CLACKAMAS COUNTY BOARD OF COUNTY COMMISSIONERS

Acting as the Governing Body of Clackamas County Service District No.1
and the Tri-City Service District

Study Session Worksheet

Presentation Date: October 8, 2013 **Approx Start Time:** 3:30 **Approx Length:** 30 min.

Presentation Title: Blue Heron West Project Update

Department: Water Environment Services

Presenters: Kathy Frasier, Greg Geist, Chris Storey, Mike Kuenzi

Other Invitees: Amy Kyle, Amanda Keller, Ryan Johnson

WHAT ACTION ARE YOU REQUESTING FROM THE BOARD? In addition to providing a project update, staff is requesting the Board's direction on the potential use of alternative contracting methods for remediation of the Blue Heron treatment lagoon.

EXECUTIVE SUMMARY:
Clackamas County Service District No. 1 and the Tri-City Service District ("Districts") entered into a co-investment strategy to acquire the Blue Heron West environmental assets in 2012 to secure a superior outfall pipe and its associated Clean Water Act permit. The objective was to meet future challenges of increasingly stringent environmental regulations governing heat discharges and toxic mixing into the Willamette River. Staff also saw the opportunity to acquire an asset that would allow the Districts to meet expected service demands due to future growth and for substantial ratepayer savings.

The Districts were successful in purchasing the property, finalizing transfer from the bankruptcy court in July 2012. Staff is currently assessing and remediating the site's contamination prior to opening a dialog with the BCC on the final disposition of the site. Staff is providing an update on the status of the project to date, including the investigation related to the clean-up of the former Mill's treatment lagoon and status of the water quality permit for the site.

FINANCIAL IMPLICATIONS (current year and ongoing): The Districts have established a total investment of $6 million for the procurement and clean up of the site while negotiating permits for its outfall.

LEGAL/POLICY REQUIREMENTS: Staff is seeking the Board's direction on the potential use of alternative contracting methods for the remediation work to minimize District risk until permit negotiations with the Oregon Department of Environmental Quality (DEQ) are concluded and the disposition of the property has been determined. County Counsel has prepared a brief analyzing the statutory requirements and staff and Board obligations for granting an exemption to the traditional competitive bidding process.

PUBLIC/GOVERNMENTAL PARTICIPATION:

- The Districts' standing Advisory Boards and the Regional Wastewater Capacity Advisory Committee supported the purchase and receive regular updates on the project.
- The Districts and the City of West Linn are coordinating planning activities for the future use of the areas of the property not needed by the Districts.
- The Districts are working through the processes outlined in their Prospective Purchaser Agreement with the DEQ, as well as on a proposed water quality permit modification.

OPTIONS:

1. The Board supports staff exploring the use of alternative contracting methods for the remediation of the Blue Heron West treatment lagoon.
2. The Board requests that staff pursue a more traditional approach to contracting the site cleanup.
3. The Board requests additional information from staff prior to providing its support of alternative contracting methods.

RECOMMENDATION:

Staff respectfully recommends that the Board support staff exploring the potential use of alternative contracting methods versus traditional contracting procedures for the remediation of the Blue Heron West treatment lagoon.

ATTACHMENTS:

1) Letter dated September 13, 2013 from Oregon DEQ Northwest Region Director Dick Pederson to Chair Ludlow regarding transfer of the Blue Heron NPDES Permit.
2) County Counsel brief analyzing the use of alternate contracting methods as opposed to traditional competitive contracting procedures.
3) Blue Heron Remediation Investigation Report.

SUBMITTED BY:
Division Director/Head Approval ________
Department Director/Head Approval ________
County Administrator Approval ________

For information on this issue or copies of attachments, please contact Trista Crase @ 503/742-4566.

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Oregon

John A. Kitzhaber, MD, Governor

Department of Environmental Quality
Northwest Region Portland Office/Water Quality
2020 SW 4th Avenue, Suite 400
Portland, OR 97201-4987
(503) 229-5263
FAX (503) 229-6957
TTY 711

September 13, 2013

John Ludlow, Chair
Clackamas County Board of Commissioners
2051 Kaen Road
Oregon City, OR 97045

Re: Letter on the Clackamas County Water Environment Services purchase of Blue Heron assets and transfer of NPDES permit

Dear Chair Ludlow and Commissioners:

As you are aware, communities across Oregon that treat and discharge municipal sanitary wastes are looking for solutions to address temperature and other discharge limitations that are contained in DEQ-issued wastewater discharge permits. Though recent legal challenges to Oregon's regulatory approach have complicated the wastewater permitting process, DEQ is committed to working through those issues with our stakeholders so that we can issue and renew wastewater discharge permits. We recognize that having regulatory certainty is important to you as you plan how to invest precious ratepayer dollars in ways that maintain compliance with Clean Water Act requirements and provide cost-effective wastewater treatment for your community and we share that challenge. We are endeavoring to create processes that treat permit holders with fairness and equity while providing legally defensible options for meeting water quality standards in an environment of competing uses.

Sincerely,

Dick Pedersen

Dick Pedersen
Director

To: Mike Kuenzi
From: Amanda Keller
RE: Blue Heron Alternative Contracting Methods
Date: October 1, 2013

QUESTION PRESENTED

Is it possible for Clackamas County Service District No. 1 and Tri-City Service District (collectively, the "District") to use an alternative method of contracting for the Blue Heron Restoration Project as opposed to the normal competitive bidding procedures required for public improvement contracts by the Clackamas County Code and Oregon Revised Statutes?

ANALYSIS

1. Clackamas County Code Requirements.

Alternative Contracting Methods. The Local Contract Review Board Rules contained in the Clackamas County Code[1] ("County Code") authorize contracting agencies to use alternative methods for public improvement contracts as permitted by ORS 279C.335. Alternative contracting methods are defined by the County Code as "innovative Procurement techniques for obtaining Public Improvement Contracts, utilizing processes other than the traditional method of Design-Bid-Build."[2]

Alternative contracting methods commonly include variations of Design-Build contracting, Construction Manager/General Contractor, Energy Savings Performance Contracts, as well as other developing techniques such as general "performance contracting" and "cost plus time" contracting.[3] The County Code provides the following detailed definitions of various alternative contracting methods available:[4]

- **Construction Manager/General Contractor** ("CM/GC") means a form of Procurement that results in a Public Improvement Contract for a Construction Manager/General Contractor to undertake project team involvement with design development; constructability reviews; value engineering, scheduling, estimating and subcontracting services; establish a Guaranteed Maximum Price to complete the Contract Work; act as General Contractor; hold all subcontracts, self-perform portions of the Work as may be allowed by the Contracting Agency under the CM/GC Contract; coordinate and manage the building process; provide general Contractor expertise; and act as a member of the project team along with the Contracting Agency, architect/engineers and other consultants. CM/GC also refers to a Contractor under this form of Contract, sometimes known as the "Construction Manager at Risk."

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[1] C-049-0600 Alternative Contracting Methods.
[2] C-049-0610 Definitions for Alternative Contracting Methods.
[3] C-049-0610(1) Alternative Contracting Methods.
[4] C-049-0610(2)-(5).

- **Design-Build** means a form of Procurement that results in a Public Improvement Contract in which the construction Contractor also provides or obtains specified design services, participates on the project *team with* the Contracting Agency, and manages both design and construction. In this form of Contract, a single Person provides the Contracting Agency with all the services necessary to both design and construct the project.
- **Energy Savings Performance Contract** ("ESPC") means a Public Improvement Contract between a Contracting Agency and a Qualified Energy Service Company for the identification, evaluation, recommendation, design and construction of Energy Conservation Measures, including a Design-Build Contract, that guarantee energy savings or performance.
- **Guaranteed Maximum Price** ("GMP") means the total maximum price provided to the Contracting Agency by the Contractor, and accepted by the Contracting Agency, that includes all reimbursable costs of fees for the completion of the Contract Work, as defined by the Public Improvement Contract, except for material changes in the scope of Work. It may also include particularly identified contingency amounts.

<u>Use of Alternative Contracting Methods.</u> The County Code requires a competitive bidding process for all public improvement contracts unless an exception under ORS 279C.335 applies.[5] If a statutory exception applies, then an alternative contracting method may be used if:

a) The exception that applies is sufficiently justified in accordance with the County Code;[6] and
b) Pursuant to ORS 279.355, the contracting agency provides a post-project evaluation for any projects in excess of $100,000.

2. Oregon Statutory Requirements.

<u>General Rule; Exceptions.</u> ORS 279C.335 requires public improvement contracts to be based upon traditional competitive bidding unless an exception applies. The local contract review board ("Board") may exempt a public improvement contract from the competitive bidding requirements upon approval of the following findings:[7]

a) It is unlikely that the exemption will encourage favoritism in the awarding of public improvement contracts or substantially diminish competition for public improvement contracts.

b) The awarding of public improvement contracts under the exemption will likely result in substantial cost savings to the contracting agency. In making this finding, the Board may consider the type, cost and amount of the contract, the number of persons available to bid and such other factors as may be deemed appropriate.

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[5] C-049-0620 Use of Alternative Contracting Methods.
[6] *Id.*
[7] ORS 279C.335(2).

Findings. In justifying the application of the exemption above, the District's supporting information must include specific findings. "Findings" are defined under the statute as the justification for a contracting agency conclusion that includes, but is not limited to, information regarding:[8]

a) Operational, budget and financial data;

b) Public benefits;

c) Value engineering;

d) Specialized expertise required;

e) Public safety;

f) Market conditions;

g) Technical complexity; and

h) Funding sources.

Board Obligations. In granting such exemptions, the statute requires the Board to do the following:[9]

a) When appropriate, direct the use of alternate contracting methods that take account of market realities and modern practices and are consistent with the public policy of encouraging competition.

b) Require and approve or disapprove written findings by the contracting agency. The findings must show the exemption of a contract complies with exception requirements listed above.

Public Hearing Requirement. Before final adoption of the required findings, a contracting agency must hold a public hearing and further satisfy the following requirements: [10]

- Notification of the hearing shall be published in at least one trade newspaper of general statewide circulation a minimum of fourteen (14) days before the hearing.
- The notice shall state that the public hearing is for the purpose of taking comments on the draft findings for an exemption from the competitive bidding requirement. At the time of the notice, copies of the draft findings shall be made available to the public. At the option of the contracting agency, the notice may describe the process by which the findings are finally adopted and may indicate the opportunity for any further public comment.
- At the public hearing, the contracting agency or state agency shall offer an opportunity for any interested party to appear and present comment.
- If a contracting agency or state agency is required to act promptly due to circumstances beyond the agency's control that do not constitute an emergency, notification of the public hearing may be published simultaneously with the agency's solicitation of contractors for the alternative public contracting method, as long as responses to the solicitation are due at least five days after the meeting and approval of the findings.

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[8] ORS 279C.330.

[9] ORS 279C.335(4).

[10] ORS 279C.335(5).

Post-Project Evaluation. Upon completion and final payment for any public improvement contract in excess of $100,000 for which a competitive process was not used, the contracting agency must prepare and deliver to the Board an evaluation of the project. The evaluation must be completed within 30 days of the date the contracting agency accepts the public improvement project and must be made available for public inspection.[11] The evaluation must include, but is not limited to, the following information:[12]

a) The actual project cost as compared with original project estimates;
b) The amount of any guaranteed maximum price;
c) The number of project change orders issued by the contracting agency;
d) A narrative description of successes and failures during the design, engineering and construction of the projects; and
e) An objective assessment of the use of the alternative contracting process as compared to the findings required by ORS 279.335.

CONCLUSION

Under the County Code and Oregon Revised Statutes, it is possible for the District to use an alternative contracting method as long as a statutory exception applies under ORS 279C.335 and the District is able to obtain Board approval by sufficiently justifying the use of the alternative method.

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[11] *Id.*
[12] ORS 279C.355.

CHECKLIST – MINIMUM REQUIREMENTS FOR COMPLIANCE

1. **Determine whether an exception to the competitive bidding requirement may apply.**
    a. Statutory Exception. Answer these two questions:
        i. It is unlikely that the exemption will encourage favoritism in the awarding of public improvement contracts or substantially diminish competition for public improvement contracts.
        ii. The awarding of public improvement contracts under the exemption will likely result in substantial cost savings to the contracting agency.
    b. Findings. Use the following information to answer the two questions above:
        i. Operational, budget and financial data;
        ii. Public benefits;
        iii. Value engineering;
        iv. Specialized expertise required;
        v. Public safety;
        vi. Market conditions;
        vii. Technical complexity; and
        viii. Funding sources.
2. **Get Board approval.**
    a. Present final report and findings to the Board.
    b. Satisfy notice requirements by holding public hearing prior to final adoption of findings.
        i. Notice published in a statewide trade newspaper of general circulation at least 14 days before the hearing.
        ii. Notice must state purpose of hearing is to take comments on findings.
        iii. Copies of draft findings made available to public when notice published.
        iv. Any interested party must be given chance to appear and comment.
3. **Complete a post-project evaluation.**
    a. Evaluation should at least answer the following questions:
        i. The actual project cost as compared with original project estimates;
        ii. The amount of any guaranteed maximum price;
        iii. The number of project change orders issued by the contracting agency;
        iv. A narrative description of successes and failures during the design, engineering and construction of the projects; and
        v. An objective assessment of the use of the alternative contracting process as *compared to the findings required* by ORS 279.335.
    b. Must be submitted to the Board within 30 days of District accepting the public improvement.
    c. Must be made available for public inspection.

DRAFT REPORT

Remedial Investigation and Risk Assessment

Blue Heron Paper Company
Aerated Stabilization Basin Site
1317 Willamette Falls Drive
West Linn, Oregon 97068

Prepared for:
Clackamas County Water
Environment Services
150 Beavercreek Road
Oregon City, Oregon 97045

August, 26 2013

CDM Smith

A Report Prepared For:
Clackamas County Water Environment Services
150 Beavercreek Road
Oregon City, Oregon 97045

DRAFT REPORT
REMEDIAL INVESTIGATION AND RISK ASSESSMENT
BLUE HERON PAPER COMPANY
AERATED STABILIZATION BASIN SITE
1317 WILLAMETTE FALLS DRIVE
WEST LINN, OREGON 97068

August, 26 2013

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Acronyms and Abbreviations

1,3-DCB	1,3-dichlorobenzene
µg/kg	microgram per kilogram
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
ARI	Analytical Resources Inc.
ASB	aerated stabilization basin
bgs	below ground surface
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylenes
CCSD	Clackamas County Service District No. 1/Tri-City Service District
COC	chemical of concern
COI	contaminants of interest
COPC	chemicals of potential concern
CPEC	chemicals of potential ecological concern
CPAH	carcinogenic polycyclic aromatic hydrocarbon
CRBG	Columbia River Basalt Group
CSM	conceptual site model
dioxin/furan	chlorodibenzo-p-dioxin and chlorodibenzo-p-furan
DO	dissolved oxygen
DRO	diesel range organics
E&E	Ecology & Environment, Inc.
EDL	estimated detection limit
ELCR	excess lifetime cancer risk
EPH/VPH	extractable petroleum hydrocarbons and volatile petroleum hydrocarbons
EPA	United States Environmental Protection Agency
ERA	ecological risk assessment
ESA	environmental site assessment
FEMA	Federal Emergency Management
FS	feasibility study
ft	feet
ft bgs	feet below ground surface
GRO	gasoline range organics
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
MCL	maximum contaminant level
MEK	methyl ethyl ketone
MFA	Maul Foster & Alongi
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration

NPDES	National Pollutant Discharge Elimination System
NRI	*NRI Global, Inc.*
ODEQ	Oregon Department of Environmental Quality
ORO	oil range organics
PCBs	polychlorinated biphenyls
pg/g	picograms per gram
pg/L	picograms per liter
RA	risk assessment
RAGs	Risk Assessment Guidance for Superfund
RBC	risk based concentration
RI	remedial investigation
RME	reasonable maximum exposure
SC	specific conductance
SI	site investigation
SLVs	screening level values
TEF	toxic equivalency factor
TEQ	toxic equivalency
TSS	total suspended solids
USGS	United States *Geologic Service*
VOC	volatile organic compound
WES	Water Environment Services

Section 1

Introduction

This document presents the findings of a Remedial Investigation and Risk Assessment for the Blue Heron Paper Company Aerated Stabilization Basin (ASB) property located in West Linn, Oregon (Site) (**Figure 1**). Clackamas County Service District No. 1/Tri-City Service District (CCSD) purchased the ASB property from Blue Heron in May 2012. CCSD's primary interest in the property is the permitted outfall and will retain the outfall area in perpetuity. The City of West Linn is considering acquisition of the remainder of the property and is in the process of determining the highest and best use of the land.

On July 17, 2012 CCSD entered into a Consent Order with the Oregon Department of Environmental Quality (ODEQ) to complete a Remedial Investigation (RI), Risk Assessment (RA), Feasibility Study (FS), and Remedial Actions for the ASB property. Clackamas County Water Environment Services (WES) retained CDM Smith Inc. (CDM Smith) on behalf of CCSD to complete this RI and RA in accordance with the Consent Order.

1.1 Roles and Responsibilities

The primary contact names and roles of entities involved with the completion of this RI and RA are as follows:

ODEQ Project Manager - Shawn Rapp: Mr. Rapp is responsible for overseeing the adequacy of the technical aspects of the project on behalf of the agency and communicates the agency's needs, comments and other requirements to the WES project manager.

Phone: (503) 229-5614

Email: rapp.shawn@deq.state.or.us

WES Project Manager – Leah Johanson: Ms. Johanson is responsible for overseeing the overall project, budget, tasking CDM Smith with the work required to complete the project, and coordinating communications between ODEQ, WES, and CDM Smith.

Phone: (503) 742-4620

Email: LJohanson@co.clackamas.or.us

CDM Smith Project Manager – Jennifer Jones: Ms. Jones communicates with the WES project manager on the RI work and has overall responsibility in ensuring that the specific objectives of the field investigation have been met.

Phone: (503) 205-7403

Email: Jonesjm@cdmsmith.com

1.2 Objectives

The objectives of the RI and RA are as follows:

1. Identify the hazardous substances that have been released to the environment through non-permitted discharges from the facility.
2. Determine affected media and the nature, extent and distribution of hazardous substances.
3. Determine potential chemicals of ecological concern as a result of geochemical changes caused by existing conditions in the ASB.
4. Determine the fate and transport of hazardous substances and other chemicals of ecological concern identified at the Site.
5. Identify receptors potentially at risk from releases at the Site.
6. Estimate the risk to human health and/or the environment.
7. Obtain the information necessary to develop and evaluate remedial action alternatives and select a remedial action during development of an FS.

1.3 Report Organization

The following sections of this report detail the basis, rationale, methodology and findings of this RI as follows:

- Section 2 - Site Background: This section presents a summary of the Site features, general hydrogeology, and historical industrial processes as revealed during CDM Smith's Phase I environmental site assessment (ESA) completed on March 12, 2012 (CDM Smith, 2012a) and Phase II ESA completed on March 26, 2012 (CDM Smith, 2012b). The scope and findings from prior environmental investigations completed for the Site by others are also summarized.
- Section 3 – Remedial Investigation: This section presents the approach and methodology for conducting the RI, including the field data collection and observations, analytical methods and results.
- Section 4 – Nature and Extent of Contamination: This section provides the preliminary risk screening, including a discussion of where contaminants of interest (COI) are found, naturally occurring constituents, and concentrations observed compared to media-specific screening levels.
- Section 5 – Contaminant Fate and Transport: This section presents an evaluation of the persistence and potential migration of COI at the Site, including an evaluation of the magnitude of impact to various media, and environmental fate and transport of COI.
- Section 6 – Beneficial Water and Land Use: This section discusses current and reasonably likely future beneficial uses of the land, groundwater and surface water, considering the City of West Linn's plans for future Site development.

- Section 7 – Baseline Risk Assessment: This section presents a summary of the human health risk assessment completed for the Site to identify chemicals of concern (COC) and the ecological risk assessment to identify chemicals of potential ecological concern (CPEC).
- Section 8 – Summary and Conclusions: This section presents a summary of the significant findings regarding the nature, extent, distribution and environmental fate and transport of contaminants in various media, along with our conclusions and recommended remedial action objectives.
- Section 9 – References: References cited in this RI are presented in this section.
- Appendices: Supporting information for this RI, including the human health and ecological risk assessments, is included in the appendices at the end of this report.

Section 2

Site Background

2.1 Site Location and Description

The Site lies approximately three miles southwest of the City of West Linn on the north bank of the Willamette River (**Figure 1**). The official Site address is 1317 Willamette Falls Drive; however, the property lies north of Volpp Street and is bisected by 4th Street. The Site is an irregular shaped area of approximately 39.15 acres. Site boundaries and features are shown on **Figure 2.**

The southern portion of the Site is occupied by an approximately 15-acre aerated settling basin that was used for industrial wastewater treatment (the ASB). The ASB is constructed of an approximately 15-foot high earthen berm. The top of the earthen berm is constructed as an access road. The as-built drawings of the ASB (PPC 1981; SWE 1971) indicate the presence of a compacted clay "seal" perhaps 1 to 2 feet thick in portions of the ASB, but no evidence of a clay seal or liner was discovered during CDM Smith's Phase II ESA when the sludge was sampled using a coring device to penetrate the entire sludge interval. The base of the ASB appeared to be constructed with native sediments.

The ASB and its earthen berm are surrounded by chain-link fencing with a locked gate at the entrance. A large wetland exists to the north of the ASB and is partly contained by the northern side of the ASB berm. A stream traverses the northern side of the ASB berm from west to east, passes through a culvert under 4th Street and meets up with Bernert Creek, which extends in a northwest-southeast direction, ultimately discharging into the Willamette River. The northern side of the ASB berm creates a barrier for the southern side of the wetland. The remainder of the Site is undeveloped and thickly vegetated with grass, trees, and brush.

Additional structures at the Site include:

- A boat house and sample shed that extend over the south edge of the ASB.
- A motor control room, pad-mounted transformer, and maintenance shop with attached shed located along the south side of the ASB.
- A dilapidated former landscape equipment shed located to the west of the ASB.
- A single-family residence located northwest of the ASB (1317 7th Street).
- A residential mobile home located northeast of the ASB (1355 4th Street), together with one, and possibly more, outbuildings.

The surrounding area is primarily residential with limited industrial land use. The only non-residential uses in the immediate surrounding area are a sewer pump station and a wastewater treatment ASB operated by a local pulp and paper company, both of which are located to the northeast of the Site.

Photographs of the Site and vicinity are presented in **Appendix A.**

2.2 Topography

The natural land surface topography on the Site is irregular, but slopes generally downward from northwest to southeast towards the Willamette River. The highest elevations (up to about 120 feet) are located at the north edge of the Site, along 5th Avenue. From there, the land surface slopes downward to the area on the north side of the ASB where the stream and wetland are located, which is also the area of the lowest onsite elevations (approximately 65-68 feet) of the portion of the property that is northwest of Volpp Street. A strip of the property extends south across Volpp Street and down to the River. The elevation at Volpp Street is approximately 78 feet. Elevations are based on North American Vertical Datum of 1988 (NAVD88).

The land surface slopes upward around the sides of the ASB to the top of the earthen berm. The as-built drawings indicate the base of the ASB is approximately 59.5 to 60 feet and the top of the berm at elevation 81.5 feet NGVD29 (PPC 1981; SWE 1971). Converting to NAVD88, the base of the ASB occurs at elevation 63 to 63.5 feet, and the top of the berm at 85.0 feet. The current survey measured the elevation of the top of the berm at approximately 85 feet NAVD88 – consistent with the as-built drawings. Based on this information, the berm is approximately 22 feet higher than the base of the ASB.

According to the National Oceanic and Atmospheric Administration (NOAA) the daily mean river stage on the Willamette River at the station above the Oregon City Falls ranges between about 55 and 60 feet (National Geodetic Vertical Datum - NGVD29). The flood stage is 64 feet. Using NOAA's vertical datum conversion online tool to convert to NAVD88, results in the daily mean river stage ranging between approximately 58.5 and 63.5 feet and the flood stage at 67.5 feet NAVD 88 (NOAA VERTCON). According to the Federal Emergency Management (FEMA) flood insurance maps, the base 100 year flood elevation at the Site is 75 feet NAVD88 (FEMA 2008).

2.3 General Geology and Hydrogeology

The Site is underlain by fine-grained alluvium consisting primarily of silt, sandy silt and silty sand, with occasional layers of sand and gravel. Bedrock occurs below the alluvium and was encountered at depths of 17 to 20.5 feet below ground surface (bgs) in three borings drilled during the RI. Groundwater occurs at depths ranging between approximately 10 and 17 feet bgs (deeper when drilling on top of the ASB berm). Static water level elevations range between approximately 62 and 69 feet NAVD88. Comparison of the elevation of the base of the ASB to the groundwater elevations measured in onsite monitoring wells indicates that the water in the ASB is in hydraulic communication with the groundwater. However, as further discussed in Section 5, the extreme difference between the water table elevations for wetland surface/groundwater and the ASB indicates that the permeability of the base and sides of the ASB is very low, flux from the ASB to shallow groundwater is very low, and thus the ASB likely has little impact on the overall groundwater flow regime at the Site.

The overall direction of groundwater flow at the Site is generally southeast toward the Willamette River. The Site geology and hydrogeology are further detailed in Section 5.

2.4 Site History

The ASB was constructed to receive industrial wastewater and stormwater from the former Blue Heron paper mill (and its predecessors) in Oregon City. The ASB operated from 1972 until early 2011 when the mill shut down. The ASB received wastewater from the former Blue Heron mill through a 3-

mile pipeline that passes under the Willamette River, continues aboveground, and then extends underground onto the subject property from the eastern side of the Site.

Wastewater from the mill's primary treatment clarifier, bleach plant, chemical recovery area, cooling water, and storm water was pumped to the ASB for further treatment. This treatment included settling of solids and use of microorganisms in the ASB to further break down the organic matter in the wastewater. The treated water was then discharged through an outfall to the river via a multi-port diffuser located at River Mile 27.8 (Outfall 001) under an NPDES (National Pollutant Discharge Elimination System) permit, leaving an accumulation of sludge in the ASB.

Currently, stormwater and certain wastewater are still being discharged to the ASB under a Use & Environmental Indemnity Agreement with CCSD dated July 18, 2012. Under the terms of the agreement NRI Global, Inc. (NRI) may discharge "treated Compliant Wastewater meeting all effluent limits and other requirements of the Permit." Discharges of bulk chemicals such as oil, coolant, organic solvents, transformer oil, or fuel are specifically prohibited, other than as may be present in incidental concentrations in the discharge water. NRI is responsible for monitoring and reporting of its effluent discharges. All discharges from the mill are to cease by the end of August 2013, unless a new agreement is drawn up between NRI and WES that extends this date.

Based on historical research conducted during CDM Smith's Phase I ESA, it appears that, with one exception, waste sulfite liquor (a historical waste by-product of one of the chemical pulping processes) was not discharged directly to the property or the ASB. The sulfite-based pulping process can be of concern because it typically included the use of chlorine to bleach and/or break down lignin in the pulp and is associated with the production of dioxins/furans. The one exception was a one-time, failed experiment in 1951 whereby 47,700 gallons of waste sulfite liquor was deposited into an asphalt-lined 50x50 foot waste pond constructed on the Site within the approximate area of the current ASB boat house (see **Figure 2**). All of the liquor leached into the ground from this experimental waste pond over an 18-day period. This is the only known industrial use of the Site by the paper mill prior to 1972.

In addition to the sulfite pulping process, facility representatives have reported that chlorine was likely used to bleach pulp during the period that magnesium sulfite processing was being employed, which occurred between 1965 and 1983. The use of elemental chlorine to bleach pulp is also associated with the generation of dioxins/furans. Thus, the wastewater discharging to the ASB between 1972 and 1983 may have contained dioxins/furans.

Paper recycling also was historically conducted at the mill. De-inking sludges may contain low concentrations of heavy metals. In addition, polychlorinated biphenyls (PCBs) were used in coatings on the back of carbonless paper and could have been a source of PCBs in the waste stream.

The sludge in the ASB has been dredged four times over the years between 1978 and 1999, although dredging was never conducted to such a degree that all of the sludge was removed. The average amount of sludge left at the base of the ASB after each dredging event ranged from 4 to 9.3 feet. Based on measurements completed by Blue Heron in 2010, current sludge thickness in the ASB ranges from approximately 1.3 to 16.2 feet. To date, the wastewater/stormwater discharges to the ASB have been consistent enough, even following the mill shut down, such that the water surface has never dropped low enough to expose the surface of the sludge and allow for drying to occur.

2.5 Previous Site Investigations

The Site, whether in conjunction with the paper mill or by itself, has been the subject of several environmental investigations over the years, including the following:

- In 2008 Ecology & Environment, Inc. (E&E) completed a Site Inspection (SI) for the entire Blue Heron Paper Company facility on behalf of the EPA, which included limited sampling on the Site (E&E 2008).
- In April 2008 Maul Foster & Alongi, Inc. (MFA) completed a Phase I and II ESA for the Site (MFA 2008).
- Sampling and analysis of the ASB sludge was sampled and analyzed on several occasions in order to gain approval of land application of the sludge prior to dredging.
- Discharge water from the ASB was sampled to comply with the NPDES permit.
- In 2011 Bridgewater Group Inc. conducted an investigation of PCBs in soil (Bridgewater Group 2011).
- CDM Smith completed Phase I and Phase II ESAs for the Site in 2012 (CDM Smith 2012a and 2012b).

CDM Smith's Phase I ESA included a review and evaluation of the earlier E&E, MFA, and Bridgewater Group reports and the historical ASB sludge and discharge water data. While NPDES information and existing river sediment data were reviewed, it is the understanding that WES will not be held responsible for potential environmental concerns, if any, as a result of discharges to the river, including river sediment quality. Thus, the Phase I ESA focused on the potential for soil and groundwater contamination, as well as potential contaminants within the sludge. The following potential contamination sources were identified:

- A 1951 experiment (before construction of the ASB) resulted in a release of waste sulfite liquor to the subsurface, which represented a potential source of subsurface contamination, particularly by organochlorides and dioxins/furans **(Figure 2)**.
- The historical chlorine-based processes used at the paper mill represented a potential source of organochlorides and dioxins/furans in the ASB sludge.
- Historical paper recycling activities at the paper plant represented a potential source of heavy metals and PCBs in the ASB sludge.
- Elevated metal concentrations in groundwater (in particular, arsenic, cadmium, chromium, and lead) were suspected based on prior sampling by MFA; however, the concentrations were suspected to be biased high due the probability that analyses were conducted on highly turbid samples.
- Stained soils present in the landscape equipment shed represented a source of petroleum hydrocarbon contamination.

- Petroleum products or other hazardous substances may have been discharged to the floor drain in the maintenance shop and if so, represented a potential a source of subsurface contamination.

CDM Smith's Phase II ESA evaluated the potential contamination sources identified during the Phase I ESA. The following sections provide a brief summary of the scope and findings of the Phase II ESA by media. The information relevant to completion of the RI is provided in further detail in later sections of this report. The Phase II ESA exploration locations are shown on **Figure 3**.

2.5.1 Soil

The possible presence of PCB contamination associated with a reported spill of transformer oil at a transformer located behind the motor control room in 1988 was investigated by the Bridgewater Group, Inc. in 2001, but no PCBs were detected. This sampling effort was not repeated during CDM Smith's Phase II ESA.

CDM Smith's Phase II ESA included sampling and analysis of subsurface soils to evaluate the following:

1) The area of the experimental asphalt-lined sulfite liquor waste impoundment to evaluate the potential presence of dioxins/furans.

2) The landscape equipment shed to evaluate petroleum impacts from apparent surface spillage.

3) The maintenance shop area subsurface to evaluate the potential impacts of discharges to the floor drain or surficial spillage as may have occurred in the area.

Field screening of soils collected from borings found negligible evidence of volatile organic compounds (VOCs), discoloration, sheen, odor or other evidence of soil contamination. Following is a summary of analytical findings from the soil sampling effort.

Petroleum Hydrocarbons and VOCs: Low concentrations of methylene chloride, acetone and benzene were detected in one soil sample collected at depth by the maintenance shop (**Figure 3**, boring B4). Methylene chloride and acetone are common laboratory contaminants and at the low concentrations reported, the detections in the sample may have been due to laboratory contamination. The concentration of benzene detected in the sample at 1.6 micrograms per kilogram (µg/kg) is less than the ODEQ's residential and occupational direct contact risk-based screening levels (RBCs) and the leaching to groundwater RBC.

Dioxins/Furans: Dioxin/furan concentrations in the two soil samples collected from within the area of the experimental sulfite liquor waste impoundment (**Figure 3**, boring B1) were below any of ODEQs RBCs by one to two orders of magnitude.

Based on the apparent lack of contamination, no further subsurface soil sampling was conducted during the RI.

2.5.2 ASB Sludge

During the Phase II ESA, the sludge in the ASB was sampled by collecting cores of the material at eight locations as shown on **Figure 3**. The core locations were selected to provide spatial representation across the entire ASB, as well as targeting of areas where the sludge was thickest, with the assumption that the oldest, and therefore likely most contaminated sludge, resides in areas where the sludge is deepest. Sludge thicknesses ranged from approximately 5 to 11 feet. Four-foot-long sample cores were collected from the intervals of 0-4 feet (as measured from the base of the ASB upward) and from 4-8 feet (ft). The top few feet of the sludge layer was generally too fluid to successfully capture. Sometimes the 4-8 ft interval was a little less than 8 ft. If more than 8 ft of sludge was captured it was discarded. The material from each four-foot core was homogenized, sampled and submitted for analysis. In some instances, multiple four-foot cores from the same depth interval were composited. The exception was that of samples collected for petroleum hydrocarbon analyses, which were discrete samples collected before homogenization. Following is a summary of findings from the sludge sampling effort during the Phase II ESA.

Total Petroleum Hydrocarbons: Petroleum hydrocarbons were not identified as a potential contaminant of concern during the Phase I ESA. However, during sludge sampling and processing, a hydrocarbon-like odor was noted in the samples and it was determined that these analyses should also be included. Results of this testing confirmed that total petroleum hydrocarbons, particularly diesel (DRO) and oil range (ORO) are prevalent throughout the ASB sludge. Concentrations of DRO ranged as high as 18,000 mg/kg and ORO concentrations ranged as high as 32,000 mg/kg.

The source of petroleum hydrocarbons in the ASB sludge has not been determined. However, review of the coagulants, flocculants, and defoamer used in the primary clarifier at the Oregon City mill plant indicates these products contain 20 to 30 percent aliphatic hydrocarbons and one product may contain mineral spirits.

PCBs: The PCB Aroclors 1248 and 1254 were detected in all of the sludge samples. Although PCB concentrations were relatively low (less than 0.5 mg/kg) the concentrations of total PCBs in nine of the 11 samples exceeded the RBC for residential direct contact (0.20 mg/kg).

Dioxins/Furans: Dioxins were detected in each of the 11 samples analyzed. 2,3,7,8-TCDD is considered the most toxic of the congeners. Other dioxin congeners are given a toxicity rating from 0 to 1 with 2,3,7,8-TCDD being the most toxic. These toxicity ratings are called toxic equivalency factors (TEFs). The congeners are multiplied by their respective TEF values and summed to calculate a total dioxin toxic equivalence (TEQ). The TEQ concentrations ranged from 3.91 picograms per gram (pg/g) to 90.6 pg/g in the 11 samples analyzed.[1] When compared to ODEQ's RBCs, dioxin TEQ concentrations exceeded the residential direct contact RBC (4.4 pg/g) in 10 of the 11 samples.

Metals: Total metals were analyzed in four composite samples, each prepared from three to four core locations. The sludge metals data was comparable to historical sludge data. None of the metals concentrations exceeded the residential direct contact RBCs; however, copper and zinc concentrations exceed Oregon default background concentrations (ODEQ 2013).

2.5.3 Groundwater

CDM Smith's Phase II ESA included sampling and analysis of groundwater to evaluate the following:

1) Potential impacts of discharges from the floor drain inside the maintenance shop or surficial spillage that may have occurred in the maintenance shop area.

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[1] The dioxin and TEQ values for the sludge samples presented this RI are different from those presented in the Phase II ESA. The dioxin values presented in this RI are based on the validated data. See Section 3.3.1 for additional discussion on the data validation.

2) Groundwater conditions upgradient and downgradient of the ASB to verify and characterize elevated metals concentrations in groundwater as indicated by MFA in 2008.

The Phase II ESA included extending five temporary push probes to collect groundwater samples (**Figure 3**, borings B1, B4, GW1, GW2, GW3). One sampling location was situated upgradient of the ASB and the remaining sample locations were situated along the top of the berm at the downgradient side of the ASB. Samples analyzed for metals were field filtered. Following is a summary of findings from the groundwater sampling effort during the Phase II ESA.

Petroleum Hydrocarbons and VOCs: Analytical results of the groundwater sample collected adjacent to the maintenance shop did not indicate impact by petroleum hydrocarbon compounds. Two VOCs, 2-butanone (aka, methyl ethyl ketone [MEK]) and 1,3-dichlorobenzene (1,3-DCB) were detected at relatively low concentrations of 6.1 and 0.2 micrograms per liter (µg/L), respectively (**Table 11**). It is expected that these are true detections (as opposed to laboratory cross contamination) as the compounds are consistent with solvents that may have been used and discharged to the sink or floor drain and they are not common laboratory contaminants. There are no RBCs for MEK or 1,3-DCB; however, the concentrations of both of these compounds are not considered high enough to present a threat to human health or the environment. Based on the low VOC concentrations and apparent lack of a contamination source, no further analyses for VOCs in groundwater was conducted during the RI.

Metals: Cadmium, chromium, copper, lead, and mercury were not detected in any of the samples. Arsenic, manganese, nickel and zinc were detected in all groundwater samples analyzed. In all instances reported concentrations in the groundwater samples collected downgradient of the ASB were greater than the upgradient "Site background" sample.

Manganese concentrations in groundwater samples collected downgradient of the ASB appeared highly elevated as compared to background. Arsenic, nickel and zinc concentrations appeared to be slightly elevated downgradient of the ASB compared to background.

The fact that metals concentrations in groundwater, particularly manganese, tends to be greater at locations immediately downgradient of the ASB than upgradient of the ASB suggests that the ASB could be the source of elevated metals in groundwater. However, the ASB sludge does not contain manganese, arsenic, or nickel at concentrations greater than background soil concentrations. Zinc concentrations are somewhat elevated in the sludge as compared to background soil concentrations, but not exceedingly so. The absence of elevated metals concentrations in the sludge indicates that a change in ambient groundwater conditions in the vicinity of the ASB, such as pH or redox potential, may be causing an increase in the equilibrium concentration of some naturally occurring metals, most particularly manganese. The source and significance of elevated metals concentrations downgradient of the ASB was identified for further investigation during the RI.

2.5.4 ASB Water

The ASB water was not sampled and analyzed during the Phase II ESA, but monitoring reports required under the NPDES permit were reviewed. Monitoring was conducted for a variety of parameters, including flow, biological oxygen demand (BOD), total suspended solids (TSS), pH, temperature, whole effluent toxicity, mercury, methylmercury, cadmium, copper, lead, and zinc. Historical ODEQ records indicate that BOD and TSS limits were exceeded in the past (1970s and 1980s) due to excessive accumulations of sludge. Discharge monitoring reports from 2001 to 2005 found that the facility met effluent limits with one exception in February 2003 when the monthly average turbidity limit was violated. The September 2010 NPDES renewal application indicates the facility was meeting all permit requirements at that time.

With the mill shut down, the current discharges to the ASB are strictly limited by the agreement between WES and NRI. NRI is responsible for monitoring these discharges until the complete cessation of discharges in August 2013. Considering that the mill is no longer discharging industrial waste water, the contaminant loading of future discharges to the ASB are expected to be less than when the mill was in operation. While the conditions of the NPDES permit were and are expected to be met, applicable discharge limitations, as applied to the water in the ASB, may not be sufficiently protective of human health and the environment under a future land use scenario, should the ASB remain as it is currently.

2.5.5 Willamette River Sediment

E&E conducted sediment sampling in the Willamette River as a part of the Blue Heron Site SI (E&E 2008). During the SI sediment samples collected up and down river from the ASB outfall. While a range of chemicals were detected at relatively low levels, there is no conclusive evidence that the ASB had contributed significant contamination to the Willamette River. Because the Consent Order does not hold WES responsible for investigation of the Willamette River sediment, further investigation of the sediment is not covered in the RI.

2.5.6 Potential Environmental Concerns Not Previously Investigated

The Phase I ESA noted that the ASB had overtopped in 1974 and 1990 (CDM Smith 2011a). Recent observations indicate that there may have been other smaller events of overtopping, as small bits of plastic and a Styrofoam type of material were observed along the top, southern side of the ASB berm, approximately 200 feet west of the boat house/sample shed. A significant release of contaminants associated with the ASB sludge from overtopping events is considered low, as the quantity of sediment contained in the ASB water would be low and much of it would have been carried with the water to the river. Nevertheless, the potential that overtopping may have left contaminant laden sediment on the ground surface warranted further evaluation during the RI.

Section 3

Supplemental Field Investigation

3.1 Objectives

The objectives of the supplemental field investigation necessary to complete the RI were developed to fill in datagaps left following the Phase II ESA. By media, the objectives of the supplemental field investigation were as follows:

Surface Soil:

- Evaluate the potential presence of COI in surface soil as a result of the ASB overtopping.

Groundwater:

- Determine whether groundwater is impacted by petroleum hydrocarbons, dioxins/furans or PCBs as a result of leaching from the sludge in the ASB.
- Evaluate the source and mechanisms for the presence of elevated metals in groundwater.
- Evaluate the transport and fate of metals in groundwater; specifically whether groundwater is transporting metals to the Willamette River and wetlands at concentrations that may present a threat to aquatic receptors.

Surface Water:

- Evaluate COI in the ASB surface water, and if present, whether the concentrations present a threat to ecological receptors.
- Evaluate the potential presence of ASB COI in wetland surface water.

3.2 Investigation Methodology

The field investigation was conducted between March 14 and April 29, 2013. The following sections present a summary of the methodology and general field observations for the field investigation. All work was performed in general adherence with the RI Work Plan (CDM Smith 2013); any differences between the actual work performed and the RI Work Plan are noted in the text.

3.2.1 Surface Soil Sampling

Surficial soil sampling was conducted in areas considered most likely to have been impacted by sediment deposited from water overtopping the ASB. A total of three composite samples (CS-1 through CS-3) were collected from the general locations shown on **Figure 4**. One composite sample was collected along the top outside edge of the ASB berm (CS-1), adjacent to the location where particles of plastic and Styrofoam, apparently deposited from water overflowing the top of the ASB, were observed. A second composite sample was collected between the Site gate and Volpp Street, further "downstream" along the apparent overflow path, utilizing two sample points on each side of the paved driveway into the Site (CS-2). A third composite sample, representing the furthest location along the overflow path, was collected between Volpp Street and the river (CS-3). The three composite soil samples were collected in accordance with procedures described in the RI Work Plan, and analyzed for DRO and ORO by Northwest Method NWTPH-Dx, for dioxins/furans by EPA Method 1613B, and for PCBs by EPA Method 8082.

Deviation from the RI Work Plan:

- The RI Work Plan stated that the soil samples would be 3-point composite samples. For sample CS-2, a total of four samples were composited to allow for equal characterization of both sides of the Site driveway.

3.2.2 Well Installation and Development

Five monitoring wells (BH-1 through BH-5) were installed on March 14th and 15th, 2013 at the locations shown on **Figure 4**. One well was installed upgradient of the ASB (BH-1), on the west side of 4th Street to provide background water quality data. Two wells were installed at the downgradient base of the ASB berm near the southeast and southwest corners of the ASB (BH-2 and BH-3, respectively). A fourth well was installed at the top of the berm near the boat house (BH-4). The purpose of wells BH-2, BH-3, and BH-4 was to assess whether groundwater has been impacted by the contaminants identified in the ASB sludge. BH-4 was also situated in the area of the former sulfite waste liquor pond. The fifth monitoring well (BH-5) was installed on the south side of Volpp Street, across from BH-4, to assess the potential migration of contaminants associated with the ASB, if any.

The well construction details, including total depth and screened interval, are shown on **Table 1**, and boring logs are included in **Appendix B.** BH-1, BH-4, and BH-5 were advanced to depths ranging between 17 and 27 ft bgs when refusal occurred and weathered basalt was encountered. BH-2 and BH-3 were advanced to 20 feet bgs – weathered basalt was not encountered. The soils encountered in all the boreholes were generally fine-grained, ranging from silt to silty fine sand. Groundwater was first encountered at depths ranging between approximately 10.5 and 23 feet bgs. The stabilized water levels were approximately 2 to 7.5 feet higher than the apparent first encountered groundwater, except at BH-3.

Well development occurred between March 18 and 22, 2013. Wells were developed by purging (pumping water from the well) and surging (moving a cylindrical block of slightly smaller diameter than the well screen up and down within the screened interval of the well). General water quality parameters temperature, turbidity, and specific conductance were measured during development with depth-to-water and the volume purged from the well. Flow rates during development of wells BH-2 and BH-4 were relatively high (about 15 gallons purged per hour), and the turbidity in those wells improved quickly. The well development was considered completed when turbidity was not noticeably improving. In contrast, wells BH-1, BH-3, and BH-5 quickly dewatered; consequently, it was necessary to develop them over the course of multiple days. While the water level at BH-1 recovered in a matter of hours, BH-3 and BH-5 required 24 hours to recover after each purge. Development for each of these wells was considered completed after purging dry 2 to 3 times.

Deviations from the RI Work Plan:

- The RI Work Plan specified that borings would be advanced using hollow-stem auger drilling methods, and that soil would be sampled at 2.5-foot intervals using a split-barrel sampler. Instead, the monitoring well borings were advanced and soil was sampled continuously using direct-push methods.

- Well locations were modified slightly from the RI Work Plan because of drilling rig access limitations and to avoid utility lines. The planned locations and the final surveyed locations are shown on **Figure 4**.
- The top of the screened interval was below the static water level at BH-1 and BH-2 because the static water level more than 6 feet above the estimated depth of first encountered groundwater.

3.2.3 Groundwater Sampling

Groundwater samples were collected using a peristaltic pump and following low-flow procedures (EPA 1996). Field measurements of temperature, pH, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity were collected during purging, as specified in Section 6 of the RI Work Plan. Ideal low-flow sampling conditions were met at wells BH-3, BH-2, and BH-4; however, steady flow could not be sustained at BH-1 and BH-5. BH-1 and BH-5 were purged at the lowest rate possible with the peristaltic pump and purged dry before field parameters stabilized. The wells were allowed to recover for 24 hours before collecting the samples. When BH-1 and BH-5 were sampled after the 24 hour recovery, field parameters were recorded immediately after purging the sample tubing, followed by sample collection. Stabilized field measured parameters are presented in **Table 2.**

Groundwater samples collected from each of the five monitoring wells were analyzed for metals and select geochemical parameters. In addition, samples collected from BH-2, BH-3, and BH-4 were analyzed for petroleum hydrocarbons, dioxins/furans, and PCBs, to evaluate the ASB-to-groundwater pathway for these contaminants of concern. The groundwater analytical schedule is provided in **Table 3.**

Deviations from the RI Work Plan:

- Sampling methods were modified at BH-1 and BH-5, as described above due to the low yield at these wells.

3.2.4 Surface Water Sampling

One surface water sample was collected from the ASB and three surface water samples from the wetland at the approximate locations shown on **Figure 4**. The surface water samples were collected from the water's edge using a precleaned single-use polyethylene dipper with a 46-inch extension handle. Field parameters were measured once before sampling. Surface water field measured parameters are provided in **Table 2.**

The surface water sample collected from the ASB was analyzed for petroleum hydrocarbons, dioxins/furans, PCBs, metals, and selected geochemical parameters. Surface water samples collected from the wetland were analyzed for metals for use in evaluating background concentrations and potential impact from the ASB. The wetland sample collected adjacent to the ASB also was analyzed for petroleum hydrocarbons, PCBs, and dioxins/furans to evaluate the ASB-to-wetland pathway of these contaminants of concern. The surface water analytical schedule is provided in **Table 3.**

Deviations from the RI Work Plan:

- None.

3.2.5 Water Level Monitoring

Groundwater levels were measured manually at monitoring wells using an electronic water level indicator. To obtain surface water level measurements, 6-foot staff gauges were installed in the wetland and in the ASB to assess stage level changes. The surface water staff gauge locations are shown in **Figure 5**. Select locations, including wells BH-1, BH-4, and BH-5, and the wetland staff gauge, were monitored continuously between March 27 and April 26, 2013 using datalogging pressure transducers. A barometric pressure logger was installed at the Site to correct the water level data for barometric changes. The water level in the ASB was recorded four times per week over the same time period. Manually measured water levels are provided in **Table 4** (groundwater) and **Table 5** (surface water).

Compass Engineering surveyed the monitoring wells and staff gauges using NAVD88 Oregon real-time GPS network (Geoid 03) as the benchmark. At each monitoring well, the horizontal, ground surface and casing elevations were surveyed. The location and the top (6-foot mark) of each staff gauge were surveyed. Finally, the locations and ground surface elevations at two additional reference points (the top of the berm near BH-2 and BH-3) were surveyed. The survey data are summarized in **Table 1.**

Deviations from the RI Work Plan:

- None.

3.2.6 Other Data Sources

Willamette River stage data and precipitation data from a nearby station were obtained for comparison to Site water levels and to interpret groundwater and surface water level changes. Willamette River stage data were obtained online from the nearest United States Geological Survey (USGS) gauging station, approximately one mile from the Site: *14207740 Willamette River above Falls, at Oregon City, OR* (USGS 2013a). Precipitation data were obtained online from the nearest USGS precipitation station, approximately seven miles from the Site: *452359122454500 Durham Wastewater Treatment Plant at Durham, OR* (USGS 2013b). Although precipitation may vary over the seven-mile distance between the precipitation station and the Site, the data are expected to be reasonably representative of storm intensity, timing, and duration at the Site.

3.3 Field Measured Parameter Data

The stabilized field measured parameters for groundwater and surface water samples are summarized in **Table 2.**

Specific conductance (SC) in the groundwater samples ranged between 174 microsiemens per centimeter (µS/cm) (BH-1) and 1,533 µS/cm (BH-4). As will be seen in later sections, this is consistent with the groundwater analytical data, where solute concentrations were typically highest in BH-4 and lowest in upgradient well BH-1. SC was consistent in the wetland samples, ranging between 178 and 187 µS/cm, and the SC in ASB-1 at 270 µS/cm was only marginally higher than in the wetland samples.

Ferrous iron concentrations in BH-2 through BH-4, immediately downgradient of the ASB, ranged from 2 to greater than 3 milligrams per liter (mg/L). Ferrous iron concentrations at BH-1 and BH-5 (0.53 and 0.74 mg/L, respectively) were lower by at least an order of magnitude.

Dissolved oxygen (DO) concentrations at BH-2 through BH-4 were all less than 1 mg/L and oxidation reduction potential (ORP) ranged between -83.6 and 34.7 millivolts (mV). At upgradient well BH-1, the DO concentration was 1.2 mg/L and ORP was 140 mV. At downgradient well BH-5 the DO was 2.57 mg/L) and the ORP, -98 mV.

The pH in the ASB (8.67) was notably higher than in the groundwater and surface water samples, which ranged between 6.27 and 7.02.

3.4 Laboratory Analysis and Results

All soil, groundwater, and surface water samples were submitted to Analytical Resources, Inc. (ARI) in Renton, Washington for chemical analyses under chain-of-custody protocols. The samples were analyzed per the analytical schedule presented in **Table 3**. Copies of ARI's analytical reports are included in **Appendix C**. The following sections present the results of the quality assurance review of the data and summary of the analytical data.

3.4.1 Quality Assurance Review

CDM Smith performed a Stage 2a review and validation of the analytical reports in accordance with the EPA National Functional Guidelines for Superfund Organic Methods Data Review (2008), National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review (2011), EPA National Functional Guidelines for Superfund Inorganic Methods Review (2010), and Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (2009). Copies of the data validation reports are included in **Appendix C.**

Based on the data quality assurance review, the only data that were modified from the laboratory reported values were the dioxins/furans. Congener results with ion abundance ratios outside of control limits were qualified as estimated and were noted as being either biased high or low. Congeners were also detected in associated method blank samples and evaluated as described below.

According to the dioxin/furan data validation guidelines, the assessment of blank contamination should be conservative in that care should be taken to avoid reporting false negatives. In other words, if possible, it is preferable to estimate a value less than the reporting limit rather than qualify a value as nondetect due to the presence of a congener reported in the method blank. Given these guidelines, the following actions were taken for the evaluation of method blank contamination:

1. If the concentration of a congener was greater in the method blank than in the project sample, then the sample concentration was qualified as nondetect at the laboratory reporting limit (sample < method blank = qualify as nondetect).

2. If a congener was detected in the method blank, but the congener was detected at a higher concentration in the sample, then the sample concentration was qualified as estimated and flagged with a J qualifier (sample >method blank and <10x method blank = qualify as estimated).

3. If the congener was detected at a concentration 10 times higher in the sample than in the method blank then no qualification was applied to the sample (sample > 10x method blank = no qualification).

For the calculation of 2,3,7,8-TCDD TEQ values, nondetect values were set at zero rather than one half the reporting limit because sampling results were set as low as possible at the estimated detection limit (EDL) by the laboratory, while the reporting limit was approximately two orders of magnitude higher. Therefore, using one half the reporting limit for those results qualified as nondetect due to blank contamination would have skewed the results high to the point that the results would no longer be representative of field sampling conditions. For example, several congener concentrations in surface water sample W-1-1303 were reported at lower concentrations than in the associated method blank. The results for these congeners were qualified as nondetect at the reporting limit. If the TEQ was calculated for this sample using one half the reporting limit for each congener then the TEQ would have been significantly higher for this sample than the TEQ the laboratory reported for the method blank. This would not have been a representative concentration since the majority of congener results for sample W-1-1303 were reported as less than the method blank.

The data summary tables present the qualified data values and corresponding qualifiers, as appropriate.

3.4.2 Soil

Petroleum Hydrocarbons: Petroleum hydrocarbon data for CS-1 through CS-3 are summarized in **Table 6.**

PCBs and Dioxins/Furans: PCB and dioxin/furan data for CS-1 through CS-3 are summarized in **Table 7.** The data for the two soil samples collected from soil borings during the Phase II ESA are also included in **Table 7.**

3.4.3 ASB Sludge

Total Petroleum Hydrocarbons: Results for petroleum hydrocarbon analyses performed on the sludge samples are summarized in **Table 8.** The Northwest hydrocarbon screening analysis NWTPH-HCID was run on four of the submitted sludge samples in order to ascertain the types of hydrocarbons present in the sludge before running the quantification analyses. According to the screening analysis, petroleum hydrocarbons were confirmed to be present in two of the four samples screened. DRO and ORO were detected in samples F5-2 and E2-1.5. TPH-G was also detected in sample F5-2. Follow-up quantification analysis for DRO and ORO per the NWTPH-Dx Method was performed on samples E2-1.5, F5-2, A10-6, C8-1, F7-0.5, C5-1 and C5-7 and quantification analysis for TPH-G was performed on samples F5-2, F7-0.5 and C5-1.

PCBs and Dioxins/Furans: Results for PCB and dioxin/furan analyses performed on the sludge samples are summarized in **Table 9.**

Metals and Conventional Analytes: Results for total metals and conventional analyses performed on the sludge samples are summarized in **Table 10.**

3.4.4 Groundwater

Petroleum Hydrocarbons and Metals: Groundwater analytical results for petroleum hydrocarbons and metals are in **Table 11.** The 2013 groundwater data for the monitoring wells are grouped with the corresponding 2012 groundwater data for samples collected during the Phase II ESA. Monitoring well BH-1 (similar to Geoprobe sample GW-4) was installed and sampled to establish the Site-specific background level for groundwater. Monitoring well results are generally considered more representative than those collected from temporary boreholes during the Phase II ESA, particularly for metals, because of the well development and sampling methodology.

PCBs and Dioxins/Furans: PCB and dioxin/furan data for groundwater samples are summarized in **Table 12.**

Conventional Analytes: **Table 13** presents a summary of geochemical indicator compounds, such as alkalinity, chloride, sulfate, and total organic carbon.

3.4.5 Surface Water

The wetland surface water data are summarized in **Tables 11** (petroleum hydrocarbons and metals) and **12** (PCBs and dioxins/furans).

3.4.6 ASB Water

Petroleum Hydrocarbons and Metals: Petroleum hydrocarbon and metals data for the ASB water are summarized in **Table 11.**

PCBs and Dioxins/Furans: PCB and dioxins/furan data for the ASB water are summarized **Table 12.**

Conventional Analytes: **Table 13** presents a summary of geochemical indicator compounds, such as alkalinity, chloride, sulfate, and total organic carbon analyzed in ASB-1.

Section 4

Nature and Extent of Contamination

This section evaluates the nature and extent of COI in soil, ASB sludge, groundwater, ASB water, and wetland surface water using chemical analytical results of samples collected during Phase II ESA and RI field sampling programs, as summarized in Sections 2 and 3. This section compares contaminant concentrations to the State of Oregon's human health-based RBCs (residential, urban residential, occupational, leaching to groundwater), surface water criteria, and Oregon default background concentrations, and considers mechanisms for occurrence of COI, whether anthropogenic or under natural background conditions.

4.1 Soil

The Phase II ESA did not identify COI in subsurface soils at levels of concern, so the RI field investigation was limited to investigation of potential contamination in surface soil as a result of the historical ASB-1 overtopping. Sample CS-1 was obtained from the top of the berm where there is visual indication of overtopping, and samples CS-2 and CS-3 were obtained along the Site driveway and across Volpp Street where water from overtopping of the ASB during two documented historical events was observed to flow.

4.1.1 Petroleum Hydrocarbons

DRO and ORO were detected in all three samples, but the greatest concentrations were detected in sample CS-3. DRO concentrations were 35 mg/kg in soil samples (CS-1 and CS-2) collected on the ASB berm and the slope beside the Blue Heron driveway and about 10 times higher, at 390 mg/kg, in the sample (CS-3) collected adjacent to the road. However, the ODEQ RBCs for DRO were not exceeded in any of the samples and the DRO concentration in sample CS-3 was 2.8 times less than the most stringent RBC (1,100 mg/kg residential). A similar pattern was observed for ORO concentrations. The sample collected adjacent to the road contained an ORO concentration (1,200 mg/kg) that was an order of magnitude higher than the two samples collected on the ASB berm and berm slope. There are no ODEQ RBCs for ORO (only insulating mineral oil).

4.1.2 PCBs

PCBs were not detected in the three surface composite samples, and the laboratory method reporting limits were less than the ODEQ RBCs.

4.1.3 Dioxins/Furans

The dioxin concentrations in the CS samples were similar to the petroleum hydrocarbon data, in that the CS-1 and CS-2 had the lowest concentrations (TEQ values less 4 pg/g) and the sample collected next to the road was about an order of magnitude higher (TEQ 29.5 pg/g). The dioxin concentrations in CS-1 and CS-2 were less than the direct-contact ODEQ risk-based screening levels, and not significantly greater than the leaching to groundwater RBC. The dioxin/furan TEQ for CS-3 exceeded all of the RBCs.

4.2 ASB Sludge

4.2.1 Petroleum Hydrocarbons

DRO was detected in seven of the nine samples analyzed. DRO concentrations ranged from 670 mg/kg (E2-1.5) to 18,000 mg/kg (F7-0.5). ORO was detected in all the same samples that DRO was detected at concentrations ranging from 910 mg/kg (E2-1.5) to 32,000 mg/kg (F7-0.5). DRO concentrations in six of the nine samples analyzed exceeded the residential direct contact RBC of 1,100 mg/kg. The DRO concentration in one sample (F7-0.5) also exceeded the occupational direct contact and leaching to groundwater RBC. While there are no RBCs for lube oil range petroleum hydrocarbons, the reported ORO concentrations were, in every instance, greater (by 26 to 43 percent) than the DRO concentrations, ranging up to 32,000 mg/kg.

TPH-G was detected in samples C5-1, F5-2 and F7-0.5 at concentrations of 320 mg/kg, 63 mg/kg, and 310 mg/kg, respectively. However, the TPH-G analyses were complicated by matrix effects and the chromatographic profiles did not match that of gasoline. It is possible that the hydrocarbon concentrations reported as TPH –G are carry over from the heavier end DRO compounds present. TPH-G concentrations in all of the samples analyzed were less than the residential direct contact RBCs. The leaching to groundwater RBCs were exceeded for TPH-G in the three samples.

4.2.2 PCBs

PCB Aroclors 1248 and 1254 were detected in all of the sludge samples. In **Table 9**, the total concentrations of these aroclors are summed. Total concentrations of PCBs ranged from 0.14 mg/kg in sample F5-0-4 to 0.48 mg/kg in samples A10-0-4 and C8-0-4. The concentrations of total PCBs in all but two of the samples (E2-0-4.5 and F5-0-4) exceed the RBCs for residential direct contact (0.20 mg/kg), but all were less than the screening level for occupational direct contact (0.70 mg/kg). PCB concentrations in all samples exceeded the RBCs for protection of groundwater. However, PCBs are not highly soluble and it is expected that PCBs would preferentially bind to the highly organic sludge and are not likely to migrate from the ASB to groundwater at levels that would pose a risk to human health. As will be shown in Section 4.3, this is empirically demonstrated with groundwater samples collected at BH-2, BH-3, and BH-4, where PCBs were not detected.

4.2.3 Dioxins/Furans

Dioxin TEQ concentrations ranged from 3.91 pg/g to 9.05 pg/g. Dioxin TEQ concentrations exceeded the residential direct contact RBC (4.4 pg/g) for all samples except F11-4-8. Seven of the 11 samples exceeded the occupational direct contact RBC (15 pg/g), although none of the exceedances were more than an order of magnitude. The leaching to groundwater RBC (3.3 pg/g) was exceeded in each instance; however, dioxins/furans are not highly soluble and it is expected that they would preferentially bind to the highly organic sludge and are not likely to migrate from the ASB to groundwater at levels that would pose a risk to human health. As will be shown in Section 4.3, this is empirically demonstrated with groundwater samples collected at BH-2, BH-3, and BH-4, where dioxin/furans were not detected.

4.2.4 Metals

Total metals were analyzed in four composites prepared from three to four core locations as follows: A10, C8, E2, and F11 at the 0 to 4 foot interval; A10, C8 and F11 at the 4 to 8 foot interval; E2, C5, F5 and F7 at the 0 to 4 foot interval; and C5, F5 and F7 at the 0 to 4 foot interval. Arsenic, cadmium, and selenium were undetected. Chromium, lead, mercury, and nickel concentrations were less than

Oregon default background concentrations (ODEQ 2013). Copper concentrations ranged between 90.3 and 112 mg/kg; the default background concentration is 34 mg/kg. Zinc concentrations ranged between 210 and 414 mg/kg; the default background concentration is 180 mg/kg. None of the metals concentrations exceeded the residential direct contact RBCs. Of the metals analyzed, only copper and zinc appeared to be elevated as compared to default background concentrations (ODEQ 2013).

4.2.5 Conventional Analytes

Conventional analyses were performed on the same composite samples as for the metals. Historically, the conventional analyses have been used in conjunction with the metal analyses to determine the suitability of the material for agricultural land application. The sludge contains a high percentage of volatile solids (average 24.3%) and relatively high total solids content (average 30%). It also contains a high nitrogen content (average 1,461 mg-N/kg).

4.3 Groundwater

The groundwater investigation was designed to: 1) verify the initial groundwater data collected at the Site from temporary wells installed in Geoprobe borings during the Phase II ESA, 2) compare groundwater quality immediately downgradient of the ASB (BH-2, BH-3, BH-4) with background (BH-1) concentrations for COI that are naturally occurring, 3) compare groundwater quality immediately downgradient of the ASB with groundwater quality further downgradient (BH-5) between the ASB and the river, and 4) compare COI concentrations with State RBC concentrations.

4.3.1 Petroleum Hydrocarbons

Four groundwater samples were analyzed for petroleum hydrocarbons. DRO and ORO were detected at monitoring well BH-4 only. The concentration of DRO was 0.65 mg/L, exceeding residential, urban residential, and occupational RBCs. The concentration of ORO was 1.1 mg/L, for which there are no RBCs. BH-4 is installed through the ASB earthen berm, as opposed to BH-2 and BH-3, which were installed at the foot of the berm. Based on: a) the single detection at BH-4 and the non-detects at BH-2 and BH-3; b) that heavy end hydrocarbons are not particularly soluble in water and tend to sorb to soil (as they are in the sludge), and; c) that there is no release of a free phase product (such as from a leaking underground storage tank), the extent of petroleum hydrocarbon impacts in groundwater is likely very limited.

4.3.2 PCBs

PCBs were not detected in any of the three groundwater samples analyzed for this class of COI. As an additional line of analysis, partitioning calculations were completed to evaluate the potential for PCBs to have contaminated groundwater directly beneath the ASB. The partitioning results are presented in Section 5.

4.3.3 Dioxins/Furans

Dioxins/furans were not detected in any of the three groundwater samples. As an additional line of analysis, partitioning calculations were completed to evaluate the potential for dioxins/furans to have contaminated groundwater directly beneath the ASB in lieu of advancing a boring through the base of the ASB to collect a groundwater sample. The partitioning results are presented in Section 5.

4.3.4 Metals

Comparison between Sampling Rounds

The following discussion is presented in terms of dissolved metals concentrations so they may be compared to the original groundwater sampling conducted from Geoprobes during the Phase II ESA. Arsenic concentrations ranged between 0.6 and 15.8 µ/L. Background well BH-1 contained 1.6 µg/L arsenic. The greatest arsenic concentration occurred at BH-4, while the least arsenic concentration occurred in the downgradient well BH-5. The arsenic concentration at BH-4 (15.8 µg/L) is an order of magnitude greater than the adjacent Geoprobe sample B1-W, which contained 1.4 µg/L. The reason for this discrepancy is not evident, but the greatest arsenic concentration at this location is consistent with the other metals data, which also showed overall higher concentrations.

Manganese concentrations ranged between 250 and 5,320 µg/L. The greatest manganese concentration occurred at BH-4 and the lowest at the background monitoring well BH-1. Overall, manganese concentrations collected from the monitoring wells were lower than the samples collected from Geoprobes during the Phase II ESA. The greatest difference between the monitoring well and Geoprobe groundwater data occurred at Geoprobe sample GW-1 (9,750 µg/L) and its monitoring well counterpart BH-3 (1,110 µg/L).

Nickel concentrations ranged between <10 µg/L and 160 µ/L. The greatest differences in nickel concentrations between the Geoprobe and monitoring well samples were observed between Geoprobe sample GW-1 and monitoring well BH-3 (90 versus 10 µg/L, respectively), and between Geoprobe sample B1-W and monitoring well BH-4 (13 versus 160 µg/L, respectively). The nickel concentrations between sampling events and between dissolved and totals analyses seems much more variable than the other metals. However, during the RI sampling, the nickel concentrations were consistent with the other metals in that the greatest concentration occurred at BH-4 and the lowest concentration in background well BH-1.

Evaluation of Monitoring Well Data

The dissolved versus totals metals concentrations were comparable, with the exception of nickel at BH-5 where the total nickel concentration was 40 µg/L and the dissolved nickel concentration 60 µg/L. Theoretically, the total nickel concentration should have been higher. The samples were checked by the laboratory to ascertain whether they had been mislabeled, but this does not appear to have occurred. The laboratory also reanalyzed the samples, but came up with the same results. The cause of the discrepancy was not determined. However, given the similarity between the dissolved and totals metals concentrations, the sampling was successful in eliminating turbidity.

Unless specified otherwise, the following discussion is based on totals metals concentrations. The Site-specific background arsenic concentration at BH-1 (1.8 µg/L) is comparable to the Oregon default background concentration of 2 µg/L. With the exception of BH-4 (16 µg/L), arsenic concentrations are comparable to background. Also, with the exception of BH-4, which was higher by an order of magnitude, the arsenic data are comparable to the 2012 data.

Manganese concentrations exceeded the ODEQ screening level value (120 µg/L; ODEQ 1998), including the Site-specific background level at BH-1 (264 µg/L). The greatest concentration of manganese was detected at BH-4 (5,200 µg/L). The manganese concentration at BH-5, located approximately 90 feet downgradient of BH-4, was 80% less than the concentration at BH-4.

Nickel was not detected at the background monitoring well BH-1 at the laboratory method reporting limit of 10 µg/L. This is consistent with the Oregon default background concentration of 5.5 µg/L. Nickel was detected in the remaining four samples, with the maximum concentration of 160 µg/L found at BH-4. The nickel concentration at downgradient well BH-5 Z (60 µg/L) was 62% less than the concentration at BH-4 and just slightly higher than the surface water criterion (of 52 µg/L).

All results for total iron exceeded the Site-specific background level detected at BH-1 (2,000 µg/L). The greatest concentration of total iron was found at BH-4 (77,800 µg/L). The total iron concentration at downgradient well BH-5 was 2,110 ug/L, 97% less than the concentration at BH-4, and similar to the Site background concentration.

4.4 Surface Water

Surface water sampling was conducted to evaluate potential impacts on the wetland surface water quality. Wetland sample W-1 was collected immediately adjacent to the ASB while W-2 and W-3 were collected about 150 to 200 feet away (from approx. center of berm).

4.4.1 Petroleum Hydrocarbons

Petroleum hydrocarbons were not detected in the wetland sample W-1, and the detection limit for DRO was low enough to identify concentrations in excess of ODEQ RBCs.

4.4.2 Dioxins/Furans

Dioxins/furans were detected in the wetland sample W-1; however, virtually all of the dioxin/furan data were qualified as estimated and the TEQ (0.165 pg/L) only exceeded residential RBC of 0.076 pg/L.

4.4.3 Metals

Metals concentrations in surface water are generally expected to be at or below the concentrations found in groundwater because it is subject to different redox conditions than shallow groundwater and receives surface inputs from rainwater. The wetland water also receives input via the stream that flows along the north side of the Site.

Metals concentrations in the wetland samples were less than the concentrations detected at the upgradient monitoring well (BH-1). Total iron concentrations ranged from 920 g/L in W-2 to 1,840 µg/L in W-3 (total iron in BH-1, 2,000 µg/L). Total manganese concentrations ranged from 41 µg/L in W-2 to 179 µg/L in W-3 (total manganese in BH-1, 264 µg/L). Variability in the iron and manganese concentrations is likely attributable to suspended solids in the samples. W-3 exceeded the surface water criterion for iron. Two out of the three samples exceeded ODEQ's surface water criterion for manganese (120 µg/L; ODEQ, 1998); however, the manganese concentrations in wetland samples do not exceed the Site-specific background level detected at BH-1. Nickel was not detected in any of the wetland samples (<10 µ/L). Zinc also was not in any of the wetland samples (<10 µg/L).

Arsenic was detected at low levels (0.6 to 0.8 ug/L) in all three wetland samples. The concentrations exceed the ODEQ RBCs but are below the Oregon default background concentration (2 µg/L) and the Site-specific background level at BH-1 (1.8 µg/L). Nickel and Zinc were not detected in wetland samples.

4.5 ASB Water

4.5.1 Petroleum Hydrocarbons

DRO was reported at a concentration of 0.32 mg/L and ORO at 0.39 mg/L. These petroleum hydrocarbon concentrations are expected, considering the concentrations of hydrocarbons consistently found in the sludge. The DRO exceeded the residential and urban RBCs (0.1 µg/L by a factor of three, but did not exceed the occupational RBC (0.43 µg/L).

4.5.2 Dioxins/Furans

The dioxin/furan TEQ for the ASB water sample (3.55 pg/L) exceeded the residential, urban residential and occupational RBCs by one to two orders of magnitude. Virtually all of the dioxin/furan data were qualified as estimated.

4.5.3 Metals

Overall, metals concentrations in the ASB water were fairly low. The arsenic concentration of 0.7 µg/L was less than background. Iron, manganese, nickel and zinc concentrations did not exceed surface water quality criteria or RBCs.

4.6 Nature and Extent Conclusions

4.6.1 Soil

Results of the surface soil sampling indicate some impact of DRO, ORO and dioxins/furans in surface soil downgradient of the ASB, with the greatest impact beyond the berm, on the opposite side of the road. There are several potential sources of dioxins/furans and petroleum hydrocarbons to soil, especially near the roadway at the CS-3 sample location. Sources may include runoff from the asphaltic-concrete roadway, atmospheric deposition of dioxins/furans, and/or deposition of ASB sediment during overtopping events. The State of Washington Department of Ecology (Ecology) has published a document "*Urban Seattle Area Soil Dioxin and PAH Concentrations Initial Summary Report*," that studied dioxin/furan concentrations in surface soils (0-3 inches) of six Seattle neighborhoods (Ecology 2011). The samples were collected from right-of-way land (i.e., median planting strips). This study found dioxin/furan TEQ concentrations ranging from 1.7 to 110 pg/g, with an average concentration of 19 pg/g. The median and nonparametric 90th percential concentrations were 12 and 46 pg/g, respectively. Considering that CS-3 was collected from an area subject to road runoff, whereas the samples collected during Ecology's urban study were not, the dioxin/furan TEQ of 29.5 pg/g in CS-3 is well within the range that could be considered background.

4.6.2 ASB Sludge

Heavy end petroleum hydrocarbons, dioxins/furans, and PCBs remain as COI in the ASB sludge. The concentrations of heavy end petroleum hydrocarbons are fairly high throughout the sludge. Dioxins/furans and PCBs, while present at much lower concentrations also typically exceed occupational and/or residential RBCs. Overall, metals concentrations in the ASB sludge are comparable to background soil concentrations, with the exception of zinc and copper, which are somewhat elevated.

4.6.3 Groundwater

Dioxins/furans and PCBs were not detected in groundwater, which is consistent with the low overall concentrations of these COI detected in the sludge and low mobility of these compounds in the subsurface. Petroleum hydrocarbons detected at BH-4 are consistent with the petroleum hydrocarbons identified in the ASB sludge. Similarly, metals concentrations are consistently highest at BH-4. The fact that metals concentrations in the ASB sludge and surface water were low indicate that the overall higher metals concentrations in groundwater are being caused by redox conditions specific to the groundwater. These petroleum hydrocarbon and metals concentrations appear to attenuate within a short distance downgradient of the ASB. Further discussion of contaminant fate and transport in groundwater is provided in Section 5.

4.6.4 Surface Water

The preliminary conceptual Site model presented in the RI Work Plan identified a potential route of contaminant migration from the ASB, to groundwater, to the wetland. However, dioxins/furans were not detected in groundwater. Therefore, it is very unlikely that dioxins/furans in the ASB sludge were transported to the wetland water via groundwater. It is possible that the ASB overtopped on the wetland side, depositing dioxin/furan-containing sediment from the ASB into the wetland. But this is not a known occurrence. The only known impact of the wetland by another surface water body is the Willamette River, which has on occasion, inundated the wetland.

4.6.5 ASB Water

The ASB water appears to be impacted by petroleum hydrocarbons that are in the sludge, albeit at fairly low concentrations, as well as dioxins/furans. Metals concentrations in the ASB water are low as compared to surface water criteria and RBCs.

Section 5

Contaminant Fate and Transport

This section presents an interpretive physical conceptual site model (CSM), which has been refined and informed by data collected for the RI. Description of the CSM is followed by a discussion of the transport mechanisms for contaminants at the Site, grouped into two key contaminant classes. Finally, the exposure pathway summary relates the interpretive CSM to the various exposure pathways evaluated in the human health and ecological risk assessments for the specific COPCs identified (see Section 7).

5.1 Interpretive Physical Conceptual Site Model

Figure 6 presents the physical CSM developed through interpretation of data collected for the RI. This CSM provides a description of the physical setting and processes that control the transport and migration of contamination in soil, air, groundwater, surface water, and/or sediments to human health and ecological receptors.

The Site is located on the southern end of the Portland Hills, a linear topographic high representing the Portland Hills – Clackamas River structural trend (Beeson and Tolan, 1990), which defines the southern end of the Portland Basin. The Site rests on a broad shelf bordering the northwest bank of the Willamette River. The shelf represents the scoured surface of a tabular basalt flow of the Columbia River Basalt Group (CRBG), which is blanketed by a thin, unconsolidated alluvial sedimentary sequence consisting of fine-grained (silt and fine sand) facies of Pleistocene glaciofluvial flood deposits and Holocene alluvial overbank sediments. The edge of the overlying basalt flow forms an 80-foot bluff bordering the northwest side of the shelf. The Willamette River incises the shelf and truncates overlying sediments on the southeast side of the Site.

The fine-grained flood deposits and recent alluvial sediments comprise the primary hydrostratigraphic unit at the Site. Water-bearing zones hosted by basalt flows of the CRBG are not anticipated to have a significant role in the shallow hydrogeology of the Site, other than possibly discharging groundwater into the shallow alluvial unit from the basalt flow contact at the base of the bluff northwest of the Site.

Shallow alluvial groundwater is recharged by direct infiltration of precipitation, and likely by infiltration of surface flow from the adjacent uplands. A large wetland exists to the north of the ASB and is partly contained by the northern side of the ASB berm. The alluvial sediments also may receive recharge from the basalt flow contact if juxtaposed against the sediments at the base of the bluff, northwest of the Site.

The approximate direction of groundwater flow within the alluvial sediments is southeasterly, towards the Willamette River (**Figure 5**). The shallow groundwater gradient is relatively flat across the Site (0.006 ft/ft or 0.6%), until it steepens between the southeast side of the ASB and the River (approximately 0.03 ft/ft or 3%). Groundwater and surface water hydrographs (**Figure 7**) of continuous water level measurements recorded over the course of one month illustrate that the two main influences on water levels at the Site are rainfall and Willamette River stage. The water level at upgradient well BH-1 shows a marked response to the large rainfall events in early April, with increasingly dampened responses to rainfall downgradient, including a barely-perceptible response in the wetland, which likely acts as a constant head source on the shallow alluvial groundwater system. The most downgradient well BH-5, closest to the Willamette River, shows a delayed response to abrupt changes in the river stages and rainfall events. The river stage response is quickly dampened upgradient and by BH-4 becomes indistinguishable from the rainfall response.

The elevation of the wetland surface indicates that the wetland is an expression of groundwater. In contrast, the water surface of the ASB is approximately 18 feet above the water level measured in the nearest monitoring well (BH-4), which is located on the ASB berm, and 16 feet above the water level in the wetland, as measured at the staff gauge, located on the outside edge of the northern side of the ASB. This extreme difference in water levels indicates that the permeability of the base and sides of the ASB is very low, flux from the ASB to shallow groundwater is very low, and thus the ASB likely has little impact on the overall groundwater flow regime at the Site.

5.2 Key Contaminant Classes

For discussion of fate and transport, the Site COI have been grouped into two key contaminant classes: ASB contaminants and metals in groundwater. ASB contaminants originate at the ASB, whereas metals in groundwater are naturally occurring in native sediments but are mobilized under redox conditions controlled by the ASB. The fate and transport of the two contaminant classes are discussed in the following sections.

5.2.1 ASB Contaminants: Petroleum Hydrocarbons, PCBs, and Dioxins/Furans

The primary mechanism for transport of ASB COI above ground is by water overtopping the ASB and depositing contaminated sediments outside the ASB. Two such releases were documented in the Phase I and II ESA (MFA, 2008), and debris was observed at the south-central edge of the berm during a site walk preceding the RI field effort, which appeared to be evidence of overtopping. There are no known occurrences of the ASB overtopping on the wetland side and topographically, this appears very unlikely (Roholt, 2013). The Willamette River has on occasion flooded the area and in doing so, inundated the wetland, which could in turn deposit sediments containing low concentrations of dioxins/furans. The ASB itself has never been inundated when the Willamette River has flooded the area (Roholt, 2013).

The potential mechanism for transport of ASB COI in the subsurface is by seepage into groundwater. Evidence of impacts to groundwater was evaluated during the RI, and only petroleum hydrocarbons were detected in one sample at BH-4, which was installed within the ASB berm. Petroleum hydrocarbons were not detected in the two next closest wells to the ASB, which were installed adjacent to the outside of the ASB berm. The results indicate that any transport of ASB COI via seepage to groundwater is strongly inhibited by the low permeability of the materials around the ASB, and contamination is generally confined within the perimeter of the berm.

Groundwater directly beneath the ASB could not be accessed for sampling to assess the potential impacts of vertical seepage from the ASB. To address this potential transport mechanism, partitioning calculations were completed to calculate theoretical concentrations of PCBs and dioxins/furans in groundwater immediately beneath the ASB, based on concentrations detected in samples of sludge obtained from the base of the ASB. The resulting concentrations were compared to the most conservative surface water screening levels (EPA national recommended water quality criteria [NRWQC] for fish consumption); although there is no evidence that ASB COI will discharge to surface water. The input values and the assumptions made for the partitioning calculations are documented in **Appendix D** and **Appendix E**.

The resulting conservatively estimated concentration of PCBs in groundwater immediately below the ASB was 18% of the NRWQC. The resulting concentration of dioxins/furans was 0.2% of the NRWQC. The results of this analysis and groundwater data from downgradient monitoring wells show that seepage to groundwater is not a viable transport mechanism for ASB COI, and contamination is expected to remain confined laterally within the perimeter of the berm and vertically within the low-permeability and carbon-rich sediments at the base of the ASB.

5.2.2 Metals in Groundwater

The primary chemical processes that can affect mobility of dissolved metals in groundwater are dissolution, precipitation, adsorption, complexation, and microbially-mediated reactions. Dissolution and precipitation are the most important processes controlling the mobility of iron, manganese, nickel, and other metals detected in groundwater at the Site. The mobility of dissolved metals in groundwater is dependent on geochemical disequilibrium between groundwater and sediments, on the presence and concentrations of other constituents such as dissolved oxygen, sulfate, and bicarbonate, and especially on redox conditions. The solubilities of iron and manganese species are particularly sensitive to changes in the oxidation or reduction capacity present in groundwater. Additionally, the presence of dissolved organic matter can facilitate metal oxide reduction and cause large increases in dissolved manganese and iron in groundwater near an organic carbon source.

Ferrous iron can be mobilized in groundwater under reducing conditions through dissolution of iron oxyhydroxides, which are typically present in alluvial sediments of volcanic origin (Hem 1985; Appelo and Postma 1999). Manganese is similarly mobilized by reductive dissolution of manganese oxides. Further, as groundwater approaches a surface water body (e.g., the Willamette River) and encounters increasing dissolved oxygen concentrations in the transition zone, dissolved ferrous iron and manganese [Mn(+II)] will be oxidized and iron oxyhydroxides and manganese oxides are expected to precipitate quickly (Appelo and Postma 1999). Nickel also can be mobilized in reducing environments, but precipitation of iron oxyhydroxides and manganese oxides tend to control nickel's mobility via co-precipitation and sorption (Hem 1985).

To evaluate the redox conditions in Site groundwater, a spreadsheet model was used to assign a redox category and to identify the dominant redox processes occurring in groundwater at the Site (Jurgens et al. 2009). The model assumes that groundwater is in equilibrium with sediments, which is not likely the case at the Site; however, the model provides a general framework for interpretation of the redox conditions at the Site. The general redox category assigned to all samples was mixed (oxic-anoxic), with oxygen and ferric iron reduction as the dominant redox processes. The redox category is designated as mixed because dissolved oxygen is present in concentrations greater than 0.5 mg/L in all samples (oxic), yet ferrous iron, sulfate, and manganese are present in concentrations that indicate reduction is occurring (anoxic). In the absence of direct porewater measurements in the ASB sludge, strongly reducing conditions are inferred to predominate at the base of the ASB because organic carbon is present at elevated concentrations in the ASB sludge.

On the basis of the redox processes described above, the processes controlling dissolved metals concentrations in groundwater at the Site are summarized as follows:

1. Background conditions are weakly oxidizing to weakly reducing, resulting in the naturally-occurring metals concentrations detected at BH-1.

2. The background well, BH-1, is in close proximity to the source of recharge (rainfall runoff and infiltration from the basalt bluff). The recharge source is dilute and most likely undersaturated with respect to the minerals encountered in the subsurface. Therefore, in the absence of the ASB, with increased residence time (along the groundwater flow path) the concentrations of dissolved constituents (e.g., metals) may be expected to increase based on mineral availability and mineral solubility as bicarbonate and hydrogen ions react with the minerals in the aquifer matrix and organic matter (Freeze and Cherry, 1979), but not to the extent that was observed in the vicinity of the ASB.

3. The organic carbon-enriched sludge at the base of the ASB likely promotes reducing conditions, which in turn would cause iron oxyhydroxides and manganese oxides to dissolve, releasing iron, manganese, nickel, and other associated metals into solution. This process is indicated by maximum concentrations of metals being detected at BH-4, adjacent to the ASB.

4. Because of the fine-grained sediments present beneath the ASB and the relative immobility of organic contaminants present in the ASB sludge, the strongly reducing environment is limited to the immediate vicinity of the water bearing zone beneath the ASB footprint.

5. Concentrations of dissolved metals in groundwater decrease rapidly over a short distance downgradient from the more reducing conditions of the ASB, as indicated by at least 80% reduction in metals concentrations between BH-4 and BH-5 (a distance of 90 feet).

6. Dissolved metals concentrations are expected to decrease further as groundwater approaches the Willamette River and encounters increasing dissolved oxygen concentrations (i.e., more oxidizing conditions) in the transition zone and sediment pore water.

7. Finally, any remedial alternative that includes encapsulation or removal of ASB sludge is expected to shift the groundwater redox conditions toward less reducing/more oxidizing conditions than are currently present and reduce the mobility of dissolved metals in groundwater.

Section 6

Beneficial Water and Land Use

6.1 Current and Reasonably Likely Future Land Use

As described in Section 2, there are currently two occupied residences on the northwestern and northeastern portions of the Site. The ASB is currently being monitored and maintained, but is not providing the industrial use that it was designed for. WES has an interest in moving forward with the remediation as soon as possible to minimize the cost of long-term maintenance of an inactive ASB and to avoid having to mitigate odor complaints, as may arise if the ASB becomes stagnant and begins to dry out.

In a public process being led by the City of West Linn, a wide variety of future land uses are currently being considered for the Site to determine the highest and best use. The alternatives being considered include very low impact, to high impact land uses, or a mix, based on zoning. Some of the alternatives being considered include:

- Passive park
- Wildlife refuge
- Interpretive center
- Community center (e.g., pool, courts)
- Active play park (e.g., skate park, picnic shelters, disc golf course, dog park, amphitheater, camp ground, rustic cabins)
- Public works services facility
- Housing (e.g., high end single family residences, model green housing, high rise for senior living).
- Commercial (e.g., medical, offices, restaurants, warehouse, hotel, retail)

As of writing of this RI, the City of West Linn has not limited the list of future land use alternatives. However, at this time, the most likely redevelopment scenario for the ASB area specifically appears to be as a combination of a passive and active play park.

6.2 Current and Reasonably Likely Future Water Use

6.2.1 Groundwater

Groundwater is currently not utilized at the Site, whether for potable water supply or irrigation purposes. The water supply for the Site is provided by the City of West Linn (West Linn 2011). There is no record of drinking water wells having been located on the Site (Oregon Water Resources, Well Log Query, 2012); although it is possible that unrecorded wells may have been located on the Site in connection with historical residential and agricultural uses of the property.

Given the likely future land uses being considered and that the Site is currently serviced by a public water supply, there would be no need to resort to using groundwater as a water supply source for the Site. The potential for illicit groundwater use, such as could occur by a private landowner installing a private well, is negligible since the land will be owned by a public entity.

According to Oregon Water Resources Department online Well Log Query the apparent closest potable wells are over one half mile away, across the Tualatin River. However, due to lack of address information not all well locations could be accurately identified on the database.

6.2.2 Surface Water

As has already been established, there are currently three surface water bodies at the Site: the wetland, the ASB, and the Willamette River. Any future land use scenario for this Site involves complete elimination of the ASB, leaving only the wetland and the Willamette River. Future land uses possibly include recreational uses along the Willamette River, such as a boat or kayak launch site. The wetland is expected to be protected generally in its current form, although boardwalks may be constructed through portions of the wetland to allow public access for recreational purposes, such as bird watching.

Section 7

Baseline Risk Assessment

7.1 Human Health Risk Assessment

CDM Smith completed a baseline human health risk assessment (HHRA) in compliance with the requirements for a deterministic risk assessment as specified in Oregon's Administrative Rule (OAR) 340-122-0084. The HHRA was conducted in accordance with ODEQ Human Health Risk Assessment Guidance (ODEQ 2010) and USEPA (EPA) Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part A), Interim Final (USEPA 1989), and other applicable ODEQ and EPA guidance documents. A copy of the HHRA is included in **Appendix F**.

The HHRA evaluated potential current and future human health risks resulting from exposures to chemicals at the Site in the absence of any actions to control or mitigate these risks (i.e., under an assumption of no action). In addition, risks associated with actions that may lead to greater exposure to Site-related chemicals (i.e., dewatering the ASB, drying the sludge and spreading it across the ground) were evaluated in the HHRA. The HHRA was conducted under a reasonable maximum exposure scenario. Uncertainties were evaluated in the uncertainty section of the HHRA. To compensate for uncertainty surrounding input variables, assumptions are made that tend to result in protective estimates of risk, rather than underestimated risk. This section provides a summary of the HHRA findings.

7.1.1 Human Health Conceptual Site Model

One step of the HHRA was to develop an exposure assessment, which identifies pathways by which human populations might be exposed to Site-related chemicals. Chemical sources, release and transport mechanisms, and intermedia transfer were evaluated. Exposure pathways are identified based on the location and activities of potentially exposed populations and on the types of potentially contaminated media. This exposure assessment was developed into a CSM, as shown on **Figure 8** which schematically presents the relationship between chemical sources, release mechanisms, exposure routes, and receptors at the Site.

This CSM was developed through consideration of sources of chemical release, contaminant distribution, chemical fate and transport, hydrogeologic conditions, current and possible future land use at the Site and adjacent area, and current and reasonably likely future groundwater and surface water use. Potentially complete and significant pathways through which receptors may be exposed to COPCs are shown in **Figure 8.** Also shown are "incomplete" exposure pathways and pathways that may be complete but exposure is considered insignificant for some receptors. Incomplete exposure pathways assume it is unlikely for a receptor to ever come into contact with COPCs. Complete but insignificant exposure pathways assume it is possible for a receptor to contact COPCs but that the frequency *and duration* of exposure or contaminant concentrations are so low that exposure would be negligible.

7.1.2 HHRA Risk Characterization Summary of Findings

Potential human health risks were characterized by evaluating: 1) results of the CSM, which identified potentially complete and significant exposure pathways; 2) estimated reasonable maximum exposure

(RME), which is defined as exposure above about the 90th percentile of the population distribution; and 3), chemical-specific toxicity..

Individual and cumulative acceptable risk levels for carcinogens and noncarcinogens are defined by OAR 340-122-115. At upper-bound exposure, acceptable risk level is an excess lifetime cancer risk (ELCR) of less than or equal to 1×10^{-6} (1 in one million) for individual carcinogens and 1×10^{-5} (1 in 100,000) for multiple carcinogens. The potential for noncarcinogenic health effects is evaluated by comparing an exposure level over a specified time period with a route-and chemical specific reference dose derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient (HQ). HQs for individual COPCs with similar toxicological effects may be summed to yield an effect-specific hazard index (HI) (EPA 1989). The HI assumes that there is a level of exposure below which it is unlikely even for sensitive populations to experience adverse health effects. The effect-specific HI can be calculated by summing HQs for chemicals with similar toxicological effects (e.g., development) or target organs (e.g., liver). If the sum of all HQs is less than 1, no effect-specific HIs are calculated because they would also not exceed one.

The following sections summarize the findings of the risk assessment for the various groups of people that may come into contact with Site-related COPCs.

7.1.2.1 Onsite Workers

The HHRA found that for current outdoor workers onsite, cancer risks and non-cancer hazards are below or at ODEQ acceptable risk levels. The HHRA found that for current outdoor ASB workers, the total upper-bound excess cancer risk is below the level (1×10^{-5}) specified by ODEQ for acceptable cancer risk for exposure to multiple carcinogens. The estimated carcinogenic risk (5×10^{-6}) is almost entirely attributable to exposure to dioxins/furans. Exposure to dioxins/furans in sludge contributed about 68% of the total risk. Non-cancer hazard indices for the outdoor ASB worker were 1 and primarily due to exposure to DRO in sludge. Estimated hazards associated with petroleum hydrocarbons were based on generic RBCs and the resulting hazard quotient is most likely overestimated.

7.1.2.2 Current and Future Residents

The HHRA found that current residents are not exposed COPCs associated with the Site.

The HHRA found that for future residents cancer risks and non-cancer hazards were greater than acceptable levels assuming that a resident used water from a drinking water well installed onsite and was exposed to sludge that had been dried and spread onto the ground surface.

As discussed in Section 6, it is unlikely that in the future a drinking water well would be installed onsite. However, the HRRA evaluated use of shallow groundwater beneath the Site as drinking water by future residents as the most conservative exposure scenario. Arsenic was the only carcinogen detected in groundwater. Carcinogenic risk due to exposure to arsenic in groundwater (2×10^{-4}) was greater than the upper-bound acceptable risk level risk for individual carcinogens of less than or equal to 1×10^{-6} for individual carcinogens. The maximum detected concentration of arsenic in groundwater was 16 µg/L which influenced the exposure point concentration based on the 90% UCL; concentrations of arsenic in all groundwater samples except from BH-4 where the maximum detection concentration was reported were below the EPA MCL. Cancer risks associated with exposure to arsenic in groundwater are likely greatly over-estimated.

Non-cancer hazards were also above 1 in groundwater for COPCs affecting the skin (arsenic HI=3), central nervous system (manganese HI=4) and gastrointestinal tract (iron HI=11). The HI for diesel petroleum hydrocarbons was below 1. If the HI exceeds unity (1), the daily intake is higher than a "safe" exposure level and some concern for potential non-cancer effects exists; however, this value should not be interpreted as a probability. Generally, the greater the HI above unity, the greater the level of concern. Safety factors are built into RfDs so that sensitive subpopulations of humans (e.g., children, pregnant women, individuals with respiratory problems) are protected. Thus, there is always a "margin of safety" built into an RfD, and doses equal to or less than the RfD are nearly certain to be without any risk of adverse effect. Doses higher than the RfD may carry some risk, but because of the margin of safety, a dose above the RfD does not mean that an effect will necessarily occur.

Future residents were also evaluated for exposure to COPCs in sludge that is dried and spread on the ground surface. While not considered a likely remedial action for the Site, land application of dredged sludge from the ASB has occurred historically under certain conditions. . In the HHRA, exposure pathways for soil (dried sludge spread onto the ground surface) included incidental ingestion, dermal contact, and inhalation of particulates. The total excess lifetime cancer risk for residents exposed to dried sludge is 8×10^{-5} which is greater than the ODEQ acceptable cancer risk of 1×10^{-5} for exposure to multiple carcinogens. Incidental ingestion of arsenic and dioxins/furans contributed most of the ELCR. Arsenic was included as a COPC for sludge although it was reported as non-detect because the reporting limit was above RBCs and background. If arsenic is excluded from the ELCR, the resulting ELCR is 1×10^{-5}, which is at the acceptable target level for exposure to multiple carcinogens.

The non-carcinogenic HI for exposure pathways associated with surface soil (dried sludge spread onto the ground surface) is 15, greater than the acceptable target level of 1. The majority of the HI is due to exposure to diesel range hydrocarbons in sludge. Because generic RBCs for residential contact with soil were used to estimate the HQ for exposure to TPH (HI=12) the resulting HQ is likely overestimated. Incidental ingestion of arsenic (HI=1) and dioxins/furans (HI=1) also contributed to the HI.

7.1.2.3 Future Construction Workers

The total upper-bound excess cancer risk (2×10^{-6}) for future construction workers is below the ODEQ acceptable cancer risk of 1×10^{-5}. The majority of the cancer risk is due to incidental ingestion of arsenic and dioxins/furans in sludge. As previously discussed, arsenic was not detected in sludge and the estimated cancer risk is based on the elevated reporting limit; if arsenic is excluded as a COPC in sludge the total cancer risk is 6×10^{-7}. The non-carcinogenic HI (4) was greater than the acceptable non-cancer target level of one. The majority of the HI was due to exposure to DRO in sludge based on generic RBCs.

7.1.2.4 Infants

Dioxins/furans and PCBs were identified as COPCs in media at the Site that bioaccumulate. The HHRA found that excess lifetime cancer risks for infants of current onsite ASB workers and future construction workers were below the ODEQ acceptable cancer risk of 1×10^{-5}. The excess lifetime cancer risks for infants of future residents were at the ODEQ acceptable cancer risk of 1×10^{-5}. The non-cancer HI was above 1 for infants of future residents and construction workers. These estimates assume that future parents of these infants are exposed to dried sludge which, based on current closure plans for the ASB, overestimates risk and hazards for future receptors.

7.1.2.5 Current Trespassers

Trespassing into the ASB area is difficult and therefore an infrequent occurrence (i.e., less than the current onsite workers). Therefore, this scenario was considered complete, but insignificant.

7.1.2.6 Future Recreational Users

The most frequent recreational users of the Site would be area residents. Residents are assumed to have more intense contact via the same exposure pathways to COPCs in Site related media; therefore, evaluation of residential exposure should be protective of recreational receptors. Recreational exposures were evaluated qualitatively. The qualitative evaluation for future recreational users concluded that exposure to Site-related COPCs for recreational users would be insignificant.

7.2 Ecological Risk Assessment

CDM Smith completed a Level I and II Screening Ecological Risk Assessment (ERA) in accordance with ODEQ Guidance for Ecological Risk Assessment (ODEQ 1998). The Level I Scoping Assessment was performed to document the presence of ecological receptors and/or exposure pathways at the Site. The presence of COI was based on findings from the Phase I and Phase II ESAs and other previous investigations at the Site. As part of the Level I scoping, a biologist conducted a visual assessment of habitats and ecological receptors observed and likely to be present at the Site and completed an Ecological Checklist and Evaluation of Receptor-Pathway Interactions (**Attachment A** in **Appendix G**). Based on the Level I Scoping Assessment, it was determined that ecological receptors and potentially complete exposure pathways exist at Site. Therefore, a Level II Screening ERA was completed, the full report of which is included in **Appendix G.**

The Level II screening ERA identified several CPECs in each of the media. The CPECs and rationale for their retention as CPECs are summarized by medium in **Table 14.** The CPECs were selected for each medium based on the results of one or more of the following screens: chemical toxicity screen, bioaccumulation screen, cumulative screen, and multimedia screen, as described in the Level II ERA, which is described in detail in **Appendix G.**

7.2.1 Ecological Conceptual Site Model

The ERA also included development of a CSM. The CSM identifies sources of contamination, migration pathways, exposure media, potential exposure pathways, and likely relationships between stressors (e.g., chemicals), assessment endpoints, and measurement endpoints for each medium of concern with regard to ecological receptors. The CSM considered sources of chemical release, distribution of chemical detections, chemical fate and transport, hydrogeologic conditions, current and possible future land, groundwater, and surface water uses use at the Site and adjacent areas. The CSM, presented as **Figure 9**, graphically depicts relationships between primary and secondary chemical sources, chemical release mechanisms and migration pathways, exposure routes, and receptors. Receptors are depicted as general categories (e.g., aquatic invertebrates, terrestrial plants, etc.).

7.2.2 ERA Risk Characterization Summary of Findings

7.2.2.1 Surface Soil

As shown in **Table 14**, three chemicals were initially selected as CPECs for surface soil. However, none of these chemicals pose a significant ecological risk based on the evaluation presented in the ERA (see **Appendix G**). This is because two of the CPECs (DRO and ORO) were selected based on the lack of screening level values (SLVs) from ODEQ or other sources. A lack of SLVs or scientific literature providing acceptable levels for the protection of ecological receptors indicate that remediation of surface soil based on these CPECs is not feasible or warranted. The third CPEC, dioxins/furans, were initially selected as a CPEC based only on the results of the multimedia screen and not based on a TEQ exceedance of the chemical toxicity screen, bioaccumulation screen, or cumulative screen. Within the multimedia screen, the total hazard quotient (HQ) was 1.0, with dioxin TEQ in surface soil contributing approximately half of the cumulative risk. Since the total HQ in the multimedia screen is equal to the acceptable risk limit of 1.0, the dioxin TEQ in surface soil was not retained as a CEPC. In conclusion, no CEPCs in surface soil were retained based on the ecological risk assessment.

7.2.2.2 ASB Sludge

As identified in **Table 14**, nine chemicals were selected as CPECs for ASB sludge. Three metals, arsenic, cadmium, and selenium were initially selected as CPECs based on the results of a single screen using elevated detection limits. None of these metals was detected above the laboratory detection limits but one half the detection limit was above each metal's respective SLV. In contrast, based on current risk and exposure, DRO, ORO, PCBs (total, and Aroclors 1248 and 1254), and copper were retained as CPECs, as identified in **Table 14.**

The identification of several CPECs in the ASB sludge confirms that it poses a current risk to ecological receptors and that conducting remedial action is warranted. A preliminary evaluation of remedial alternatives identified either sludge excavation or encapsulation as a potential remedy. If excavation and off-site disposal is selected as the preferred remedy, the source material would be removed and the pathway between the source and ecological receptors would be incomplete. If encapsulation were to be selected as the preferred remedy for the ABS, the pathway between the sludge and ecological receptor would also be incomplete. Further evaluation might be required if the dried sludge is encapsulated in an unlined containment cell to determine if chemicals from the sludge in the ASB may leach to groundwater and discharge to the nearby wetlands or Willamette River.

7.2.2.3 Groundwater

Since groundwater has the potential to discharge to surface water, including the wetland and the Willamette River, groundwater quality was evaluated relative to risk to aquatic receptors. The groundwater results were compared to applicable surface water screening level values (SLVs) without allowance for mixing or dilution (ODEQ 1998). Based on this evaluation, three metals were initially selected as CPECs for groundwater. They include iron, manganese and nickel. As shown in **Table 14**, each of these was retained as a CPEC, since each was selected based on the results of chemical toxicity screening, and in the case of iron and manganese, the multimedia screen.

7.2.2.4 ASB Water

As identified in **Table 14**, eight chemicals were initially selected as CPECs for ASB water. Two of these CPECs, calcium and iron, were not retained as CPECs. Calcium was initially selected as a CPEC based on the results of the cumulative screening (i.e., exposure to multiple chemicals). For this reason and since it is an essential nutrient, calcium was not retained as a CPEC. Iron was initially selected as a CPEC based on the results of the cumulative screen and the multimedia screen. Of the 12 chemicals detected in ASB water and evaluated in the cumulative screen, six chemicals contributed more to the overall risk than iron. Additionally, the sum of the risk estimates (HQ) associated with iron calculated in the multimedia screen was 80. Iron in ASB water contributes 0.16 that total. Thus, iron was not retained as a CPEC. The remaining six chemicals are retained as CPECs based on current risk and exposure, including dioxins/furans, DRO, ORO, manganese, nickel, and zinc.

Based on the assumed preferred alternative of draining the water from the ASB such that it will no longer provide aquatic habitat, the source material would be removed, preventing further migration or exposure to these CPECs.

7.2.2.5 Wetland Surface Water

As identified in **Table 14**, dioxins/furans, iron, and manganese were initially identified as CPECs. However, only manganese was retained as a CPEC based on ecological risk. Dioxins/furans were initially identified as CPECs based on the results of a multimedia screen, not based on the results of the chemical toxicity screen, bioaccumulation screen, or cumulative screen. Within the multimedia screen, the total HQ was 1.0, with dioxin TEQ from wetland surface water contributing only 0.022 of the cumulative risk. Since the total HQ in the multimedia screen was equal to the acceptable risk limit of 1.0, dioxins/furans in wetland surface water were not retained as a CPEC for ecological risk. Iron was selected as a CPEC based on the results of the cumulative screen and the multimedia screen. Although iron was one of the two primary contributors in the cumulative screen conducted for wetland surface water, the sum of the risk estimates (HQs) associated with iron calculated in the multimedia screen was 80. Iron in wetland surface water contributes 1.48 of that total. Thus, iron was not retained as a CPEC based on the ecological risk assessment and the only retained CPEC for wetland surface water was manganese.

7.3 HHRA and ERA Conclusions

Based on the risk assessments several COPC were retained as COC based on human health considerations, and CPECs were retained based on ecological receptors. These are summarized as follows:

7.3.1 Human Health

Based on the human health risk assessment, the Site does not pose an unacceptable human health risk. As summarized in **Table 15**, no chemicals were retained as COCs based on current conditions when considering risks to human health receptors at the Site.

While considered unlikely, future scenarios could involve drying the ASB sludge and spreading it across the ground, and/or use of the shallow groundwater as drinking water. If the ASB sludge were to be dried and spread out on the surface, DRO, dioxins/furans, and total PCBs would present a potentially unacceptable human health risk. ORO in sludge is also likely to pose a risk, but could not be evaluated quantitatively due to a lack of toxicity information,

In addition, arsenic, iron, and manganese in groundwater would pose a potentially unacceptable human health risk if the shallow groundwater is used as a drinking water source. However, future land use decisions make either of these potential future exposure scenarios very unlikely.

7.3.2 Ecological Receptors

Based on the ecological risk assessment, current conditions at the Site pose a potentially unacceptable risk to ecological receptors. As summarized in **Table 14**, the following chemicals are retained as CPECs when considering current risks to ecological receptors:

- Surface soil: none
- ASB Sludge: DRO, ORO, Aroclor 1248, Aroclor 1254, total PCBs, and copper
- Groundwater: iron, manganese, and nickel
- ASB Water: dioxins/furans, DRO, ORO, manganese, nickel, and zinc
- Wetland Surface Water: manganese

Section 8

Summary and Conclusions

8.1 Summary

The findings presented in this RI for the former Blue Heron ASB Site are based on results of previous environmental investigations (Phase I and Phase II ESA) conducted in 2012 and supplemental sampling conducted in March and April, 2013. The following sections summarize the findings of this RI by media.

8.1.1 Soil

Dioxins/furans, DRO, and ORO were detected in surface soil. For the human health pathway, exposure scenarios considered and evaluated included incidental ingestion, dermal contact, and inhalation of particulates. As suspected carcinogens, the excess lifetime cancer risk (ELCR) for exposure pathways associated with dioxins/furans in surface soil was calculated at 1×10^{-6}, which is at the ODEQ acceptable cancer risk of 1×10^{-6} for exposure to individual carcinogens. The non-carcinogenic HI for exposure pathways associated with petroleum hydrocarbons in surface soil is 0.07, well below the acceptable level of one.

There are no ecological screening level values for DRO and ORO, indicating remediation of surface soil based on these CPECs is not feasible and/or warranted. The dioxins/furans TEQ did not exceed the chemical toxicity screen, bioaccumulation screen, or cumulative screen for ecological receptors. In addition, the greatest concentrations of COPC and CPECs detected in soil were identified in a sample collected next to the road (CS-3), which is subject to road runoff. While it is possible that ASB sludge may have been released to this area during the rare occurrences of overtopping (two events; one in 1974 and one in 1990), the majority of the petroleum hydrocarbon and dioxins/furan concentrations are likely from road runoff. A Seattle urban area study shows that the dioxin/furan TEQ of 29.5 pg/g in CS-3 is within the range that could be considered background.

8.1.2 ASB Sludge and Water

Exposure scenarios for current Site workers and area residents to ASB sludge and water do not present an unacceptable risk. However, under potential worst case future conditions (e.g., the sludge is dried and spread out on the surface where humans may become exposed to it), dioxins/furans, PCBs, and petroleum hydrocarbons in ASB sludge present a potentially unacceptable human health risk.

Based on the ecological risk assessment, dioxins/furans, DRO, ORO, PCBs, and copper in the ASB sludge, and dioxins/furans, DRO, ORO, manganese, nickel, and zinc in the ASB water present an unacceptable risk to ecological receptors. The ASB is an attractive habitat for a number of ecological receptors, most particularly nutria and waterfowl, such as mallard, Canada goose, green-winged teal, and northern pintail, who are frequently observed utilizing the ASB. Given the favorable habitat (i.e., large body of water, native vegetation, and limited human activity) and current observed population of ecological receptors at the ASB and vicinity, there are a large number of additional aquatic, semi-aquatic, and terrestrial receptors likely to use the ASB, such as benthic and water column invertebrates, amphibians, raccoons, deer, and coyote.

8.1.3 Groundwater

Although highly unlikely, the human health risk assessment assumed that in the future a drinking water well would be installed onsite, and shallow groundwater beneath the Site would be used as drinking water by future residents. Under this assumption, metals, specifically arsenic, iron, and manganese, pose a potentially unacceptable human health risk in groundwater.

For ecological receptors to be exposed to groundwater, it was assumed that CPECs found in groundwater would migrate to surface waters at the same concentrations found in groundwater. Under this assumption, iron, manganese, and nickel pose an unacceptable risk to ecological receptors.

Elevated metals concentrations are apparently caused by conditions associated with the ASB. Organic carbon-enriched sludge at the base of the ASB likely promote reducing conditions, which in turn would cause iron oxyhydroxides and manganese oxides to dissolve, releasing iron, manganese, nickel, and other associated metals into solution. This process is indicated by maximum concentrations of metals being detected at BH-4, adjacent to the ASB.

As stated above, ecological risk attributed to groundwater assumes that there is a complete groundwater to surface water pathway (i.e., the same metals concentrations identified in groundwater adjacent to the ASB are discharged to the Willamette River). However, based on modeling completed during this RI, even under current circumstances, this is a highly unlikely scenario. Because of the fine-grained sediments present beneath the ASB and the relative immobility of organic contaminants present in the ASB sludge, the strongly reducing environment is limited to the immediate vicinity of the water bearing zone beneath the ASB footprint. Concentrations of dissolved metals in groundwater were found to decrease rapidly over a short distance downgradient from the more reducing conditions of the ASB, as indicated by at least 80% reduction in metals concentrations over a distance of only 90 feet (from BH-4 to BH-5). Dissolved metals concentrations are expected to decrease further as groundwater approaches the Willamette River and encounters increasing dissolved oxygen concentrations (i.e., more oxidizing conditions) in the transition zone and river sediment pore water.

8.1.4 Wetland Surface Water

Surface water in the wetland does not pose an unacceptable human health risk. Based on the ecological risk assessment, manganese in the wetland water poses an unacceptable risk to ecological receptors. Manganese concentrations in the wetland surface water were less than the background groundwater concentration, but greater than in the ASB water. There is no known or likely "source" of manganese. Most likely, the elevated manganese concentrations are being caused by relatively reducing conditions, similar to what was observed for groundwater. It is possible that the ASB is influencing the metals concentrations in the wetland surface water, as it has the groundwater; however, this seems unlikely as the radius of influence by the ASB was shown to be very small. It seems more likely that wetland itself has relatively reducing conditions, especially in areas with semi-stagnant water.

8.2 Conclusions

8.2.1 Data Limitations and Recommendations for Future Work

Evaluation of some of the analytical data was limited by elevated detection limits. This occurred for the analysis of some metals in the ASB sludge (i.e., arsenic, selenium) due to the high water content of the sludge. However, none of the historical activities at the Site give cause to suspect the presence of these metals at levels greater than may be expected for normal soil background concentrations (the most comparable media for the ASB sludge). The sludge did not contain particularly elevated concentrations of the other metals analyzed, and the detection limits were not so high as to overlook the possible presence of these metals at concentrations that would classify it as a hazardous waste. Also, and again likely due to difficult analysis of the sludge matrix, much of the dioxin/furan data were qualified as estimated when reported concentrations were outside of quality assurance control limits. None of these limitations are considered likely to hinder our understanding of the potential human health and ecological risks associated with the ASB sludge, particularly because dioxins/furans, along with several other contaminants were retained as COCs and CPECs based on the human health and ecological risk assessments, respectively.

In some instances, the RBCs are lower than the analytical method reporting limits, such as the residential RBC for arsenic in groundwater and the residential RBC for dioxins/furans in groundwater. With the extensive screening that was conducted during the HHRA and ERA, this analytical limitation is not considered likely to hinder our understanding of the potential human health and ecological risks associated with the Site.

This RI, combined with prior Site investigations, such as the 2012 Phase I and II ESAs, provide an extensive evaluation of potential contaminants of concern at the Site associated with historical Site activities. The objectives of the RI, as described in Section 3.1, were met and no additional data gaps were identified. Therefore, there are no recommendations for additional studies before proceeding with the FS.

8.2.2 Future Site Conditions and Remedial Action

Water inputs to the ASB from the former mill site will cease by the end of summer 2013. Without significant water discharges to and from the ASB, the water will become stagnant and odors may result (as occasionally occurs without the aerators in operation). During the summer and fall months, the water level in the ASB would likely decrease and the sludge could become exposed.

Immediately following this RI, a Feasibility Study (FS) will be conducted to develop the remedial action objectives for the Site that meet the standards in OAR 340-122-0040 for protection of public health, safety and welfare, and the environment. The FS will identify potential containment, treatment, and removal technologies and eliminate (screen) those technologies that cannot be implemented at the Site. Remedial action alternatives will be developed and analyzed in detail in accordance with OAR 340-122-0085 and 0090. Remedial action alternatives will then be compared and ranked to support the recommendation of a remedial action alternative for the Site.

Remedial action would likely entail draining the ASB and removing or encapsulating the sludge. This will eliminate exposures via ASB surface water and sludge and will eliminate or substantially reduce contaminants in groundwater as a result of changing redox conditions. However, if, in the future, shallow groundwater beneath the Site is used for drinking water, this pathway should be reevaluated.

Section 9

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