin and Fate of IHS

7.1.2.1 Primary IHS: chloride, ammonia, and TDS

Elevated chloride, ammonia, and TDS concentrations in site media (soil, shallow groundwater, surface water) and residual material processing byproducts (magnesite residue) are largely attributed to leaching from former FB and FBR stockpiles. Leaching of chloride and ammonia from FB likely began shortly after L-Bar Products began stockpiling FB (and some FBR) on top of the magnesite residue pile in 1988 (CH2M, 1998). Similarly, chloride and ammonia were being actively leached from the covered FBR stockpile throughout its lifetime by infiltrating precipitation and direct contact with shallow groundwater and surface water (Main Ditch). The IHS that leached from these various source material stockpiles eventually impacted water quality in the underlying groundwater system (SWBU) and former Main Ditch.

Plant growth (sedges and grasses) in the North Field continues to assist with the seasonal removal of ammonia from soil and shallow groundwater. Similarly, periodic flooding of the Colville River, and the ongoing discharge of shallow groundwater and surface water (West Ditch) to the Colville River, slowly and progressively flushes non-degradable inorganic constituents such as chloride from the northern portion of the site. Over time, these processes will continue to reduce the concentration of chloride, ammonia, and TDS. However, existing site hydraulics, fine-grained site soils, the dispersed nature of the former FB/FBR piles, and the chemical characteristics of the primary IHS likely will limit the rate at which these residual contaminants are flushed and removed from the Site.

7.1.2.2 Secondary IHS: nitrate and nitrite

Nitrate and nitrite are derived, though natural chemical transformation processes, from ammonia that was present either in the original source materials transported to the Site, or generated in place by weathering of the FB and FBR stockpiles. Nitrite generally is not detected in site groundwater. Elevated nitrate has been observed in only a single North Field well (P-20B) located close to the former Main Ditch. Like ammonia, nitrate can be used by plants growing in the North Field. Plants growing within or along the West Ditch are likely to seasonally extract and utilize nitrate that is conveyed to this drainage feature from shallow groundwater. Nitrate is expected to dissipate to background levels over time, as ammonia residuals in soil and shallow groundwater continue to dissipate and decline.

7.1.2.3 Secondary IHS: barium, manganese, selenium, thallium, and pH

A small suite of trace metals/metalloids (barium, manganese, selenium, and thallium) were identified as IHS in the CAP. The presence of these metals/metalloids indicate three potential or likely source origins and/or mobilization mechanisms:

- A known or suspected component within FB/FBR materials
- A possible component in the Magnesite Residue Pile material that became mobilized/solubilized into groundwater through changes in geochemical conditions caused by FB/FBR-associated contamination
- A naturally occurring constituent within the local alluvial soils that became mobilized/solubilized into groundwater through changes in geochemical conditions caused by FB/FBR-associated contamination

The specific source or mechanism(s) that has caused elevated manganese concentrations in shallow groundwater is not readily apparent. No strong linkage to the FB materials has been documented. It is possible that geochemical changes in areas impacted by elevated chloride, ammonia, and other source-related constituents may have influenced the tendency for naturally occurring manganese in the native alluvial soils to dissolve and become enriched in shallow groundwater. Manganese concentrations are expected to decline over time as the residual FB/FBR contaminants are progressively flushed from soil and shallow groundwater.
The specific sources or mechanisms that have caused elevated barium, selenium, and thallium concentrations in shallow groundwater are not clearly tied to a single source or geochemical factor. The Phase I RI report (CH2M, 1998) mentions that magnesite residue contains various heavy metals and metalloids. The heavy metal content of the magnesite residue is attributed, in part, to the presence of coal ash that was mixed in with waste magnesite residuals disposed at the Magnesite Residue Pile. Common contaminants in coal ash are barium, manganese, selenium, and thallium. Local wind-blown dispersion of fine-grained magnesite “dust” into the local soils may have contributed to localized enrichment of these metals in shallow groundwater. Concentrations of these trace metals are expected to decline, over time, due to ongoing natural attenuation processes, and/or as the residual FB/FBR contaminants are progressively flushed from soil and shallow groundwater.

Elevated concentrations of barium are limited to a single North Field area well (P-27), located within the footprint of the groundwater plume that largely emanated from the covered FBR pile. Barium is known to be present in the magnesite residue materials, and was commonly used as a fluxing agent in the particular magnesium metal refining process used by NWA. It also is a fairly common trace metal in northeast Washington alluvial soils containing volcanic ash such as those are found in the North Field. Either mechanism might explain the localized barium enrichment observed at P-27. The barium concentration is expected to decline over time as residual FB/FBR contaminants are progressively flushed from soil and shallow groundwater.

FB/FBR and magnesite residue materials have a slightly elevated pH. Only one well at the site, SA-14 within the Magnesite Residue Pile, has a pH value above the recommended upper limit of 8.5. The pH of shallow groundwater beneath the Magnesite Residue Pile likely will decline below 8.5 but remain elevated due to the influence of the magnesite residue materials (a pH of approximately 8.2). The pH in this area is likely to decline in response to the former FB/FBR removal actions to just above a pH of 8.

7.2 NEW SCIENTIFIC INFORMATION FOR IHS OR MIXTURES PRESENT AT THE SITE

There is no new pertinent scientific information for the contaminants related to the Site.

7.3 NEW APPLICABLE STATE AND FEDERAL LAWS FOR HAZARDOUS SUBSTANCES PRESENT AT THE SITE

MTCA cleanup levels for the indicators have not changed since remedial actions were completed at the Site in 2004.

7.4 CURRENT AND PROJECTED SITE USE

Current operations at and adjacent to the Site include commercial and light industrial activities. A portion of Parcel No. 2601080 is used for agricultural purposes. The existing agricultural/commercial operations do not adversely affect any areas where residual contamination may be found in soil or groundwater. There is no expected or anticipated change in the future use of the Site. If a change in site use does occur, the limitations in the Restrictive Covenants will prevent activities or disturbances that may increase the likelihood for exposure by humans or ecological receptors to hazardous substances remaining at the Site.

Review of the existing 2001 Restrictive Covenant for the L-Bar Site has identified certain inaccuracies and omissions that require correction to ensure ongoing protectiveness of the existing remedy. An updated Restrictive Covenant, prepared in conformance with the Uniform Environmental Covenants Act (Chapter 64.70 RCW) will be required.

The existing monitoring network (wells and surface water sampling stations) is expected to remain intact until the next periodic review. Ecology believes the current monitoring well network, and associated network of surface water monitoring stations, provides a reasonable spatial distribution and positioning to track the ongoing cleanup action progress throughout the Site.

7.5 AVAILABILITY AND PRACTICABILITY OF HIGHER PREFERENCE TECHNOLOGIES

The implemented remedy was considered practicable and preferred from a cost-benefit standpoint, which considered the contaminants involved and the projected future uses of the property. This determination has not changed.

7.6 AVAILABILITY OF IMPROVED ANALYTICAL TECHNIQUES TO EVALUATE COMPLIANCE WITH CLEANUP LEVELS

The analytical techniques used to quantify IHS concentrations are considered adequate for determining compliance with the established CULs for this Site. During certain monitoring events in 2016, the reporting limits for thallium exceeded the established CUL. Ecology has communicated these concerns with the potentially liable persons (PLPs), and procedures are in place to ensure the analytical method reporting limit for thallium remains at or below the existing CUL.

8.0 CONCLUSIONS

- Previous source removal actions were effective at eliminating the primary contaminant release mechanisms that allowed source-related contaminants to migrate into soil, sediments, shallow groundwater, and surface water at the Site.

- The existing monitoring network for surface water and groundwater is adequate for evaluating changes (both temporal and spatial) in IHS concentrations.

- Site activities and operations have changed since the 2012 periodic review. However, the current Site activities and operations do not appear to have affected or adversely impacted ongoing cleanup.

- Site CULs have not been met, although some improvements to groundwater and surface water quality have been demonstrated since the last periodic review. Concentrations of primary IHS (chloride, ammonia, and TDS) in surface water and shallow groundwater are still elevated compared to their established CULs. Concentrations of secondary IHS (trace metals, nitrate, nitrite, and pH) exceed CULs at selected locations.

- The specific sources or mechanisms that have caused elevated manganese, barium, selenium, and thallium concentrations in shallow groundwater do not appear to be clearly tied to a single source or geochemical factor.

- Concentrations of chloride, ammonia, and TDS (primary IHS) are declining progressively in many areas of the Site.

- The primary environmental fate of chloride is mobilization and transport from solid phase media (soil and magnesite residue) to shallow groundwater and surface water, with eventual discharge to the Colville River.

- The primary environmental fate of nitrogenous compounds such as ammonia and nitrate is influenced in part by plant uptake that is occurring primarily within the North Field (agricultural field), and likely to some degree by vegetation growing along or within the West Ditch. Some ammonia and nitrate currently discharge to the Colville River via shallow groundwater and surface water (West Ditch).

- Trace metal concentrations in groundwater are expected to decline over time due to ongoing natural attenuation processes. The environmental fate of trace metals likely will include sorption to soil under favorable geochemical conditions, or gradual flushing and discharge to the Colville River via shallow groundwater.

- Groundwater monitoring data analysis demonstrates declining concentration trends at several locations within the monitoring network. An increasing concentration trend is observed in one well located in the magnesite residue pile. At this location, residual contaminants from formerly stockpiled FB/FBR materials are still being flushed from this large pile of legacy wastes associated with a former magnesite processing facility.

- Surface water quality in the West Ditch (station D2) is showing progressive improvement since the previous 2012 periodic review was conducted. More specifically, the concentration and loading of IHSs declined measurably between the first periodic review interval (2005-2011) and the second periodic review interval (2012-2017).

- Shallow groundwater in the North Field discharges to the Colville River. Although primary IHS in North Field groundwater exceed CULs, continued monitoring of the Colville River upstream and downstream of the Site has shown that impacts from this groundwater discharge are negligible. Surface water standards have not been exceeded in the river.

- The existing Restrictive Covenant contains certain omissions and inaccuracies that potentially could affect the long-term effectiveness of the remedy.

9.0 RECOMMENDATIONS

- CULs are still being exceeded at the Site. However, as long the existing Restrictive Covenant is active and remains effective in protecting human health and the environment from exposure to hazardous substances, no further action is required beyond the compliance monitoring and periodic review.

- Statistical predictive trend analysis of the groundwater monitoring data indicates the likelihood that groundwater CULs will be achieved at several (but not all) locations by 2034 (30-year cleanup time frame from the implemented cleanup action). Continuing progress toward achieving cleanup levels throughout the site should be evaluated closely during the next periodic review (2023). A similar predictive trend analysis should be performed to determine if the current projected concentration trends remain similar, gradually flatten (approach asymptotic levels), or show a more rapid rate of concentration decline.

- Continue groundwater and surface water monitoring in accordance with the following frequencies:

  - Monitor for five field parameters (temperature, pH, oxidation-reduction potential, conductivity, and turbidity) and primary COCs (chloride, ammonia-N, and TDS) semi-annually.
  - Monitor for nitrate-N, nitrite-N (ammonia transformation products), and barium semi-annually, every other year.
  - Monitor for remaining secondary COCs (manganese, selenium, and thallium) semi-annually, every other year.

- Conduct two sampling events per year at the four surface water monitoring stations (CR1, CR3, D2 and D3). During these two sampling events collect water quality samples, and conduct ditch discharge measurements at the two West Ditch monitoring stations (D2 and D3).

- Collect annual discharge data from the Colville River at stations CR1 and CR3 to help assess ongoing contaminant flux to the river during late summer/fall flow conditions.

- Perform the spring/early summer groundwater and surface water monitoring events during May or early June after the peak spring freshet. Delaying the monitoring to this later seasonal period should provide more accurate and reliable flow measurements in the West Ditch – particularly in station D2.

- Perform the fall surface water and groundwater sampling events when a surface water discharge of at least 10 gpm is present at West Ditch station D2. The typical window for conducting the fall sampling event is early October to mid-November

- The reporting limits for the thallium analyses must not exceed the thallium CUL. If this is not achievable, the next periodic review should take into consideration the current cleanup level in relation to its PQL/MDL. The PLPs will need to identify analytical laboratories that can achieve these analytical concentration goals for thallium and are properly accredited. Ecology must approve any changes in writing regarding thallium sampling preparation and/or analytical methods prior to sampling.

- Well P-09 should be retained in the current monitoring network during 2019–2023. While contaminant concentrations at P-09 have declined, this well provides important tracking of groundwater conditions within the main plant area. Ecology prefers to verify the current concentration trends at well P-09 for at least another 5 years before approving any request to remove this well from the existing monitoring network. Demolition of existing buildings (some in deteriorated condition) near P-09 also may occur in the future, and any disturbances or impacts to shallow groundwater caused by these actions will need to be monitored.

- Update the Restrictive Covenant for the Site to comply with the Uniform Environmental Covenants Act (Chapter 64.70 RCW). The specific activity and property use restrictions included in a new updated covenant are expected to be similar to those identified in the 2001 covenant. The new covenant will need to be filed with Stevens County and recorded by the County Auditor.

10.0 REFERENCES

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