FINAL

RI/FS MANAGEMENT PLAN

Bradford Island
Bonneville Dam Forebay
Cascade Locks, Oregon

Prepared for

U.S. Army Corps of Engineers
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A/E	architecture/engineering
ADR	automated data review
AOPC	area of potential concern
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
AVS	acid volatile sulfides
AWQC	ambient water quality criteria
BERA	baseline ecological risk assessment
bgs	below ground surface
BSAF	biota-sediment accumulation factors
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIC	community involvement committee
COC	contaminant of concern (human health)
COI	contaminant of interest
COPC	contaminant of potential concern (human health)
COR	Contracting Officer Representative
CPEC	contaminant of potential ecological concern
CRITFC	Columbia River Inter-Tribal Fish Commission
CSM	conceptual site model
CST	column settling test
DEQ	(Oregon) Department of Environmental Quality
DHS	(Oregon) Department of Human Services
DOC	dissolved organic carbon
DoD	(United States) Department of Defense
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EE/CA	engineering evaluation/cost analysis
EPC	exposure point concentration
ERA	ecological risk assessment
ERDC	Engineer Research and Development Center

ESA	Endangered Species Act
ESCI	Environmental Cleanup Site Information
ESU	evolutionarily significant unit
ºF	degree(s) Fahrenheit
FR	Federal Regulation
FS	feasibility study
HHRA	human health risk assessment
HI	hazard index
HMTA	Hazardous Materials Transportation Act
HQ	hazard quotient
HTRW	hazardous, toxic, and radiological waste
ITR	independent technical review
MET	modified elutriate test
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
msl	mean sea level
ng/L	nanogram(s) per liter
NCP	National Contingency Plan
NHPA	National Historic Preservation Act
90% UCL	90 percent upper confidence limit
95% UCL	95 percent upper confidence limit
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
OU	operable unit
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl

PCE	tetrachloroethylene
PDF	Portable Document Format
PDT	project delivery team
PM	project manager
PM_{10}	particulate diameter less than 10 micrograms in diameter
ppb	parts per billion
ppm	parts per million
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/ feasibility study
RM	river mile
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SLV	screening level value
SPMD	Semi permeable membrane device
SRG	sediment remediation goal
SSI	supplemental site inspection
SVOC	semivolatile organic compound
TAG	technical advisory group
TBD	to be determined
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEQ	toxicity equivalent quotient
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSCA	Toxic Substances Control Act

TSS	total suspended sediment
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WDOH	Washington Department of Health

On behalf of the Portland District of the United States Army Corps of Engineers (USACE), the Portland District USACE and URS Corporation have developed a Remedial Investigation and Feasibility Study (RI/FS) Management Plan for the Bradford Island site. This RI/FS Management Plan defines the objectives of the investigation and describes the work to be performed to meet the project objectives.

Bradford Island is part of the Bonneville Dam complex, located on the Columbia River at river mile (RM) 146.1, approximately 40 miles east of Portland, Oregon. The location of the site is shown on Figure 1-1. It is a multipurpose facility (also known as the Project) that consists of the First and Second Powerhouses, the old and new navigation locks, and a spillway with a capacity of 1.6 million cubic feet per second (cfs) (USACE 2000). Features of the Bonneville Dam complex are shown on Figure 1-2. Figure 1-3 is an aerial photograph of the dam and vicinity.

The investigation around Bradford Island began as part of the evaluation of the former Bradford Island Landfill (the Landfill). The Landfill was used from the early 1940s until the early 1980s. The USACE informed the United States Environmental Protection Agency (USEPA) and the Oregon Department of Environmental Quality (DEQ) of the presence of the Landfill in 1996. The Landfill was added to the DEQ Environmental Cleanup Site Information (ESCI) database in April 1997, and the Bonneville Dam Project Manager signed a DEQ Voluntary Cleanup Agreement letter for the Landfill in February 18, 1998. In 2004, USACE elected to continue the Bradford Island project under CERCLA. The USACE is currently working with the DEQ to address the state's concerns regarding this investigation and any associated cleanup activities.

Numerous investigations have been performed by the USACE and their contractors since 1997, focusing on the upland area of Bradford Island and on river sediments near the island. A review of site records, employee interviews, site environmental audits, and environmental investigations has resulted in the identification of several potential contaminant source areas including the Landfill, a pesticide mixing area, a sandblast area (the Sandblast Area), a hazardous waste storage area, a former drum storage area, a burn pit, a septic tank, a solvent spill area, a transformer release area, an abandoned pistol range (the Pistol Range), an electric light bulb disposal area (the Bulb Slope), and the shoreline proximate to the Landfill. Past upland and shoreline disposal activities have resulted in contamination of sediments of the Columbia River, above and potentially below the Bonneville Dam. The primary contaminants of interest (COIs) that have been identified in the upland area soil and/or groundwater include metals (including butyltins), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). The primary COIs in the sediment are metals, PCBs, and PAHs.

During investigation of the extent of the Landfill, numerous pieces of electrical equipment and other solid waste were discovered in the Columbia River adjacent to the Landfill. Two removal actions were undertaken by the USACE, in December 2000 and in February and March 2002. All visible debris was removed from the river and the shoreline. Approximately 32 tons of solid waste was removed and disposed of off-site.

Current activities include developing an overall site investigation management plan (this RI Management Plan) and planning for a removal action of in-water sediments. The selection and design of the removal action is presented separately. This RI Management Plan provides the foundation for subsequent investigation work necessary to support risk assessment and a feasibility study of cleanup alternatives.

1.1 OBJECTIVES

The RI Management Plan outlines the management goals for the remedial investigation and provides the work plans for the activities included in the remedial investigation and feasibility studies (RI/FS). The primary objectives of the RI Management Plan are to (1) characterize potential impacts in environmental media that may be related to identified potential contamination sources in upland areas and in-water areas; (2) perform a screening level human health and ecological risk assessment and, a baseline human health and ecological risk assessment, as warranted; (3) identify areas of the site requiring remedial actions; and (4) develop remedial action objectives (RAOs) and evaluate cleanup alternatives. Specific objectives for the investigation activities are:

- Identify source areas
- Identify nature and extent of contamination in the upland and in-water areas
- Identify current on-site upland source contribution to sediment contamination
- Identify the contribution of off-site sources to sediment contamination
- Characterize contamination posing unacceptable risk to human health and the environment
- Collect data necessary to evaluate whether source controls are necessary to address upland sources to sediment contamination
- Collect data necessary to evaluate potential cleanup alternatives, both in the uplands and for sediment
- Recommend proposed cleanup remedies

To meet these objectives, the scope of work for this investigation consists of the following components:

- RI Management Plan development
- Sampling and analysis design and implementation
- Data review, analysis, and interpretation
- Risk assessment and identification of areas of concern
- Determination of RAOs
- Cleanup alternatives evaluation
- Cleanup action recommendations

Details of tasks to be performed to accomplish this scope are provided in Sections 6 through 8. Performance of all work described in this RI Management Plan is subject to the availability of funds during the fiscal year for which the actions are identified. Work will be prioritized to address first the areas with the most potential to adversely influence human health or the environment.

1.2 REMEDIAL INVESTIGATION/FEASIBILITY STUDY OVERVIEW

Although the USACE has completed a considerable amount of investigation at Bradford Island, it has been focused on identifying the nature and extent of impacts at the individual upland areas or in the river within the area near the dam. This document will identify data gaps that need to be filled to complete the remaining nature and extent determinations and complete the risk assessment. Two operable units (OUs) are identified in this document and may follow slightly different schedules to completion. Following collection of the remaining data, URS will prepare a summary report to determine if any remaining data are necessary to complete the RI or risk assessment for each OU.

1.3 CURRENT PROJECT SCHEDULE

The current schedule is to prepare a QAPP for the River OU and complete sampling for that OU during early 2008. The QAPP and investigation for the Upland OU will be completed in late 2007 or early 2008. Although the work is subject to the availability of funds, a RI report could be completed as early as 2009.

1.4 RI MANAGEMENT PLAN CONTENTS

In accordance with EM 200-1-3 (USACE 2001a), this RI Management Plan is intended to serve as the umbrella document for the investigation. It addresses each of the topics listed in EM 200-1-3 and the scope of work for this project.

This RI Management Plan is divided into the following sections:

1. Introduction
2. Project Organization and Responsibilities
3. Site Background and Setting
4. Previous Investigations and Cleanup Activities
5. Conceptual Site Model
6. Overview of RI/FS Process for Bradford Island
7. Data Review and Management Approach
8. Data Gaps
9. References

This section describes key USACE roles on this project, as well the roles of other federal agencies, state agencies, Indian Tribes, and contractors. Contact information for specific personnel is presented in Table 2-1.

2.1 USACE PORTLAND DISTRICT HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE COMMITTEE

A Portland District management committee was set up to provide oversight to the project team, as well as to review and approve any major decisions, including cleanup actions. The Hazardous, Toxic, and Radiological Waste (HTRW) Committee is responsible for approving all expenditures and working with the project team to plan and implement the project to meet District goals. The team consists of representatives from Operations, Office of Counsel, Engineering Construction, and Planning and Project Management. The USACE Project Manager (PM), assisted by technical staff as needed, will provide regular project updates to the committee through regularly scheduled meetings or other informal methods.

2.2 USACE PROJECT MANAGER

The USACE PM will have project management authority throughout the life of the project and is responsible for overall management and execution of the project, including project quality, cost, and schedule. Specific tasks include:

- Manage overall project and project funding.
- Communicate and coordinate with Tribal governments, agencies, and stakeholders, including the technical advisory group (TAG), community involvement committee (CIC), public, DEQ, USEPA, United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Columbia River Inter-Tribal Fish Commission (CRITFC), Oregon Department of Human Services (DHS), Oregon Department of Fish and Wildlife (ODFW), Washington State Department of Ecology (Ecology), and Washington Department of Health (WDOH).
- Document all communication with stakeholders and tribal governments.
- Initiate and participate in TAG, public, CIC, and stakeholder meetings.
- Communicate with media, including reporters.
- Lead communication and coordination with Division and Headquarters.
- Convene and coordinate with HTRW Committee as necessary.
- Make decisions affecting project after consulting with project delivery team (PDT).
- Participate in weekly PDT coordination meetings.
- Ensure that actions satisfy and conform to regulatory requirements.

2.3 USACE TECHNICAL LEAD

The USACE Technical Lead will assist the PM as needed throughout the life of the project. Specific tasks include the following:

- Manage the PDT.
- Act as a main point of contact for contractors, and initiate and manage contractor task orders.
- Initiate and participate, as necessary, in weekly team coordination meetings, as well as in technical, TAG, and other meetings.
- Assist the PM as necessary.
- Act as the PM as needed.

2.4 USACE TECHNICAL TEAM

The USACE Technical Team is composed of technical experts from both the Portland and Seattle Districts. Disciplines include risk assessment, biology, hydrogeology, chemistry, and environmental engineering. The USACE Technical Team is led by designated task leaders who are assigned on a task-by-task basis. The task leaders direct the PDT. The USACE Technical Team will be supplemented with additional USACE resources as needed.

The Technical Team will work closely with all contractors. The task leads will coordinate with the PDT, the PM, and/or the Assistant PM to help resolve all technical issues.

2.5 USACE INDEPENDENT TECHNICAL REVIEW

Independent technical review (ITR) is the process that confirms the proper selection and application of established criteria, regulations, laws, codes, principles, and professional procedures to ensure a quality product. Technical review confirms the effectiveness of the product and the use of clearly justified and valid assumptions and methodologies. Technical review also includes a comprehensive interdisciplinary review consistent with the established review budget. For this project, the ITR shall consist of discipline-specific review and interdisciplinary coordination review by senior staff or appropriate peer review by those who were not primary designers. All documents produced for this project will undergo ITR.

The ITR team consists of senior technical staff at the Portland District, the Seattle District, the HTRW Center of Expertise in Omaha, Nebraska, or the Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi. Specific reviewers will be assigned on a task-by-task basis by the task leads.

2.6 AUTHORITY

Through Executive Order 12580, authorities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA; 42 United States Code [USC] 9601 et seq.) have been delegated from the President of the United States down to the Director of Civil Works of the Army. These authorities include the authority provided in CERCLA Section 104 to conduct removal and remedial actions in response to releases or threatened releases of a CERCLA hazardous substance or pollutant or contaminant, the authority provided in CERCLA Section 121 to select remedial actions to respond to such releases, and the authority to carry out response actions on federal facilities under CERCLA Section 120 as the lead federal agency. This authority to select and carry out response actions as the lead federal agency in accordance with CERCLA has been delegated to the Commander of the USACE Northwestern Division with respect to releases or threatened releases at Bradford Island. This includes the authority to sign decision documents or records of decision (RODs) for removal or remedial actions in accordance with CERCLA and the National Contingency Plan (40 Code of Federal Regulations [CFR] Part 300) at Bradford Island.

The USACE is conducting the RI/FS at the Bonneville Lock and Dam Project, and therefore the authority the USACE has to fund the project is through its operations and maintenance funds for the Project.

The DEQ and CERCLA have the same objectives regarding protection of human health and the environment, and it is the goal of the USACE and the PDT to meet these broad objectives. The PDT is working directly with DEQ to ensure that appropriate Oregon cleanup regulations and DEQ guidance documents are being followed. However, in attempting to follow both DEQ and CERCLA, specific methodologies and guidance may not completely concur. The PDT, in conjunction with the ITR team, will use the most current, scientifically defensible methods throughout this project to develop investigation and cleanup strategies that can be used to meet both DEQ and USACE goals.

USEPA has elected not to be directly involved with this project; however, the PDT will keep USEPA informed of project progress as needed.

2.7 TECHNICAL ADVISORY GROUP

Natural resource trustees are federal, state, or Tribal officials who may act on behalf of the public as trustees for natural resources. Natural resources are land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources controlled by the United States, any state or local government, or any Indian Tribe (40 CFR 300.5 and CERCLA §107[f][1]). The federal trustees actively participating in this project include the USACE, USFWS, and NOAA. The state trustees include DEQ, ODFW, Oregon DHS, and Ecology. The federal and state trustees will be invited to participate in regularly scheduled technical advisory group meetings and be given opportunity to review and provide detailed comments on all technical work completed for this project. Comments provided by the federal and state trustees will be evaluated and addressed by the PDT.

Several Indian Tribes have interests in the Columbia River and the Bradford Island site, including the Yakama Nation, the Warm Springs Tribe, the Cowlitz Tribe, the Chinook Nation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Reservation. Tribal interests include potential sites with cultural significance (National Historic Preservation Act [NHPA] Section 106) as well as treaty fishing rights in “usual and accustomed” areas. These areas may extend beyond a Tribe’s reservation land and apply to landless Tribes.

The federal trust responsibility involves recognizing trust obligations and trust resources. In order to exercise trust responsibility it is important to obtain Indian Tribal views of trust and treaty responsibilities related to USACE actions. These responsibilities are exercised in accordance with provisions of treaties, laws, executive orders, and the Constitution of the United States when the USACE implements or takes an action that may affect a Tribal interest. In order to effectively develop a relationship with the Tribes, the PDT will consult with each Tribe as a sovereign nation on matters related to trust and treaty responsibilities. The Tribes will be invited to participate in regularly scheduled technical advisory group meetings and be given opportunity to review and provide detailed comments on all technical work completed for this project. Comments provided by the Tribes will be evaluated and addressed by the PDT. Specifically, the USACE will:

- Operate within a government-to-government relationship with federally recognized Indian Tribes
- Consult, to the greatest extent practicable and permitted by law, with Indian Tribal governments before taking actions that affect federally recognized Indian Tribes
- Assess the impact of agency activities on Tribal trust resources and assure that Tribal interests are considered before the activities are undertaken
- Remove procedural impediments to working directly with Tribal governments on activities that affect trust property or governmental rights of the Tribes
- Work cooperatively with other agencies to accomplish these goals

Consultation efforts will be coordinated through the USACE Portland District Tribal Liaison.

2.8 COMMUNITY INVOLVEMENT COMMITTEE

The USACE has initiated the formation of a CIC to assist the USACE in providing public participation opportunities regarding the investigation and proposed cleanup actions at Bradford Island. The USACE is committed to developing and implementing a comprehensive community involvement program to share information and gather input from community members, users of the Columbia River, and other interested parties. In addition to community involvement meetings, the USACE will hold public meetings at selected times throughout the ongoing investigation and cleanup process at Bradford Island.

2.8.1 Purpose and Role of the Committee

The purpose of the CIC is to assist the USACE in the community outreach process. With assistance from the project team, the CIC will serve as a conduit to the community and the interest groups they represent. Although the CIC is not a decision-making body, comments and suggestions given by the CIC will be helpful to the project team in the decision-making process related to the ongoing investigation and cleanup efforts.

2.8.2 Committee Makeup

The CIC is made up of members representing the general public, environmental groups, Tribes, and local governments. Members expressed interest in serving on a CIC when interviewed during the Bradford Island Community Involvement Program stakeholder assessment process in March through May of 2006.

Committee members may designate an alternate to attend meetings in their place; however, the use of alternates is discouraged unless the alternates are kept informed of the Bradford Island project and committee business on an ongoing basis. In the future, new members will be invited to join as requested by one or more existing CIC members and with the approval of the committee.

The current CIC members and their affiliations are: Rachael Pecore, Columbia Riverkeeper; Matt Burlin, Lower Columbia River Estuary Partnership; Darrell Driver, Cascade Locks City Council; Tom Jermann, City of North Bonneville; Paul Pearce, Skamania County Commissioner; Lynne Kononen, Cascade Locks Planning Commission; Peggy Bryan, Skamania County Economic Development Council; and Ryan Sudbury, Nez Perce Tribe.

2.9 CONTRACTOR SERVICES

Table 2-1 lists the possible types of subcontractors needed for implementation of this RI Management Plan.

2.9.1 Architectural/Engineering Services

Technical staff from the URS Portland office has supported the USACE on this project since 2000. Support includes work plan development, field sampling and analysis, data management and interpretation, risk assessment, report preparation, remedial alternatives development and evaluation, and remedial action design. URS personnel also attend all TAG meetings and provide technical support as needed. Additionally, subcontractor services may be required for this project. As needed, URS staff may be required to contract for analytical laboratory, drilling, excavation, or other specialty services they are unable to supply with in-house resources.

USACE Portland District has Contracting Officer authority for the architecture/engineering (A/E) services contract with URS. Mike Gross of Portland District is the Contracting Officer Representative (COR) for this project. Though all PDT members may consult with URS staff, any issues affecting a negotiated scope of work and budget must be coordinated with the COR for resolution.

2.9.2 Laboratory Services

Analytical laboratories will be selected on a task-by-task basis in order to provide the highly specialized analyses needed for this project. Laboratories may be contracted through the USACE Seattle District laboratory services contract or as a subcontractor to the URS A/E services contract. Depending on the contracting mechanism, the primary responsibility for assuring data quality will rest with the initiator of the contract and will follow the applicable quality assurance/quality control (QA/QC) procedures in this RI Management Plan and/or associated Quality Assurance Project Plan (QAPP). Analytical services may include chemical, physical, and/or biological testing.

2.9.3 Geotechnical Services

Drilling and excavation services may be required to support this investigation. Contractors will be selected on a task-by-task basis. Services may be contracted through the USACE Seattle

District geotechnical services contract or as a subcontractor to the URS A/E services contract. Depending on the contracting mechanism, the primary responsibility for assuring quality will rest with the initiator of the contract and will follow the applicable QA/QC procedures in this RI Management Plan and/or associated QAPP.

This section describes the Bonneville Dam complex and its general location and description, history, facility operations, and regulatory status, and presents the operable units at the site.

3.1 GENERAL LOCATION AND DESCRIPTION

The Bonneville Dam and Lock Project (the Project) is the most downstream dam within the Columbia-Snake River navigation system that consists of eight locks and dams (Figure 3-1).

The Bonneville Dam is at the upper limit of tidal influence from the Pacific Ocean, about 145 miles upstream from the mouth of the Columbia River and 40 miles east of Portland-Vancouver.

The dam is located at 45° 38’ 27’’ N - 121° 56’ 31’’ W. Bonneville Lock and Dam create a 48-mile-long reservoir from the Bonneville Dam upstream to The Dalles Dam. The reservoir is called the Bonneville Pool. The Columbia River at the Bonneville Dam is divided into three channels by two islands: Bradford Island and Cascade Island. The tailrace for the First Powerhouse forms one channel, the spillway forms channel the middle channel, and the tailrace channel for the Second Powerhouse forms the third channel (Figure 1-2). The spillway, consisting of 18 gates, each 50 feet wide, is located between Bradford and Cascade Islands, spanning the middle channel. The spill gates are raised to allow excess river flow to pass under them at a depth of about 50 feet below the upstream water surface.

The major features of the Project include the spillway, two powerhouses, two navigation locks (one lock is no longer in use), and a fish hatchery. The fish hatchery, main office, navigation lock, and visitor center are located on the Oregon shore of the Columbia River. A warehouse and automotive garage facility, and navigation lock support facilities are located on Robins Island, located between the Oregon shore and Bradford Island. The major features on Bradford Island are the visitor center, fish ladders, the service center building, the equipment building, and the sandblast building. Another fish ladder is located on Cascade Island, and a second visitor center is located on the north shore of the Columbia River in Washington State.

The old navigation lock is adjacent to the First Powerhouse and is no longer in use. The upstream side of the old navigation lock consists of an end sill (where the lock doors are located) that extends from the riverbed to an elevation of 40 feet above mean sea level (msl). The current navigation lock (Figure 1-2) is located immediately south of the old navigation lock and has an end sill that extends to an elevation of 51 feet above msl.

An authorized federal navigation channel in this reach of the river is 300 feet wide and 27 feet deep, although the depth is currently maintained at 17 feet (USACE 1991). Limited dredging is necessary to keep the channel to the maintained depth near the dam.

Bathymetric surveys conducted by USACE indicate that the pool near the Bonneville Dam (within the spillway forebay) is up to 100 feet deep.

3.1.1 Regional Geology

The Project is located in the Columbia River Gorge, a 50-mile canyon that cuts through the Cascade Range physiographic province (Orr and Orr 1999). The canyon was formed when the Columbia River incised through various geologic formations, including the Western Cascade Group, the Columbia River Basalt Group, and the High Cascade Group, in response to the uplift of the Cascades over the last 2 million years (Beeson and Tolan 1987).

Three bedrock formations are present near Bonneville project: the Ohanapecosh Formation (also referred to as the Weigle Formation), the Eagle Creek Formation, and the Columbia River Basalt Group (Holdredge 1937; Wise 1970). The Ohanapecosh Formation consists of late Oligocene-aged volcaniclastic siltstones and sandstones with minor conglomerates. As much as two-thirds of the clasts in this formation consist of glass fragments. The fragments have subsequently altered to a dominantly clay mineral assemblage, greatly weakening the formation.

Folding and faulting have significantly disturbed the Ohanapecosh Formation. Bedding generally strikes northeast and north, with a dip of 5 to 20 degrees to the east and southeast. Two predominant fault/shear zone orientations have been identified in association with the development and construction of Bonneville Dam. They include northwest-striking features dipping moderately to steeply to the northeast and northeast-striking features dipping gently to moderately to the northwest. These features do not continue into the overlying Eagle Creek Formation, indicating that fault movement ceased before the Eagle Creek sediments were deposited. No outcrops of the Ohanapecosh formation are found at the site.

The Eagle Creek Formation overlies the Ohanapecosh Formation, and is differentiated primarily by larger clast size and lack of alteration. The Eagle Creek Formation consists primarily of sandstones and conglomerates, with individual units of sedimentary tuffs. Bedding in the unit is near horizontal. The Eagle Creek Formation crops out near river level near the site.

The Columbia River Basalt Group disconformably overlies the Eagle Creek Formation. Flood basalts of this group are Miocene in age and originated from a series of fissures in eastern Washington, Oregon, and Idaho. In the vicinity of Bonneville Dam, the basalts have been uplifted several hundred feet above the current river level.

Two landslides have significantly modified the topography in the vicinity of the site (Sager 1989). Those slides are believed to have been at least partly the result of catastrophic floods during the late Pleistocene that scoured away the talus slopes from the Columbia Gorge. That action oversteepened the walls of the Gorge and effectively removed the buttressing effect of the talus slopes. Scouring also exposed the clay-rich Ohanapecosh Formation, which aided in landslides. The Tooth Rock Landslide is a large rotational block failure that originated on the Oregon side of the Gorge, south of Bradford Island. The slide is reported to have incurred only rotational movement, without lateral expansion. Large slide blocks of the Eagle Creek Formation were brought to rest to help form Bradford Island site by this slide. Because of the slide’s rotational nature, the blocks are relatively undisturbed and form a local, but variable, bedrock surface beneath the Bradford Island. Portions of the Tooth Rock slide block extend into the Columbia River and are submerged. Therefore, the river bottom in the immediate vicinity of Bradford Island consists of Eagle Creek Formation overlain by a thin layer of sands and silts that have been deposited in lower velocity areas.

A second large-scale landslide in the area is known as the Bonneville (Cascade) slide. The slide originated on the Washington side of the Gorge between 400 and 800 years ago. The toe of the landslide forms the northern abutment of the Second Powerhouse. Debris from the slide has been observed to overlie the Tooth Rock slide on portions of Bradford Island.

The Tooth Rock slide blocks at the site are also overlain by up to 30 feet of alluvium associated with Holocene to recent flooding of the Columbia River. The alluvium consists of silty sands and gravels that contain increasing amounts of Eagle Creek Formation clasts with depth.

3.1.2 Climate

A meteorological observation station has been in operation at the Project since July 1, 1948. During a 57-year period of meteorological records (1948 through 2005), the station recorded average summer daytime maximum temperatures of 65.8 degrees Fahrenheit (°F) and average winter daytime maximum temperatures of 35.4°F (Western Regional Climate Center 2002). Temperature extremes at the Bonneville Dam have varied from a low of (-5°F) on January 31, 1950, to a high of (107°F) on August 18, 1977.

The average annual precipitation at the Project for the period of record is 77.05 inches. December and January are the months with the highest precipitation rates, and July is the month with the lowest (Western Regional Climate Center 2002). Recorded daily maximum precipitation rates have exceeded 1 inch for every month, with the maximum daily rate of 5.05 inches recorded on November 25, 1999. Average annual snowfall at the dam is 17.7 inches. Normal snowfall occurs from November through March.

3.1.3 Groundwater/Hydrogeology

Occurrences of shallow groundwater have been evaluated as part of the previous environmental investigations only near the former Landfill and the sandblast building (eastern tip of Bradford Island). Additional groundwater information will be generated as part of the RI. Section 4 details previous investigations. Based on these investigations, two shallow hydrostratigraphic units exist on the eastern tip of Bradford Island:

1. **Fill/alluvium.** This unit consists of silty to clayey sands and ranges from 15 to 30 feet in thickness. At depth, there are increasing bedrock clasts. This unit occurs beneath the upland portion of the site and pinches out near the northern shore of Bradford Island.

2. **Bedrock.** The bedrock unit consists of a slide block emplaced from the Oregon side of the river. The block is composed of the Eagle Creek Formation, which consists primarily of sandstones and conglomerates. The uppermost 2 to 5 feet of this unit is fractured.

Groundwater on the eastern tip of Bradford Island appears to be perched in the alluvium above the less-permeable Eagle Creek slide block. Where the fractured bedrock crops out on the north shore of the island, seeps are formed in the winter months. The slide block forms the base of the river near the island, with no to little sediment thickness found on top of the slideblock.

Based on the horizontal hydraulic gradient measured in the fill/alluvium, the direction of groundwater flow beneath the former Landfill is to the north. Measured hydraulic conductivities in the fill/alluvium beneath the former Landfill unit range from 14 to 320 feet per day, and horizontal hydraulic gradients range from 0.03 to 0.1 foot per foot. Based on a water balance calculated for the former Landfill, approximately 61 percent of the precipitation that falls on the Landfill footprint percolates to groundwater and discharges either along the north shore of Bradford Island as seeps or offshore of Bradford Island. The groundwater elevation in the bedrock beneath the Landfill was measured in one well was 58.63 feet above msl. This elevation is lower than the normal pool surface elevation (71.5 to 76.5 feet above msl), which suggests the direction of groundwater flow in the bedrock aquifer is downward.

Groundwater is extracted from seven water supply wells located on Robins Island and used to provide water for the Bonneville Fish Hatchery. The hatchery wells were installed between 1986 and 1991 to replace wells that were abandoned during the construction of the new navigation lock. The groundwater is extracted from a former alluvial unit that was buried by the Tooth Rock landslide. The alluvium overlies the Ohanapecosh Formation in this location and is up to 100 feet thick (Scofield 1998).

3.1.3.1 Drinking Water - Bonneville Lock and Dam Project

There are no active drinking water wells on Bradford Island. Two water supply wells located on Robins Island provide potable water to the Project (McCavitt, pers. comm., 2001). The well locations are depicted on Figure 3-2. DW1 (also referred to as PW1 and WW-1794) and DW5 (also referred to as PW2 and WW-1800) are located on the eastern end of Robins Island. The boring logs indicate that these two wells are "Hatchery Test Wells" and were drilled in June 1986. No well construction logs were available for DW1 and DW5 in USACE records or in the Oregon Water Resources Department's web-based well database (http://deschutes.wrd.state.or.us/apps/gw/well_log/).

3.1.3.2 Drinking Water – Project Vicinity

The population within a 4-mile radius relies on municipal water supplies taken from groundwater supply wells (Leland, pers. comm., 2001). The Columbia River hydraulically separates these populations from Bradford, Cascade, and Robins Islands. Potential releases to groundwater from Bradford Island should not pose a threat to these populations due to the apparent lack of hydraulic connection to the perched water-bearing unit beneath the island.

3.1.4 Hydrology

Flow within the Columbia River is altered from its natural state by the operations of several federal and non-federal dams. Bonneville Dam at RM 146.1 is the dam farthest downstream on the Columbia River. Hydrologic conditions immediately upstream and downstream of the dam are the primary focus of this section; however, regional hydrology is addressed given its influence on local hydrologic processes and mainstem evolution.

3.1.4.1 Regional Hydrology

The Columbia River drains an area of 259,000 square miles and is ranked seventh in length and fourth in stream flow among United States rivers. It flows 1,243 miles from its headwaters in the Canadian Rockies of British Columbia, across Washington State, and along the border of Washington and Oregon to the Pacific Ocean (Figure 3-1). There are 11 dams on the Columbia River's mainstem in the United States and 162 dams that form reservoirs with capacities greater than 5,000 acre-feet in the United States and Canadian parts of the basin (USGS 1996).

Climate in the Columbia River Basin varies considerably, but river hydrology is dominated by snowmelt from high-elevation areas, with the majority of annual flow occurring between April and July. High flows also occur between November and March, caused by heavy winter precipitation (NPCC 2004).

All of the major dams and reservoirs within the basin operate in coordination with each other to manage floods, control fish migration, and produce power. The general operating year for the dams and reservoirs within the basin is divided into three periods:

- September through December – A fixed reservoir drawdown occurs, since a forecasted volume of runoff that will occur in the spring is not yet available. Flows are managed to enhance the spawning of chum salmon below Bonneville Dam.
- January through mid-March to April – A variable drawdown occurs to meet the forecasted volume of the spring runoff based on snow pack measurements. Water must be present in April for juvenile fish migration.
- April through August – Refill season; the reservoirs are managed in an effort to fill the reservoirs and allow fish migration.

3.1.4.2 Local Hydrology

Most technical publications concerning the Columbia River focus on the basin and subbasins, specifically as they relate to water quality and specific habitats. Publications addressing details of individual hydrologic inputs in the immediate vicinity of Bonneville Dam do not appear to be readily available. The positioning of the Columbia River as a border between Oregon and Washington presumably contributes to the disjunction of available information. A series of subbasin plans and water quality reports were reviewed to obtain general information about the Columbia River Basin within the area of interest, which runs approximately from RM 142 (Pierce and Ives Islands) to RM 148 (Bridge of the Gods).

Bonneville Dam is considered a run-of-river project. Run-of-river projects, by definition, have limited storage and were developed primarily for navigation and hydropower. These types of projects pass water at the dam at nearly the same rate it enters the reservoir, with an average variance of water level behind the dam of 3 to 5 feet.

The tailwater elevation below Bonneville Dam varies in direct relationship to the river discharges, and ranges from about 7.0 feet above msl at a river flow of 70,000 cfs to 36.3 feet above msl at a river flow of 660,000 cfs (USACE 1998). From Bonneville Dam to the ocean, the slope of the Columbia River is very flat and subject to tidal action. The daily tidal influence on water level during low water periods ranges from 1 to 2 feet at the dam (WDF et al. 1990).

Within the Columbia River Basin are numerous subbasins formed by tributaries of the mainstem river. Although the layouts of the subbasins in their entirety extend beyond the area of interest, they each contain tributaries of the Columbia, as identified below, within the area of interest.

Hydrologic inputs immediately upstream of the dam include Ruckel and Eagle Creeks on the Oregon side. Washington maps do not indicate any named creeks immediately above the dam, although drainage features are presumed to exist. Hydrologic inputs immediately downstream of the dam include Tanner and Moffett Creeks on the Oregon side with Greenleaf and Hamilton Creeks contributing on the Washington side.

Streams draining the Oregon side of the Columbia River Basin (within the area of interest) originate and flow through the Hatfield Wilderness, a 39,000-acre portion of land managed by the United States Forest Service. Although streams discharging to the Columbia originate and primarily flow through the protected wilderness, they also pass through the privately held and often developed properties located along the waterfront. Development such as roadways and railroads with riprap bisect the lower reaches of the tributaries and are presumed to have the greatest influence on the flow rate and water quality at the point where the tributaries join the Columbia.

Urbanization of the land along the Columbia on the Washington side has substantially altered original drainage and subsequent hydrologic inputs. A major highway, railroad, and associated riprap also bisect tributaries along the riverfront on the Washington side.

Forestry is a major industry upstream and downstream of the dam, especially in Washington. Timber practices are typically clear-cut and slash-and-burn, subject to Forest Practices Act regulations of both states (WDF et al. 1990). The significance of this industry, and to a lesser degree agriculture, is its effect on runoff and subsequent water quality. A damaged or destroyed riparian buffer, due to deforestation and agriculture, can substantially alter the morphology of streambeds and, in some cases, whole drainage basins. An example would be increased flow rates, which can result in aggressive streambed scour, increased turbidity, elevated concentrations of dissolved minerals, and habitat destruction. Not only is the tributary being affected but also subsequent discharge can potentially influence water quality, habitat, and flow in the mainstem.

3.1.5 Site Ecology

This section describes the habitats present at Bradford Island and identifies Endangered Species Act (ESA)-listed species that may occur or have the potential to occur in the area.

3.1.5.1 Habitats

Upland meadow and shrub/forest fringe communities occupy the actual Landfill. This area once served as a temporary nursery for landscape plants used at Bonneville Dam and adjacent facilities. Not all of these ornamental plants were removed and some have survived at the Landfill. Adjacent to the Landfill is a larger area of conifer-dominated forest. The upland meadow habitat that occupies the surface of the Landfill has been disturbed by various field investigative activities (i.e., test pits, drilling operations) but has since been recolonized by the invasion of surrounding vegetation.

The shrub and forest fringe area is characterized by rocky outcrops at the edges of the island and at the margin of the flat meadow area adjacent to the forested habitat. The substrate in this area consists of a mixture of soils, rock that may have been placed in some areas, and what appear to be natural rock outcrops. The terrain is flat at the top and slopes steeply to the north and east into the Columbia River. The slopes are more densely vegetated with shrubs and trees than the flatter areas adjacent to the meadow.

The upland conifer forest appears to be the least disturbed habitat on the island, as it is composed of mostly native species. This forest is apparently relatively young; USACE photographs from the 1930s show much smaller trees. It is likely that this forest was naturally seeded rather than planted. No stumps were observed, indicating that past logging did not occur or was followed by recontouring the land that included removal of stumps. The larger trees are up to 1.5 feet in diameter at 4.5 feet above the ground, and form a closed canopy. The substrate in the forest area consists of relatively thin topsoil and rocky outcrops. Dead and downed woody material is common.

At the eastern tip of the island, a small (less than 0.25 acre) opening is located at the top of the cliffs that form the shoreline. A thin veneer of soil covers bedrock in this area. A smattering of the shrubs similar to the forest habitat described above are present, but the area is mostly open.

Bradford Island does not contain any wetlands, lakes, or ponds that would have the potential to be considered sensitive environments. However, aquatic habitats include a portion of the Columbia River adjacent to Bradford Island, consisting of the pooled area behind the Bonneville Dam complex, known as the Bonneville Dam Forebay. Water depth behind Bonneville Dam is variable. The area between Bradford Island and Cascade Island extends to a depth of approximately 100 feet. Based on historic photographs and USACE hydroacoustic sounding data, a submerged shelf appears to be adjacent to the north side of Bradford Island at a depth of about 30 feet below pool level. This shelf appears to be about 50 feet wide, parallel to the north shore of the island. The shelf could be critical habitat for ESA-listed salmonids. Shallow water (20 feet deep or less) also occupies a band approximately 50 feet wide along the south shoreline of Bradford Island.

Ongoing hydraulic modeling of the waters near Bradford Island is being conducted by the USACE (Langsley 1999). This modeling indicates that a large eddy forms behind the dam and creates a reverse current flow next to Bradford Island. This reverse flow appears to attract adult salmonids exiting the fish ladder on their way upstream and results in the fish being swept back over the dam (Langsley 1999). Introduced fish species may be present near the Landfill for prolonged periods throughout the year and are popular recreational species with a recognized societal value.

3.1.5.2 ESA-Listed Species

The list of sensitive species with potential to occur at the Bonneville Dam Forebay is provided in Table 3-1. The table is a summary of the more detailed information presented in the Biological Characterization (Appendix F) of the *Draft Supplemental Site Inspection* (URS 2000). The list was derived from Oregon Natural Heritage Program (1999) data for species recorded within 5 miles of the Landfill, correspondence from USFWS (1999) and National Marine Fisheries Service (2000), information from USACE personnel, reference books, and reports of studies focused on protected species in the Bonneville Dam vicinity.

The special-status (federally and state-listed threatened) fish and wildlife species that are known to occur or could potentially occur at the site are described below. In addition, a brief discussion of nonlisted resident fish species that may occur in the forebay is provided.

Fish Species

The Lower Columbia River is characterized by warmer, slower waters than the upper reaches, and this region consequently supports a larger diversity of native resident fish species such as white sturgeon (*Acipescer transmontanus*), longnose suckers (*Catostomus catostomus*), and minnows (i.e., chiselmouth [*Acrocheilus alutaceus*]). Other native species that are found throughout the Columbia River include trout (i.e., steelhead [*Oncorhynchus* spp.], bull trout [*Salvelinus confluentus*], and cutthroat trout [*Oncorhynchus clarki clarki*]), whitefish (i.e., mountain whitefish [*Prosopium williamsoni*]), and a variety of sculpins (*Cottidae*) (Troffe 1999; USACE 2001b). Although some of these fish are ubiquitous to the Columbia Basin, resident species such as the white sturgeon and chiselmouth are restricted in their current distribution. White sturgeons are the largest freshwater fish in North America and are currently considered a rare, threatened species in western North America. Sturgeons prefer large, cool, fluvial environments and, therefore, have the potential to pass through the portion of the river adjacent to the Landfill, although sturgeon from the Bonneville Pool are unlikely to pass through the dam to downstream sections. Little is known about the life history and habitat requirements of the chiselmouth. The decrease in their distribution may be associated with their unique habitat requirements and feeding behavior that entails scraping algae from smooth rocks and submerged logs with a chisel-like lower jaw (Troffe 1999). Chiselmouth have the potential to forage near the island due to the presence of underwater riprap that supports algal communities.

Anadromous fish species that have the potential to be present in the Bonneville forebay are listed in the table below.

Federally Listed Anadromous Salmonid Species

Evolutionarily Significant Unit (ESU)	Status	Life History Type	Federal Register (FR) Citation
Chinook Salmon (*Oncorhynchus tshawytscha*)			
Snake River	Threatened	Ocean	57 FR 14653; April 22, 1992
Lower Columbia River	Threatened	Stream	64 FR 14308; March 24, 1999
Upper Columbia River	Endangered	Stream	64 FR 14308; March 24, 1999
Upper Willamette River	Threatened	Ocean	64 FR 14308; March 24, 1999
Chum Salmon (*Oncorhynchus keta*)			
Columbia River	Threatened	Ocean	64 FR 14508; March 25, 1999
Sockeye Salmon (*Oncorhynchus nerka*)			
Snake River	Endangered	Stream	56 FR 58619; November 20, 1991
Steelhead Trout (*Oncorhynchus mykiss*)			
Snake River Basin	Threatened	Stream	62 FR 43937; August 18, 1997
Lower Columbia River	Threatened	Stream	63 FR 13347; March 19, 1998
Middle Columbia River	Threatened	Stream	64 FR 14517; March 25, 1999
Upper Columbia River	Endangered	Stream	62 FR 43937; August 18, 1997
Upper Willamette River	Threatened	Stream	64 FR 14517; March 25, 1999
Coho Salmon *(Oncorhynchus kisutch)*			
Lower Columbia River	Threatened	Stream	60 FR 38011; July 25, 1995

Ten of the 12 ESUs shown in the table above have the potential to be present near Bradford Island as juveniles, adults or both. The Columbia River near Bradford Island is used by these species primarily as a migratory route between upstream spawning areas and the Pacific Ocean. The listed ESUs fall into two juvenile life-history strategies: "ocean-type" that rear in freshwater for only a few weeks to a few months before migrating to the estuary/ocean during their first year of life, and "stream-type" that spend at least a year rearing in freshwater prior to their downstream migration to the ocean. The BA (USACE 2007) provides additional information as well as a general overview of the life history and status of each ESU and describes when adults and juveniles would be expected to occur near Bradford Island.

Adult salmon typically nearly cease feeding once leaving the Columbia River estuary on their upstream migration. Adult steelhead migrating upstream feed to a limited extent. Juvenile salmon and steelhead feed on their downstream migration. Juveniles feed on aquatic invertebrates and small fish. As noted above, several listed and candidate anadromous fish pass through the lower Columbia River on their journeys between spawning areas and the ocean.

The residence time for anadromous fish near Bradford Island is expected to be minimal, but native and introduced resident species may forage at the Bonneville Dam Forebay and many of these fish are popular recreational species.

Popular recreational fish species such as largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieui*) bass are common to the lower Columbia River and could reside in the Bradford Island vicinity. Other introduced fish species such as catfish (*Ameiurus* spp.), yellow perch (*Perca flavescens)*, and walleye (*Stizostedion vitreum*) are also important sport fish that may be present near the landfill for prolonged periods throughout the year.

Wildlife Species

The following wildlife species that are indigenous to this area of the Columbia River Gorge are federally (USFWS) or state (ODFW) listed as endangered or threatened (USFWS 2006):

- Northern spotted owl *(Strix occidentalis caurina)* – Federally and state-listed threatened
- Bald eagle *(Haliaeetus leucocephalus)* – Federally and state-listed threatened
- Columbia white-tailed deer *(Odocoileus virginianus leucurus)* – Federally listed endangered

The northern spotted owl lives in old-growth forests of the nearby Mount Hood and Gifford Pinchot National Forests. No old-growth forest exists on Bradford or Cascade Islands, and it is unlikely that adult spotted owls occur there due to lack of suitable nesting habitat. However, juvenile spotted owls might pass through the area.

The bald eagle is the only special-status piscivorous species that has the potential to occur in the upland habitats of Bradford Island. Bald eagles occur as nesting and wintering residents of the Columbia River Gorge/Bonneville Dam area. Eagles primarily feed on fish, waterfowl, and waterbirds that occupy the Bonneville Dam Forebay. Several bald eagles were observed during Landfill investigations by USACE and URS personnel during 2001.

Columbia white-tailed deer are very unlikely to occur on Bradford or Cascade Islands. Habitat for this species most frequently consists of riparian zones and bottomland hardwood forests and agricultural areas, including islands within the Columbia River downstream of Portland, Oregon (between RM 32 and RM 50), approximately 100 miles downriver from Bonneville Dam.

3.1.6 Land Use and Population

3.1.6.1 Project-Related Land Use

The Bonneville Project is a multiuse project, managed for hydropower, navigation, recreation, and natural resource and wildlife preservation. The Bonneville Master Plan (USACE 1996) describes the land use details for the Project. Specific Project uses are described below.

Areas of Bradford Island are specifically managed for wildlife use. Thirteen acres of wooded and open areas on the eastern tip of Bradford Island are for multiple resource wildlife management, primarily goose nesting and pasture areas. The open area immediately south of the service building is managed for goose pasture. Geese also use lawn areas associated with the visitor's facilities for feeding. The downstream western end of the island has 34 acres used for low-density recreational fishing. Eighteen acres on Bradford Island are used for visitor facilities, and the remaining acreage is used for project operations, including office, storage, and equipment maintenance facilities.

Approximately half of Cascade Island (34 acres) is managed for goose pasture, with small areas set aside for goose nesting. The remainder of Cascade Island is used for project operations, including equipment storage and powerhouse management.

All of Goose Island is set aside for goose nesting or pasture. A portion of the north bank of the Columbia River (Washington State) between the Second Powerhouse and an upstream Tribal treaty fishing site is also goose pasture.

Hamilton Island is located two river miles downstream of the Bonneville Project and is a 221-acre multiple resource management area providing habitat for resident wildlife species. Three acres are managed specifically for goose foraging, and 27 acres are managed for low-density recreation, primarily fishing from the bank and a boat launch.

Lawn areas of Robins Island and the fish hatchery are used for goose foraging. The fish hatchery on the Oregon shore is a 22-acre cooperative use site with ODFW. The hatchery is mitigation for resource damage caused by the dam construction. Portions of Hamilton Island also are managed for goose pasture.

Fort Cascade is a 56-acre cultural resource area on the downstream Washington shore preserved because of Native American and early European American settlement.

Approximately 46 acres of the north shore of the river within the Project are used for low-density recreation, and 2 acres are specifically for goose foraging.

Other visitor facilities include the Navigation Lock visitor area (6 acres) and the north shore visitor complex (22 acres). Other areas for recreation on the project include Robins Island (21 acres), the south shore area near the fish hatchery (24 acres), and the Pacific Crest Trailhead (4 acres). The remaining Project areas (more than 100 acres) are used for Project operations.

There are no plans to change the above land uses at the Project, therefore these appear to be the likely future land uses.

3.1.6.2 Surrounding Area Land Use

The Bonneville Dam complex lands set aside specifically for project operations include 97 acres of land that is owned and operated by USACE and occupied by the main facilities at the Project.

The dam complex is located within the Columbia River Gorge National Scenic Area. The Mount Hood National Forest is located south of the dam and south of Interstate 84. Gifford Pinchot National Forest is located on the Washington side of the river, approximately 6.5 miles north of the dam. Beacon Rock State Park is located approximately 2.5 miles to the west, on the Washington side of the river. All of these areas are used for various forms of recreational activities including fishing, boating, hiking, biking, and camping.

The vast majority of land near Bonneville Dam is dedicated to forestry activities, with agriculture a distant second. Timber resources in the region support large, integrated timber processing industries in the major population centers (WDF et al. 1990).

Pierce and Ives Islands are located downstream of the dam at RM 142. Pierce Island is a 200-acre nature conservancy preserve dedicated to protecting native riverine flora and fauna. Ives Island is part of the Gifford Pinchot National Forest and is managed by the Columbia River Gorge National Scenic Area.

Population densities along subbasin tributaries are low, and uses of the streams are not as significant as those along the Columbia River. Habitat alteration and loss due to logging or agriculture are more common threats on these small streams (WDF et al. 1990).

3.1.6.3 Population Profiles

The three distinct human populations in the general site area are the site staff, site visitors, and the nearby residents.

Site Staff

The USACE currently employs 152 full-time-equivalent positions at the Bonneville Dam complex. Staff duties include a wide range of occupations, including maintenance, construction, office staff, visitor services, and natural resource management.

Approximately 10 additional staff from the Portland District headquarters are stationed at the dam. Approximately 300 fisheries-related personnel (contractors/researchers from state and federal agencies) work at the dam from April through September. The number of construction and service contractors at the project varies depending on workloads but can number approximately 175 people (McCavitt, pers. comm., 2006).

Site Visitors

A road from Interstate 84 provides access to the Bonneville Dam complex. The access road is gated, and visitors are allowed to access several dam facilities (visitor centers, fish ladders, etc.). The site and general vicinity on Bradford Island is gated and off limits to the public. Only USACE personnel and authorized visitors are allowed into these areas.

Nearby Residents

No permanent residential dwellings are located on the Project. The primary population center in proximity to the dam is the town of North Bonneville, situated on the Columbia River just west of the dam on the Washington side of the river. The 2000 population is estimated at approximately 7,000 persons and is expected to increase to 10,500 by 2020.

Major population centers to the west include Portland, Astoria, and St. Helens in Oregon, and Vancouver, Longview-Kelso, and Camas-Washougal in Washington. The cities of Cascade Locks, Hood River, and The Dalles in Oregon and Stevenson, Carson, and White Salmon in Washington lie upstream of the dam. Municipal and industrial pollution from these urban areas are expected to have affected the water quality of the mainstem Columbia River.

Population growth is anticipated to result in the conversion of forest, rural residential and agricultural land uses to high-density residential uses, with potential impacts to habitat conditions (LCFRB 2004).

3.1.7 Beneficial Uses

DEQ has placed groundwater use in the area falls within the Willamette Basin. According to DEQ guidance for determining beneficial water uses (DEQ 1998a), groundwater may be classified as unlikely to be suitable for potable water uses of it meets the criteria of greater than 10,000 milligrams per liter (mg/L) of total dissolved solids (TDS) and yield less than 0.5 gallons per minute (720 gallons per day). Neither the shallow perched groundwater nor the deeper groundwater at Bradford Island appears to meet the yield criterion. A water supply well originally drilled at Bradford Island to supply potable water to on-site workers was abandoned and left inactive due to inadequate yield (McCavitt, pers.comm., 2001). This will be confirmed during completion of the risk assessment. Therefore, potable water supply use is not included among the beneficial uses for groundwater.

Designated beneficial uses for surface water in the mainstem of the Columbia River are described in Oregon Administrative Rules (OAR) 340-41-0101. They include a variety of high-quality uses such as public and private domestic water supply, fishing, water contact recreation and protection of fish and aquatic life (Table 3-2). Beneficial use designations for fish uses include salmon and steelhead migration corridors as well as shad and sturgeon spawning and rearing (Table 3-3).

3.2 SITE HISTORY

3.2.1.1 Site History Before Bonneville Project

While Bonneville Dam was being constructed, a significant archeological site was excavated. It is the only known relatively undisturbed site along the lower Columbia River with evidence of occupation from prehistoric into historic times. This site was first noted in the Lewis and Clark journals, and is on the National Register of Historic Places. Evidence at the site spans about 500 years, from the time of Native American occupation to the time of historic settlement in the mid-1800s. When it was realized that the site would be affected by construction, work began to retrieve cultural material necessary for site interpretation (USACE 2005).

An analysis will be completed during the RI to evaluate the impact the investigation would have on the cultural resources of the Project.

3.2.1.2 Site History Following Construction of the Bonneville Project

Construction of the First Powerhouse and navigation lock, spillway, fish passage facilities, fish hatchery, and office and maintenance buildings began in 1933. Construction was completed in the early 1940s. Between 1974 and 1981, the Second Powerhouse was constructed adjacent to the Washington State shore, to aid in supplying the electrical power needs of the Northwest. A second navigation lock was constructed on the Oregon side between 1989 and 1993. Associated with construction of the new lock, the southeastern edge of Bradford Island was excavated to improve the approach channel. Soils from that excavation were placed to create Goose Island, 0.5 mile upstream near the Oregon shore.

3.3 CURRENT FACILITY OPERATIONS

The USACE operates and maintains Bonneville Lock and Dam for hydropower, fish and wildlife protection, recreation, and navigation. The major features of the dam complex include a spillway, two powerhouses, two navigation locks, and a fish hatchery. The fish hatchery, main office, and navigation lock visitor center are located on the Oregon shore of the Columbia River. A warehouse and garage facility and navigation lock support facilities are located on Robins Island. The major features on Bradford Island include the Bradford Island visitor center, fish ladders, the service center building, the equipment building, and the sandblast building. A fish ladder is located on Cascade Island, and the Washington Shore visitor center is located on the north shore of the Columbia River.

3.4 BONNEVILLE PROJECT REGULATORY HISTORY

The Bonneville Lock and Dam was initially placed on the Federal Facilities Compliance docket after the 1986 explosive failure of a bushing on an oil circuit breaker in the switchyard on the roof of the First Powerhouse. The bushing failure released approximately one pound of PCBs in tar from the core of the bushing. The bulk of the tar fell on the powerhouse roof, but an unknown quantity reached the river. A second bushing failed in 1991 with similar results. Both spills were cleaned up in accordance with the Toxic Substances Control Act (TSCA) and documented in a preliminary assessment in 1992. In 1994 USEPA declared No Further Action was necessary with respect to these accidental releases. All PCB-containing bushings and circuit breakers on the powerhouse roof were replaced in the 1995 rehabilitation of the powerhouse.

In 1987, Hamilton Island, a former construction landfill on project lands 1.5 miles downstream from the Second Powerhouse in Washington State, was placed on the Federal Facilities Compliance Docket. The site was investigated for wastes from the construction of the Second Powerhouse at Bonneville Dam, possible PCB waste from the Bonneville project, and wastes from the demolition of the town of North Bonneville. In 1991 the site was placed on the National Priorities List under CERCLA. USACE completed an RI/FS in 1994 and the site was delisted by USEPA in 1995 after a No Further Action ROD.

USACE maintains a point source discharge permit for discharges from the facility's wastewater treatment plant. The plant services all sanitary waste facilities on the project. The ODFW-managed fish hatchery discharges are not treated by this facility but have a separate discharge in Tanner Creek.

The investigation around Bradford Island began as part of the evaluation of the former Bradford Island Landfill. The Landfill is a former waste disposal site at the Bonneville Lock and Dam Project on the Oregon side of the river. The Landfill was used from the early 1940s until the early 1980s. On June 13, 1996, the USACE submitted a letter to USEPA Region 10 and DEQ, informing them of the presence of the Bradford Island Landfill. In response to the letter, the USEPA requested that sediment samples be collected in the Columbia River around the Landfill perimeter, and that groundwater seep samples be collected if seeps were identified. These issues were considered during the first investigation (the 1998 site inspection) at the site.

The Bradford Island Landfill was added to the DEQ ECSI database on April 1, 1997. On April 24, 1997, the Bonneville Lock and Dam Project signed a Letter of Intent to participate in DEQ's Voluntary Cleanup Program (VCP) for the investigation and remediation of the Landfill site. On February 18, 1998, the Portland District Engineer signed a DEQ Voluntary Cleanup Agreement letter for the Landfill site.

The USACE has investigated the Landfill and other areas in and around Bradford Island under the oversight of the DEQ, through the VCP. The USACE will complete the RI/FS in accordance with CERCLA principles with DEQ requirements as applicable or relevant and appropriate requirements (ARARs).

Both USEPA and Ecology have been provided the opportunity to comment and participate in the USACE investigations. Both agencies have not committed resources to the project, but support the USACE efforts and have informally deferred to DEQ.

Several investigations have been conducted by the USACE and its contractors both upland and in the Columbia River to evaluate the environmental impacts from the inactive Bradford Island Landfill and to support the operation mission of the Bonneville Lock and Dam complex. This section summarizes the previous investigations and references the individual reports where additional details can be found. The upland investigations on Bradford Island began as an evaluation of the former Bradford Island Landfill and progressed into other discrete areas on the eastern tip of the island. The investigations completed to date have focused on the following areas:

- The Bradford Island Landfill
- Sandblast area
- Pistol range
- Bulb slope
- In-water (upstream of the spillway and powerhouses)

The areas are in various stages of investigation, from a preliminary assessment on the Bulb Slope to a site characterization and risk assessment on the Landfill. Interim cleanup activities have also occurred within the Sandblast Area and in the river proximate to the eastern tip of Bradford Island.

There are several phases or levels of ecological risk assessment evaluation, which are often called scoping level, screening level, and baseline level assessments in USEPA and DEQ literature. Human health risk assessments may include an initial problem formulation and a later baseline assessment. Several investigations and evaluations at various levels that provide risk-relevant information have been conducted to date for the Bradford Island site. Human health and ecological risk assessments performed to date for various areas of potential concern (AOPCs) at Bradford Island generally followed DEQ risk assessment guidelines (DEQ 2000a, 2000b, 2001a, 2001b).

The discussion about the previous investigations and risk evaluations is presented by geographic area. Figure 1-3 illustrates the areas that have been investigated at the project.

4.1 LANDFILL INVESTIGATIONS AND RISK ASSESSMENT

Three separate Landfill investigations have been conducted (the site inspection, the supplemental site inspection, and the site characterization report). A total of 44 soil samples were collected from several test pits (up to 10 feet deep). Five groundwater sampling events have resulted in 29 groundwater samples from up to nine wells. Figure 4-1 depicts the Landfill footprint and the previous sampling locations.

The investigations found that for approximately 40 years, the USACE managed, stored and disposed of waste materials at the eastern end of Bradford Island. Landfilling was apparently done in excavated pits or existing depressions within a 0.5-acre area. Some additional wastes were disposed of over the northern and eastern edges of the island.

Disposal and handling practices have impacted soil and groundwater at the Landfill with low levels of petroleum products, metals, PCBs, pesticides, and herbicides. Disposal of materials in the Columbia River has impacted nearshore sediments with petroleum products, metals, and

PCBs. Debris disposed of in the river has been removed; a discussion of the removal and river investigations is presented in Section 4.5. Evidence of Landfill debris materials eroding into the river has not been found, and the bedrock slopes of Bradford Island proximate to the Landfill appear relatively stable.

The USACE started an engineering evaluation/cost analysis (EE/CA) to assess the value of conducting a non-time critical removal action at the Landfill. The Landfill EE/CA work was suspended pending completion of the RI. A number of factors made the USACE re-evaluate the need for a removal action at the Bradford Island Landfill including:

- The site-wide RI will look at all potential contamination holistically, including completely answering questions regarding risk from the Landfill. Areas posing unacceptable risk and requiring response or remediation will be identified by the RI.
- Conservative assumptions and risk from groundwater beneath the Landfill will be resolved in the RI.
- Given the apparent low risk at the Landfill, it is likely that some remedy less than a complete removal may be required.
- A complete removal may be more costly than the original conceptual estimates.
- Limited budget resources may keep the higher-priority projects from going forward if resources are diverted to this lower priority and potentially out-of-sequence removal.

4.1.1 Bradford Island Landfill Site Inspection – December 1998

The purpose of the site inspection (SI) was to assess the potential for historical disposal practices to have adversely impacted the environment and to assess whether additional investigation or remediation was necessary (Tetra Tech 1998). Specific areas of concern that were addressed during the SI included the Landfill, a pesticide mixing area located just south of the Landfill, and the shorelines proximate to Bradford Island Landfill. The SI included:

- Collection and analysis of four surface soil samples (three from background locations and one from downgradient of the pesticides mixing area)
- Collection and analysis of 10 subsurface samples from eight test pits (TP1 through TP8) and one soil boring (SB3) located within the Landfill footprint
- Collection and analysis of three samples of building materials (found within the Landfill test pits) for the presence of asbestos
- Installation and sampling of four groundwater monitoring wells (MW1 through MW4)
- Completion of a visual survey of groundwater seeps along the north, east and south shores of Bradford Island, and the attempted collection of Columbia River sediment samples from the nearshore areas of Bradford Island

The SI report concluded that past disposal practices had impacted soil and groundwater in the Landfill with petroleum hydrocarbons, organochlorine pesticides, PCB Aroclor 1260, tetrachloroethylene (PCE), semivolatile organic compounds (SVOCs), arsenic, and lead. Landfill debris encountered in the test pit excavations included mercury vapor lamps, electrical equipment, and asbestos-containing materials. None of the materials encountered in the excavations were removed. Additional investigation of the Landfill was necessary in order to evaluate potential remedial alternatives.

4.1.2 Bradford Island Landfill Supplemental Site Inspection – June 2000

URS conducted a supplemental site inspection (SSI) of the Landfill for the USACE during 1999 and 2000. The purpose of the SSI was to augment information presented in the 1998 SI report, fill data gaps, conduct a risk evaluation, and provide a list of alternatives for the long-term management of the Landfill (URS 2000). The SSI included:

- Collection and analysis of 10 surface soil samples from the Landfill site
- Installation of one additional groundwater monitoring well (MW-5), and the collection and analysis of groundwater samples from five wells during three monitoring events
- Additional visual assessment for groundwater seeps, and the collection of seep soil and water samples
- A site survey to facilitate completion of a biological characterization
- A screening level human health and ecological risk assessment

The SSI report concluded that surface and subsurface contained relatively low concentrations of VOCs, SVOCs, metals, chlorinated herbicides, organochlorine pesticides, and PCBs. Groundwater contained relatively low concentrations of VOCs, SVOCs, petroleum hydrocarbons, and metals. One seep was found and results indicated that low concentrations of SVOCs and metals were detected in both the soil and groundwater at this location.

This report included a preliminary risk screening for human health and ecological receptors based on Landfill contamination. The report identified maintenance workers and on-site construction/excavation workers as human receptors that could be affected by inhalation of, incidental ingestion of, or dermal contact with surface and subsurface soil. Since groundwater was not used, it was not included in the preliminary human health screening.

The report identified three preliminary potential exposure pathways for aquatic and terrestrial ecological receptors: incidental ingestion of groundwater discharged to the Columbia River, dermal contact with groundwater discharged to the Columbia River, and incidental ingestion of on-site surface soil. Ecological and human health risk screening was conducted and concluded that soil and groundwater posed no risk to human receptors. The report also concluded that there were localized exceedances of risk-based screening levels for ecological receptors.

Due to DEQ comments on the conclusions made in the Draft SSI report, USACE elected not to finalize the report. The DEQ and USACE agreed that additional investigation and analysis were necessary to address DEQ comments on the SSI report. The results of the additional investigation were used to complete a site characterization report and a screening level risk assessment in accordance with DEQ guidance.

4.1.3 Draft Level I Ecological Scoping Assessment and Human Health Problem Formulation – 2002

A Draft Level I Ecological Scoping Assessment and Human Health Problem Formulation report was completed in 2002 for the Bradford Island Landfill (URS 2002a). This report discussed (qualitatively) potentially complete exposure pathways and identified COIs for human and ecological receptors. Additional exposure pathways for maintenance and excavation workers were identified and included inhalation of surface soil dust, incidental ingestion of surface soil, and dermal contact with surface and shallow soil (0 to 3 feet below ground surface [bgs]; maintenance workers) and surface and surface soil (0 to 10 feet bgs; construction/excavation workers). An exposure pathway identified for recreational anglers included consumption of contaminated aquatic biota.

Additional exposure pathways for terrestrial biota include the following.

- Dermal contact with surface soil; food web transfer from contaminated surface soil
- Inhalation of, incidental ingestion of, or dermal contact with, subsurface soil (exposed by erosion)
- Food web transfer from groundwater discharged to Columbia River surface water; incidental ingestion of contaminated sediments
- Dermal contact with contaminated sediments
- Food web transfer from contaminated sediments

Additional exposure pathways for aquatic biota include:

- Food web transfer groundwater discharged to Columbia River surface water
- Incidental ingestion of contaminated sediments
- Dermal contact with contaminated sediments
- Food web transfer from contaminated sediments

COIs identified in surface soil (0 to 3 feet bgs) were trace metals, pesticides, PCBs, herbicides, SVOCs, and total petroleum hydrocarbons (TPH). COIs identified in groundwater included trace metals, VOCs, SVOCs, and TPH. In conclusion, the report recommended that a Level II Ecological Screening Assessment (based on DEQ guidance) be performed to provide a more thorough evaluation of the potentially complete and significant exposure pathways for ecological receptors based on soil, sediment, groundwater, surface water, and food-web contamination. The report also recommended that a baseline risk assessment for human health be performed.

4.1.4 Bradford Island Landfill Site Characterization Report – April 2004

The objective of the site characterization investigation was to collect additional site information to assist in the characterization of known or suspected potential environmental concerns at the Landfill (URS 2004a). The additional site characterization field activities included:

- Collecting and analyzing 10 primary soil samples from a test pit in the gully area
- Removing mercury vapor lamps from a known area of disposal at the Landfill, and collection and analysis of seven primary soil samples from the excavation
- Completing a geophysical evaluation of the Landfill using electrical resistivity and seismic refraction methods to estimate the extent of the Landfill
- Installing and developing four monitoring wells

- Collecting and analyzing nine primary groundwater samples (one each) from the new and existing Landfill monitoring wells
- Collecting and analyzing six primary soil samples to assist in the determination of preliminary hot spots at the Landfill
- Collecting and analyzing representative samples from soils excavated from the gully and mercury vapor lamp test pits, to assist in the selection of disposal options for this material

Additional tasks used to refine the conceptual site model included:

- Developing a water budget for the Landfill area
- Determining the thickness of Landfill material and the thickness of unconsolidated material above the slide block
- Determining aquifer characteristics

The site characterization report concluded that wastes disposed of within the Landfill include household waste and project-related wastes such as grease, lightbulbs, sandblast grit, and miscellaneous metal. A minimal amount of electrical debris was observed in the Landfill, when compared to the amounts removed from within the river or on the shore of the island. There was no evidence that significant and/or multiple past slope failures have occurred along the north slope of the island. Consequently, the possibility that failures have transported electrical debris to the river was considered low to negligible.

Turbid groundwater conditions were observed in several monitoring wells at the Landfill. This condition was because the groundwater beneath the Landfill exists as a perched zone and in some areas lacked enough water to allow full development of select monitoring wells. The turbid conditions may affect data quality due to the mobility of trace metals, and to a lesser extent on other constituents, in groundwater being affected by adsorption of contaminants onto particulate matter.

The Landfill is located within a 0.63-acre area, and Landfill materials and visually impacted soils did not appear to extend beyond 15 feet in depth. The estimated volume of the Landfill ranged from 9,900 to 7,500 cubic yards, whereas the estimate for the actual debris may be as low as 3,758 cubic yards plus any sandblast grit. Since RAOs have not been developed, these volumes are appropriate for conceptual planning purposes only.

The Landfill wastes were considered to have impacted soils primarily with petroleum hydrocarbons, and select VOCs, SVOCs, metals, and PCBs. This resulted in groundwater being impacted with low levels of VOCs, SVOCs and metals. Groundwater was expected to discharge from the site into the river predominantly through diffuse flow or through fractures on the north side of the island. Based on DEQ guidance (1998b), potential hot spot concentrations were exceeded in a few areas for soil and groundwater.

4.1.5 Level II Screening Ecological Risk Assessment and Baseline Human Health Risk Assessment – 2004

In response to the previous investigation, a Level II Screening Ecological Risk Assessment and Baseline Human Health Risk Assessment (HHRA) report (URS 2004b) was completed for the Bradford Island Landfill. This report indicated that human receptors could include maintenance workers, construction/excavation workers, and recreational anglers. The maintenance workers could be exposed by incidental ingestion of and dermal contact with surface and shallow soil (0 to 3 feet bgs), and inhalation of respirable particulates (particulate matter less than 10 micrometers in diameter [PM_{10}]) and vapor emissions from surface soil. The construction/excavation workers could be exposed by incidental ingestion of and dermal contact with surface and subsurface soil (0 to 10 feet bgs), as well as inhalation of respirable particulates and vapor emissions from this soil depth interval. The recreational anglers could be exposed via food-web transfer by eating contaminated fish and shellfish.

The ecological receptors identified during the risk assessment included plants, soil-dwelling invertebrates, and terrestrial wildlife represented by the California ground squirrel, vagrant shrew, Canada goose, and American kestrel. Plants and invertebrates could be exposed to COIs through direct contact with surface and shallow soil (0 to 3 feet bgs). Birds and mammals could be exposed to COIs through direct contact with surface and shallow soil and indirect contact via the bioaccumulation pathway by consuming COI-impacted food.

COIs identified for soil (0 to 10 feet bgs) included trace metals, butyltins, pesticides, PCBs, herbicides, SVOCs, VOCs, and TPH. COIs identified in groundwater included trace metals, butyltins, pesticides, herbicides, SVOCs, VOCs, and TPH. A further screening of these compounds against site-specific risk-based chemical concentrations, USEPA water quality standards, and DEQ Level II screening values, resulted in identification of contaminants of potential concern (COPCs) for human health and CPECs for ecological receptors.

The Level II report concluded (with caveats pertaining to benzo[a]pyrene and PCE in the gully area and Test Pit 7) that risks to human health at the site were considered acceptable under current land use conditions and that risk reduction measures were not necessary to protect human health. The primary concerns identified for ecological receptors were the potential for direct exposure toxicity (from chromium, lead, zinc, barium, PCE and dibenzofuran) to birds and mammals from contact with Landfill soils in the gully area and Test Pit 1, and the potential for food-web toxicity from bis(2-ethylhexyl)phthalate, pentachlorophenol, and dibenzo(a,h)anthracene to insectivorous mammals from exposure to soils in Test Pit 7 and the gully area. Based on some exceedances of ambient water quality criteria (AWQC) by site groundwater concentrations, additional evaluation of the potential for groundwater to impact surface water quality of the river was recommended.

The Level II report deferred a quantitative evaluation of risks posed by the aquatic habitat to the in-water (sediment removal) work. Consequently, an EE/CA (URS 2005) for in-water sediment removal work was prepared in 2005 and provides the most recent evaluation of human health and ecological risks related to the aquatic environment (primarily from contaminated sediment). The in-water EE/CA is discussed in Section 4.5.9.

4.2 SANDBLAST AREA ACTIVITIES

The Sandblast Area includes the area surrounding the former sandblast building on the eastern end of Bradford Island (Figure 4-2). Sandblasting has not been conducted at this location since 1988. The “Sandblast Area” is an informal name that has been used during past investigations to describe the sandblast building and the area around the building where spent blast media (sandblast grit) has been placed on the ground surface. The Sandblast Area encompasses a current hazardous waste storage area and a small former burn pit, both of which are located just southeast and east of the sandblast building.

The USACE and/or its contractors have conducted two separate investigations as well as an incidental sampling effort, and cleaned out stormwater drains in this area. A total of four catch basin samples, 70 soil and sandblast grit samples, and 10 groundwater samples were collected. Figure 4-2 depicts the Sandblast Area, the observed footprint of sandblast grit, and the previous sampling locations.

The investigations concluded that the primary source of soil contamination in the Sandblast Area is from the disposal of sandblast grit. The sandblast grit contains metals (primarily lead and chromium) and butyltins (dibutyltin and tributyltin). Additionally, an incidental spill of hazardous materials at the southwest corner of the hazardous waste storage area within the Sandblast Area is believed to have resulted in localized VOC impacts in the soils and groundwater.

4.2.1 Stormwater Drain Cleaning – February 2002

Based on the review of the preliminary results of the In-Water Investigation Report (URS 2002b) (Section 4.5.3), the USACE cleaned the sediment from the stormwater system, replaced the filter fabric “socks” that line each catch basin, and characterized and disposed of the waste generated during the cleaning process. As documented in the Storm Water Drain Cleaning Summary technical memorandum, three drain systems (two systems north of the sandblast building and one on the east side of the building), totaling 300 feet of buried pipelines and four catch basins, were cleaned (URS 2002c).

Following removal, the sediment and wastewater waste streams generated during the cleaning operation were sampled for characterization and disposal. The filter socks were included in the sediment waste stream. The water testing results indicated that lead was present at low levels and was characterized as nonhazardous waste. The drain sediment testing results indicated that PCBs were present up to 9.2 milligrams per kilogram (mg/kg) and lead was present above toxicity characteristic levels (5 mg/L) as measured by the toxicity characteristic leaching procedure (TCLP). The sediment was characterized as hazardous waste (D008) and transported to Waste Management’s Arlington, Oregon, facility for disposal.

The technical memorandum concluded that spent sandblast grit disposed around the sandblast building has been transported into the drain system. The spent sandblast grit contains lead above toxicity characteristic levels, making it a Resource Conservation and Recovery Act (RCRA) hazardous waste. Since the sandblast grit remains near the drains and is uncontained, further runoff would likely transport lead-contaminated sediments into the drains. Because of these findings, the USACE developed and implemented a regular inspection and maintenance program to prevent the discharge of sediment into the storm drain system (e.g., replacement of the filter socks on a periodic basis).

4.2.2 Preliminary Assessment/Site Inspection Sandblast Area, Transformer Release Area, and Former Drum Storage Area – September 2002

The preliminary assessment/site inspection (PA/SI) was conducted in 2001 and 2002 to aid in the characterization of environmental concerns associated with the Sandblast Area, transformer release area, and a former drum storage area (URS 2002d). A summary of the findings is provided below.

The sandblast building was used for sandblasting operations and painting from approximately 1958 to 1988. After 1988, the sandblasting and painting operations moved to the service center building. No records of disposal activities for sandblast grit were kept from 1958 to 1994. A record of disposal from 1994 shows 215,680 pounds of sandblast grit were disposed of as hazardous waste, and after 1997 waste disposal records indicate that on average, approximately 70 tons of spent blast media were generated per year from sandblasting operations. Sandblast grit generated since 1994 has been characterized as RCRA hazardous waste (for lead and occasionally for chromium) and disposed of off-site.

In December 2001, 18 samples were collected from the Sandblast Area north, south, and east of the sandblast building. Samples included sandblast grit samples and soil samples collected from native soils. Two samples were collected from beneath the asphalt pavement in the Sandblast Area. Also in December 2001, 14 soil samples were collected near catch basin #1 and along the shoulders of the access road northeast of the sandblast building.

The area of sandblast grit disposal includes the Sandblast Area and the transformer release area. The PA/SI report estimated that an area of approximately 20,000 square feet and 1 to 3 feet deep (1,500 to 2,000 cubic yards) might be regulated as hazardous waste if excavated based on lead and chromium concentrations. The total volume of sandblast grit present was estimated at between 1,410 cubic yards and 2,025 cubic yards.

A burn pit located southeast of the sandblast building and a septic system northwest of the building was identified at that time as additional potential sources of contamination within the Sandblast Area. In addition, an area of previously unknown contamination was discovered in the course of soil sampling. Evidence of localized solvent-impacted soil was discovered south of the hazardous materials storage area. A soil sample collected below the grit-soil interface at approximately 2.5 feet bgs at this location exhibited a strong VOC odor and detections of VOCs and SVOCs above USEPA preliminary remediation goals (PRGs).

4.2.3 2004 Soil Sampling

In April and May 2004, the USACE cleared the vegetation and graded an area of approximately 1,600 square feet near catch basin #1 (Figure 4-2). This work was completed for storing dam gates on several concrete piers. Less than 6 inches of topsoil were excavated by the USACE during vegetation removal. The vegetation and some soil connected to the roots were temporarily stockpiled in a roll-off dumpster.

After grading the area, USACE personnel collected 18 surface soil samples from the area that had been cleared (Figure 4-2). The samples were submitted to Wy'East Environmental Sciences, Inc. of Portland, Oregon for analysis of leachable lead and chromium by the TCLP method (USEPA Methods 1311/7190/7421). Six soil samples were also collected from the dumpster and analyzed for TCLP lead and chromium to characterize the material prior to disposal.

Chromium was detected at the reporting limit (0.2 mg/L) in nine of the 18 soil sample locations and was not detected in the other nine locations. No chromium was detected above the reporting limit in the six samples from the dumpster. Lead was detected in all 18 soil samples at concentrations between 0.4 mg/L and 13.0 mg/L, with a mean lead concentration of 3.6 mg/L.

Lead was detected in all six samples from the dumpster, with concentrations ranging from 2.1 to 12.0 mg/L.

One soil sample from the dumpster had a concentration that exceeded the toxicity characteristic of 5.0 mg/L for lead (reported concentration of 12.0 mg/L). Based on this, the soil in the dumpster was disposed of as hazardous waste at the chemical waste landfill in Arlington, Oregon.

4.2.4 Supplemental Site Inspection Report – January 2006

The objective of the SSI was to collect additional site information to assist in the characterization of known or suspected potential environmental concerns at the Sandblast Area. The investigation method details and analytical results were summarized in the Supplemental Site Inspection, Sandblast Area, Bonneville Lock and Dam Project, Cascade Locks, Oregon (URS 2006a).

An additional 23 soil samples were collected from hand augers and direct push borings. The samples were collected in the following general locations: near the hazardous waste storage area, adjacent to the river, outside of the sub basin captured by the sandblast building stormwater system, from within the catch basins, around the septic tank, and beneath the former burn pit.

Ten groundwater samples were collected from direct-push borings in the Sandblast Area. Four borings were drilled along the Landfill access road that parallels the riverfront. Three borings were drilled within the drain field for the sandblast building septic system, and the last three were drilled in the presumed downgradient direction adjacent to the hazardous material storage area.

In conjunction with the metals and butyltins, detected during the previous investigations, several other COIs and contaminants of potential ecological concern (CPECs) were detected in the sandblast grit and grit-impacted soil. These include PCBs, SVOCs, and VOCs. The sandblast grit is not believed to be the source of contamination for these COIs and CPECs. The four most likely sources of PCB, SVOC, and VOC contamination are:

- Incidental spills of hazardous materials at the southwest corner of the hazardous materials storage area.
- Storage of dam-related equipment along the Landfill access road. Oil-stained soil, metal painted with lead-based paint, and potentially PCB-containing equipment and insulators were observed in this area in 1996.
- Disposal and incineration of wastes in a former burn pit at the east end of the Sandblast Area.
- Transformer maintenance documented in the PA/SI (URS 2002d). A small release of PCB-contaminated oil occurred in 1995 at the paved area east of the sandblast building during a transformer rehabilitation project.

Additionally, low levels of petroleum hydrocarbons, VOCs, SVOCs, butyltins, and pesticides were detected in several groundwater samples in the Sandblast Area.

This report (URS 2006a) provides information on potential site contaminants related to past operations in the vicinity of the sandblast building, including the grit placement area, hazardous materials storage area, burn pit, storage area along the Landfill access road, and vicinity of a historic hydraulic-fluid PCB (Aroclor 1260) spill. Chromium and lead were detected above

DEQ's suggested regional background concentrations at nearly every sample location obtained from less than 1 foot bgs. Numerous SVOCs (notably benzo[a]pyrene and bis-2[ethylhexyl]phthalate) and VOCs were detected in soil borings and groundwater. Perchloroethene and trichloroethene exceeded maximum contaminant levels for drinking in groundwater. PCBs and butyltins were not detected in groundwater but were detected in several soil borings. The catch basin was also sampled; cadmium, nickel, zinc, some butyltins, diesel and motor oil range petroleum hydrocarbons, low levels of several pesticides, VOCs, and SVOCs were detected in filter media. Several compounds, specifically PCBs, benzo(a)pyrene and bis-2(ethylhexyl)phthalate, were seen to be more concentrated in these media than in the uplands, suggesting runoff and accumulation on the media. COIs were not screened in this report.

4.3 PISTOL RANGE INVESTIGATION

The Pistol Range is located on the south side of Bradford Island, immediately adjacent to the forebay that is formed by the First Powerhouse (Figure 1-3). The Pistol Range was used for small arms target practice from the late 1950s to the late 1960s or early 1970s. During a PA/SI conducted in 2002, 73 soil samples were collected from 42 sample locations (in some locations samples were collected at different depths). The area considered as part of the pistol range for the PA is approximately 200 feet long and between 20 to 30 feet wide (approximately 4,550 square feet). Figure 4-3 depicts the location of the Pistol Range and former firing shed in relationship to the sample locations. The investigation method details and analytical results were summarized in Preliminary Assessment and Site Inspection, Former Pistol Range, Bonneville Lock and Dam Project, Cascade Locks, Oregon (URS 2003a).

Surface soil was collected downslope of the Pistol Range in a limited number of samples. Groundwater was not sampled during the PA/SI.

Some uncertainties exist with respect to soil data for nickel. Since groundwater data were not collected during the PA/SI, the potential for chemicals in soil to leach into groundwater and subsequently discharge into surface water at levels that may exceed protective concentrations for aquatic biota has not yet been addressed.

No risk evaluation has occurred at this area (URS 2003a). In the preliminary screening, the maximum soil analytical concentrations indicated that lead was the only metal elevated above USEPA Region 9 PRGs, and it was found primarily near the former firing shed and around the backstop. These areas appeared to be relatively small (600 square feet around the firing shed, and 1,400 square feet of soil around the backstop) and shallow (impacts likely extend up to 2 feet bgs). The extent of lead impacts in one area (behind the backstop) were not defined as noted in the report and in DEQ's comments on the PA/SI. The report also concluded that both lead and zinc could exceed sediment protective values for the benthic community should the upland soils migrate to the river.

4.4 BULB SLOPE RECONNAISSANCE INVESTIGATION

The Bulb Slope disposal area is situated east of the Bonneville Dam spillway and west of the Bradford Island Landfill, on a steep, vegetated slope between the Landfill access road and the Columbia River. The Bulb Slope disposal area was identified during a Landfill-related remedial action offshore of Bradford Island in February and March of 2002. During the removal operation, a previously undocumented area of upland waste disposal (the Bulb Slope) was identified. A significant number of broken electrical lightbulbs was observed on the ground surface. The Bulb Slope is situated approximately 280 feet west of the Bradford Island Landfill, on a steep, densely vegetated slope between the Landfill access road and the Columbia River (Figure 4-4).

A reconnaissance investigation of the Bulb Slope area was conducted November 2002. The investigation and findings are described in the Draft Bulb Slope Reconnaissance Investigation and Evaluation of Potential Remedial Options (URS 2003b).

During the reconnaissance investigation, soil samples were collected from eight locations and analyzed for PCBs as Aroclors, lead and mercury (Figure 4-5). This included one duplicate sample from location 02. The investigation report concluded that PCBs as Aroclor 1260, lead, and mercury are present in soils within the area of visually observed glass debris at the Bulb Slope. Reported concentrations of PCBs (Aroclor 1260) ranged from 27 micrograms per kilogram (µg/kg) to 251 µg/kg, with lead concentrations ranging from 25 mg/kg to 597 mg/kg, and mercury concentrations ranging from 0.05 mg/kg to 1.54 mg/kg. The reconnaissance investigation concluded that during the completion of a removal action, it would be difficult to prevent materials from entering the river, given the steep slope.

It appears that approximately 95 to 125 cubic yards of debris and impacted soil is present at the Bulb Slope. This material is present on a bedrock base (the slide block).

No risk evaluation has been completed for the Bulb Slope area. Direct contact exposure pathways for human receptors appeared to be limited. The potential for threats to terrestrial ecological receptors also appears to be low, but with some potential concerns regarding lead and mercury in soils. Since materials are eroding from the steep slope (based on the presence of bulbs observed in the river during the in-water equipment removal action), exposure pathways to aquatic receptors may be complete. Due to the presence of bioaccumulative chemicals (PCBs and mercury), additional evaluations using the existing data may be necessary to assess risks to the aquatic receptors. DEQ has expressed concern about the direct runoff of PCB- and mercury-impacted soils into the river.

4.5 IN-WATER INVESTIGATIONS

The in-water investigations at the site can be divided into investigations related to sediment dredging and investigations related to environmental issues.

As part of the environmental investigation of the Bradford Island Landfill (Section 4.1), hydrographic and underwater dive surveys were conducted in October and November 2000. The surveys were initiated due to the discovery of light ballasts on-shore on the north side of the island, adjacent to the Landfill. The surveys identified waste-related items submerged in the Columbia River, just offshore of the Landfill. The waste-related items were located in three distinct piles. A preliminary in-water investigation was conducted in May 2001 to evaluate sediment near the waste items in order to plan for a removal of the items. The waste-related items were removed in February and March 2002. Additional investigations were completed in 2002 and 2003 to assess the extent of sediment related impacts from the waste-related items.

4.5.1 Dredge Evaluations and Other Studies by USACE

Four studies (two published reports and two unpublished evaluations) were completed to evaluate sediment dredging within the area.

4.5.1.1 Bonneville Navigation Lock Sediment Evaluation – 1991

The downstream area below the old navigation lock was dredged infrequently. The most recent event in 1986 removed 2,050 yards of material. Two samples were collected within the area directly downstream of the navigation lock using a ponar sampler and a third sample was collected downstream of the tip of Bradford Island. The third sample was collected to characterize a potential site for in-water disposal of the dredged sediments, and chemical analysis was not completed. The navigation lock samples were submitted for the following analyses: grain-size, organic content, metals, volatile solids, pesticides, PAHs, and PCBs.

The two samples within the navigation lock channel were silty sands with gravel or clay, depending upon the location. The sample downstream of Bradford Island was reported to be a well-graded gravel.

The results indicated that low levels of metals were reported above detection limits, with pesticides, PCBs, and PAHs not detected above the reporting limits.

4.5.1.2 Minimum Operating Pool Study – 1991

A Minimum Operating Pool study was conducted within the Bonneville Pool. The study included 12 sites between RM 149 and RM 181 (upstream of the Project). All sites were analyzed for metals, PAHs, pesticides/PCBs, total organic carbon (TOC) and acid volatile sulfides (AVS). Some sites were also analyzed for phenols, dioxins/furans and tributyltin. None of the test sediments exceeded the Dredge Material Evaluation Framework screening guidelines at the time for open water disposal (no PCBs were detected at or above the method reporting limit of 0.04 mg/kg).

4.5.1.3 Bonneville Second Powerhouse Forebay Sediment Evaluation – 1997

Due to debris buildup from high-water events in 1996, seven sediment samples were collected from the Second Powerhouse forebay and from within the auxiliary water supply conduits in the Second Powerhouse. Two samples were collected from within the auxiliary water supply conduits by divers, three surface sediment samples were collected from the north end of the forebay, and two additional samples were collected from sediment that had been recently removed from the auxiliary water supply intake trash rack.

The samples were submitted for physical and chemical analysis. The results indicated the sediments collected consisted mostly of sand-sized particles, and consequently low TOC concentrations were detected. Low levels of metals, select PAHs, lindane, and DDT were reported. PCBs as Aroclors were not detected above the reporting limits. The sample locations and PCB results are depicted on Figure 4-6.

4.5.1.4 Bradford Island Fish Ladder Exit Sampling – 2001

Prior to dredging sediments that had been deposited at the exit of the fish ladder on Bradford Island; three surface samples were collected from the area in December 2001. The samples were collected to determine disposal options for the dredged materials. The samples were submitted for chemical laboratory analysis for PCBs and organochlorine pesticides by USEPA Method 8081. The analytical results indicated that none of the parameters was detected above the method reporting limits. The approximate sample locations and PCB results are depicted on Figure 4-6.

4.5.2 Debris Pile #1 Partial Removal – December 2000

In December 2000, approximately 60 electrical items were removed from the easternmost pile (Debris Pile #1) proximate to Bradford Island. Items recovered from the pile included post insulators, lightning arrestors, electrical panels, and one inerteen capacitor. Due to adverse weather conditions, the removal efforts were suspended prior to recovery of all electrical items from the river.

Four sediment samples were collected during the recovery activities. Two samples were collected near the area where the inerteen capacitor was recovered (one beneath the capacitor and one approximately 10 feet from the capacitor). A third sample was recovered from a 5-inch round disk that had fallen out of a broken lightning arrestor. The fourth sample was collected from the back of an electrical panel.

The disk and the back of the panel had acted as a sediment trap; therefore these samples consisted mostly of fine sands and silt-sized particles. The other two samples that were collected from the riverbed consisted mostly of medium-sized sands.

Each sediment sample collected was submitted for analysis for PCBs by USEPA Method 8082, TOC by USEPA Method 9060, and petroleum hydrocarbons by Method NWTPH-Dx.

PCBs as Aroclor 1254 were detected above the reporting limit in three samples ranging from 0.15 mg/kg to 8.3 mg/kg. Petroleum hydrocarbons were not detected above reporting limits. The sediment TOC values ranged from 370 mg/kg to 10,000 mg/kg.

A technical memorandum that describes the sampling and analysis details was provided as an appendix in the In-Water Investigation Report, Bradford Island Landfill (URS 2002b). The sample locations and PCB concentrations are depicted on Figure 4-7.

4.5.3 In-Water Investigation – May 2001

In May 2001, an additional investigation was conducted to further characterize the area surrounding the underwater debris, and to support evaluation of options for additional debris removal activities. The investigation included sampling several matrices in the area surrounding the debris piles, a detailed survey of the offshore areas proximate to the Landfill, and an estimate of the volume of debris located in the river.

The survey confirmed the presence of the two most upstream debris piles in the Columbia River near the Landfill, and located one additional pile downstream near the access road that leads to the Landfill. Waste items were observed on the surface of the bedrock outcrops on Bradford Island and down the slopes to the water level. These observations support the anecdotal accounts that the materials on the shore and in the water adjacent to the Landfill were disposed of in the water following storage on the surface of the Landfill.

The piles consisted of electrical equipment and miscellaneous debris (primarily wire rope). Sampling consisted of the collection of sediment, tissue and water column samples. Sediment samples were collected within and on the perimeter of two of the debris piles.

The samples contained concentrations of PCBs (Aroclor 1254), metals, and SVOCs above selected ecological benchmark screening values. PCBs in sediments were detected at concentrations ranging from nondetect to 23.9 mg/kg. Clams and crayfish collected in the debris piles exhibited PCB concentrations above background results found at Goose Island (approximately 500 feet upstream of Bradford Island, near the Oregon shore).

Sample results from Semi permeable membrane devices (SPMDs) indicated that PCBs as Aroclors were not detected in the dialysate above reporting limits.

The investigation method details and analytical results were summarized in the In-Water Investigation Report, Bradford Island Landfill (URS 2002b). The sample locations and PCB concentrations are depicted on Figure 4-7.

4.5.4 Off-Shore Debris Removal – March 2002

The May 2001 in-water investigation concluded that the offshore electrical equipment items in the debris piles in the river may represent an ongoing human or ecological risk and that the electrical equipment should be removed as soon as possible (URS 2002b). Electrical and other solid waste was removed from the river and shoreline of Bradford Island between February 14 and March 4, 2002.

Divers were used to locate the electrical items and any other solid waste located within the three identified piles. Additionally, solid waste items (primarily wire rope) located upland from Debris Piles #1 and #2 (located on the steep slopes below the Landfill) were removed. The USACE also conducted a limited sediment removal effort in areas where PCB-containing oils may have been released.

A total of 32 tons of solid waste was removed and disposed of at an appropriate off-site facility. The PCB-containing electrical debris that was recovered filled four 55-gallon drums. Seven 55-gallon drums of sediment and water were generated using a small hydraulic pump fitted with a hose directed by the diver. PCBs as Aroclor 1242 and 1248 were detected in the sediments that were removed using this method at concentrations up to 6,470 mg/kg. The sediments were managed as investigative derived waste by the USACE. The debris, sediment, and water were transported off-site by USACE for disposal.

PCBs as Aroclor 1254 were detected in the water column in the particulate phase during the recovery activities up to 0.0218 micrograms per liter (μg/L), and up to 0.0308 μg/L in the dissolved phase, i.e. <0.45 microns.

The investigation method details and analytical results were summarized in the In-Water Removal Work, Bradford Island Landfill, Cascade Locks, Oregon technical memorandum (URS 2002e).

4.5.5 First Powerhouse Trashboom Sediment Evaluation – January 2002

The First Powerhouse forebay south of Bradford Island is the proposed location for a new trashboom. Installation of the concrete anchors required to hold the trashboom in place would require excavation of the Columbia River sediments. URS collected 12 sediment samples at four locations identified by the USACE as possible anchor points (three at each location). Figure 4-6 depicts the sample locations and PCB concentrations.

A gravity core sampler was used to collect sediment at Anchor Point #1 (nearest to the old navigation lock). Due to the lack of sample recovery, a clamshell bucket sampler was utilized to obtain river sediment samples at the three remaining sample locations. Adequate sample media was obtained at each location, and the samples were submitted for chemical analysis.

The analytical results indicate that PCB Aroclors were below the practical quantitation limit at all four anchor point locations. Two samples contained levels of mercury above the stated NOAA Freshwater Sediment Threshold Effects Level, both occurring at Anchor Point #4, which is located off the Bradford Island south shoreline. Motor oil range hydrocarbons were also detected in several samples in both Anchor Points #1 and #4. There is no established threshold effects level for motor oil. Gasoline and #2 diesel were also below the practical quantitation limit at all sample locations.

The results of the TOC and grain size analysis revealed that the sediments sampled consist primarily of sandy silts with some clay. Surficial fine gravels were also encountered at Anchor Points #2 and #3. The sediment fraction of TOC ranged from 0.16 to 1.4 percent.

The investigation method details and analytical results were summarized in Trashboom Structure Foundation Anchor Sediment Sampling Report, Bonneville Dam Project (URS 2002f).

4.5.6 Bonneville Forebay Characterization – August 2002

In August 2002, the USACE collected sediment samples from the Bonneville Pool between the dam and RM 147 to gather baseline data regarding potential upstream contribution of contaminants to the sediments in this area. The USACE attempted to sample sediment at 24 stations using a box core sampling device. Fine-grained sediments were collected at six of the 24 stations. There was poor to no recovery using the box core at the remaining locations. Samples were analyzed for grain size, TOC, metals, PCBs, and SVOCs. Low levels of metals and SVOCs were detected above the reporting limit at several locations throughout the forebay. PCBs, as Aroclor 1254, were detected at only one station (out of the 24 stations sampled) on the south side of Bradford Island at 0.0192 mg/kg. TOC results ranged from 0.2 to 1.6 percent. Figure 4-6 depicts the PCB sample locations and results.

4.5.7 Stage 1 Data Report – November 2003

In February and March 2002, waste-related items submerged in the Columbia River just offshore of the Landfill were removed (Section 4.5.4). Following this work, the USACE conducted a post-removal investigation of Columbia River sediments within the forebay of Bonneville Dam. The objectives of the investigation were to estimate the nature and extent of sediment impacts in the immediate vicinity of Bradford Island refine the conceptual model to evaluate the potential upstream contributions to sediment contamination, and to collect data necessary to assist in selection of a removal action area (URS 2003c).

The post-removal sediment investigation fieldwork was conducted from March 3 to April 10, 2003, and included the collection of sediment, tissue, and surface water samples at over 120 stations.

The investigation was divided into two analytical stages to streamline data analysis. The stage 1 analytical program included chemical analysis of 24 "source area" sediment samples and 20 reference area sediment samples. The source area was defined for this investigation as locations within the footprint of the former debris piles. Figure 4-8 depicts the source area samples and Figure 4-6 depicts the depositional and reference area samples. Following the validation, the data from the source area were compared to the reference area using statistical techniques.

Eleven metals, 2 PCB Aroclors, and 12 SVOCs were found to be higher in the source areas when compared to the reference area.

The primary goal of the Stage 1 analysis was to begin a post-removal nature and extent delineation for the in-water portion of the site. The results of the Stage 1 analysis were as follows:

- The area of the former piles and the drain outfall area have been characterized with respect to nature of contamination (based on the statistical evaluation)
- Extent of contamination at the edges of the piles and between the piles has not been defined
- A reference area has been well characterized
- Additional data will be necessary to meet the project objectives

4.5.8 Stage 2 Data Report – December 2004

Based on the stage 1 results and the high PCB concentrations in the source area, the USACE decided a removal action would be appropriate to reduce potential exposure to ecological and human populations. A statistical analysis was conducted to develop a list of COIs. The remaining sediment samples were analyzed for the COIs during the stage 2 analysis in order to assist in the definition of a removal action area.

The purpose of the stage 2 sediment investigation was to characterize the nature and extent of former waste and stormwater outfall-related contamination in the Bonneville Dam Forebay area (URS 2004c). The study area includes the forebays of the two powerhouses and the dam spillway, submerged areas adjacent to Bradford Island and Goose Island, the upland portion of Goose Island, and reference (i.e., background) areas located about 1 mile upstream from the dam complex.

The investigation was designed to collect data necessary to meet the following goals:

- Estimate the nature and extent of sediment impacts in the immediate vicinity of three former in-water debris piles, two existing stormwater outfalls, and Bradford Island
- Refine the conceptual model, and evaluate the upstream contributions to sediment impacts

- Evaluate whether Goose Island soils could be a continuing source of contamination to nearby river sediments
- Evaluate the possible connection between impacted sediment at Debris Pile #1 and the PCBs identified in sediments on the south side of the island
- Evaluate whether contaminated sediment may have been transported and redeposited in the Bonneville Dam Forebay area

The sediment sampling locations were divided into three main groups: (1) source areas, (2) potential depositional areas, and (3) reference areas.

A sampling grid across the source areas (the three former in-water piles and the stormwater outfalls) was used to select sampling locations. Relatively low river flow areas, identified from river flow modeling results, were selected as likely sediment depositional and accumulation areas. The upstream reference area was selected based on modeling results characterizing the upstream extent of the river flow reversal caused by the powerhouses and the spillway that could transport impacted sediment back upstream. Sample collection occurred at locations in all three groups.

Sampling was also completed on Goose Island. Two surface soil samples were collected from the island and analyzed for PCBs as Aroclors, PAHs, and several metals. Goose Island soil samples appear to exhibit low levels of copper, chromium and a few PAHs primarily on the east end of the island. PCBs were not detected in the surface soils; therefore, Goose Island does not appear to be a source of PCBs to Columbia River sediments.

A statistical analysis comparing the source area to the reference area indicated the source area was enriched when compared to the reference for copper, lead, Aroclor 1254, and 11 PAHs.

Sediment contaminants were largely found in the offshore area north of Bradford Island (Figure 4-8 and Figure 4-9). PCB Aroclor 1254 was detected with greater frequency and at more elevated concentrations than any of the other COIs in the source area. Aroclor 1254 detections were found in the source area and a small depositional area south of Bradford Island, indicating that PCB-contaminated sediments appear to have been present within the source area and somewhat south of Bradford Island, but were not deposited throughout the forebay pool. Only three of the 17 depositional samples had detectible concentrations of Aroclor 1254 (Figure 4-6). Furthermore, concentrations of Aroclor 1254 decreased by as much as three to four orders of magnitude away from the former location of the debris piles.

4.5.9 Draft Engineering Evaluation and Cost Analysis – December 2005

Based on the results of sediment investigations within the forebay, the USACE decided to complete a sediment removal action and the EE/CA was used to select the most appropriate removal action alternative. The removal action area in which the alternatives were evaluated consists of 5.7 acres upstream of the dam on the north side of Bradford Island within the spillway forebay and 1.1 acres upstream of the First Powerhouse on the south side of Bradford Island.

The in-water EE/CA concluded that recreational anglers and subsistence anglers could be exposed by eating contaminated fish. Potential exposure scenarios for ecological receptors in the aquatic environment were identified as follows:

- Fish and aquatic invertebrates coming in contact with groundwater discharging to surface water in the nearshore environment
- Benthic invertebrates residing in contact with impacted sediment in the vicinity of Bradford Island, particularly in the areas near the former waste piles and the storm drain outfalls
- Ingestion of benthic invertebrates, sediment, and gill uptake from surface water by forage fish
- Ingestion of fish and gill uptake from surface water by piscivorous fish
- Ingestion of benthic and aquatic biota (e.g., piscivorous fish, forage fish, and benthic invertebrates) by aquatic-dependent wildlife
- Incidental ingestion of sediment and surface water by aquatic-dependent wildlife

COIs identified for the aquatic environment included copper, lead, bis(2-ethylhexyl)phthalate, PCBs, and a suite of PAHs. The list of compounds was developed using a statistically based approach where the source area sediments were compared to a reference area. The compounds that were enriched in the source area when compared to the reference area were selected as COIs warranting further evaluation.

The EE/CA presented the screening of technologies, development of alternatives, evaluation of alternatives, and selection of the preferred alternative for conducting the removal action.

The RAOs in the EE/CA included:

- To remove, treat, and/or manage the greatest practical mass of PCB-impacted sediments that will contribute to the long-term management of PCBs at the site
- To remove, treat, and/or manage PCB-impacted sediments to a level that will reduce risk to human receptors by addressing the dermal adsorption, food web, and incidental ingestion routes
- To remove, treat, and/or manage PCB-impacted sediments to a level that will reduce risk to higher trophic-level ecological receptors or the benthic community in the immediate vicinity of Bradford Island by addressing the incidental ingestion, uptake/dermal contact, and food web routes
- To prevent migration of PCB-impacted sediments

Based on the removal action area and the RAOs, remedial options and technologies were assembled and screened in order to form the six removal action alternatives identified and evaluated in the EE/CA:

- No action
- Dredging
- Hot spot dredging with capping
- Capping
- Hot spot dredging with enhanced natural recovery
- Hot spot dredging only

The dredging alternative involved the removal of Aroclor 1254-impacted sediment from within the northern and southern removal action areas using a diver-assisted dredging technique. The hot spot dredging with capping alternative consisted of the selective dredging of materials considered hot spots of contamination in the area around Bradford Island and capping the remainder of the removal area. Hot spot areas were defined as areas where PCB Aroclor 1254 was found in the sediment at concentrations greater than 1 part per million (ppm). The capping alternative consisted of placement of a sediment isolation cap over the entire removal action area. The hot spot dredging alternative with enhanced natural recovery consisted of hot spot dredging, combined with placement of a thin (average 6-inch thick) layer of clean sediment over the entire removal action area to enhance the natural recovery process in the forebay. The hot spot dredging only alternative consisted of dredging the hot spots only, with no isolation or enhanced natural recovery caps.

A detailed evaluation of the six removal alternatives was conducted against short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. The six alternatives were then compared against USEPA recommended criteria.

The hot spot dredging only alternative was selected as the preferred removal action alternative. Figure 4-9 depicts the area covered by the selected alternative. These areas were further evaluated during the removal action design process and updated. Figure 4-10 depicts the final footprint where the Corps will implement the removal action.

The hot spot dredging alternative received one of the highest overall ratings in the comparative analysis (two good ratings and one superior rating). The following are the primary features of this alternative that resulted in its selection as the preferred alternative:

- This alternative is the least costly alternative (except for No Action). The second least costly alternative is approximately 50 percent more expensive based on present-worth values.
- Based on present-worth values, this alternative is the most cost-effective alternative from the standpoint of mass removal of PCB-impacted sediment, at an estimated $49,000 per pound of PCBs removed. The next most cost-effective alternative with respect to contaminant mass removal is approximately $25,000 more expensive per pound of PCBs removed.
- This alternative would permanently remove an estimated 94 percent of the PCBs from the removal action area.
- In terms of risk reduction and contaminant mass removal, this alternative is nearly as effective as Alternative 2, dredging, but is less than half the cost.
- This alternative would be compatible with any potential future in-water remedial action that may be selected for the site and would not affect the ability to conduct any removal or remedial actions that may be selected for the upland areas of Bradford Island. Furthermore, in the event that a follow-on remedial action is necessary, the scope of such an action would be greatly reduced.
- Hot spot removal alone may achieve adequate risk reduction (i.e., complying with future cleanup goals that may be established in the follow-on RI) without further action (i.e., additional capital investment).

Despite the technical challenges of the site, this alternative could be implemented using standard diver-assisted hydraulic dredging equipment and methods that have previously been used at many dredging sites.

4.5.10 Pre-Design Investigation

Surface water and sediment data were needed to assess the potential for water quality impacts to occur from effluent that will be discharged from the dredged sediment after dewatering. The predicted effluent concentration, the appropriate surface water quality standard, and the background Columbia River water concentrations for identified COPCs are needed to assess and manage water quality impacts during the sediment removal action. Sediment and water samples were collected to meet these data needs between April 3 and 9, 2006.

To accomplish these objectives, the samples were collected from within the area where the removal action will occur. One surface water sample was also collected as a river background location upstream of Goose Island and outside the potential backwater influence of Bonneville Dam. Water was collected at this located by both grab surface water sampling and high-volume surface water sampling.

Sediment samples were collected to support both column settling tests (CST) and modified elutriate tests (MET). These analyses were used in the sediment removal design to address dredging effluent water quality, determine sediment disposal practices, calculate the size of sediment impoundment, and determine the extent of possible water quality exceedances when the effluent is returned to the river.

The CST results indicated that the sediments from both piles settled rapidly. The total suspended sediment (TSS) sample collected after 12 hours of settling was at 3 to 4 percent of initial sediment concentrations, and at 1.8 to 2.2 percent of initial concentration after 24 hours.

The sediment PCB Aroclor concentration for Aroclor 1254 for Debris Pile #1 was 440 parts per billion (ppb). Debris Pile #2 had concentrations of 160 and 2,100 ppb.

After the 24-hour MET analyses, the total PCB Aroclor concentrations in the elutriates were 0.024 ppb and 0.063 ppb for Debris Piles #1 and #2, respectively, and the dissolved Aroclor concentrations in the elutriate were nondetect for both Debris Piles #1 and #2. In addition, the PAH analytes were also nondetect for both samples after the MET analyses.

The surface water sample data show similar concentrations for both the “background” sample (Goose Island) and the sample collected downstream of Debris Pile #1 for total copper, total lead, turbidity and TSS. Similarly, the high-volume surface water data show comparable results for Goose Island and the Debris Pile #1 samples for PAHs, and the PCB Aroclors with the exception of slightly elevated concentrations of Aroclor 1254 in Debris Pile #1.

While the PCB Aroclor data for the grab water samples were nondetect, the high-volume surface water sampling analysis technique detected picogram levels of PCB congeners in the river water. The PCB congener data for the high-volume water samples show a general trend of higher concentrations of PCBs on the particulate phase (XAD filter) for the more heavily chlorinated, more insoluble congeners.

4.6 SUMMARY OF EXISTING RISK ASSESSMENT INFORMATION

Based on evaluation of the risk information presented above and on evaluation of general investigative information, contaminant sources exist on or adjacent to Bradford Island that have historically released, have the potential to release, or may be releasing contaminants to air, water, sediment, soil, and tissue. Potentially exposed populations include on-site maintenance and excavation workers, recreational and subsistence anglers, terrestrial biota (plants, soil invertebrates, terrestrial birds and mammals), aquatic biota (plankton, plants, water-column invertebrates, and fish), benthic organisms (infaunal and epibenthic invertebrates and demersal fish), and aquatic-dependent wildlife (birds and mammals).

The contaminant sources include the Landfill, the Sandblast Area (including the hazardous waste storage area, the former transformer oil release areas, and the drum storage area), the Pistol Range, the Bulb Slope, Goose Island upland, and sediments including those that anglers may contact near the park at the mouth of Eagle Creek. (Goose Island is included because Bradford Island surface soils and rock, as well as sediments, were removed to Goose Island.) The Eagle Creek mouth is in the backwater area of the dam, so it is possible that sediment transport to this location could have occurred. All of these areas have been investigated in varying levels of detail to detect the presence and concentrations of contaminants such as metals, butyltins, pesticides, PCBs, herbicides, VOCs, SVOCs, PAHs, and TPH. While all of these contaminants have been screened to some degree in previous investigations to determine if they should be retained as COPCs (human health) or CPECs (ecological health), not all were screened consistently using DEQ methods (DEQ 2001a, 2003). Consequently, no unified list of COIs has been generated for the site to date. This is further discussed in Section 5.

The purpose of the conceptual site model (CSM) is to identify the physical and/or ecological setting, the potential sources of contamination, and the release mechanisms and transport media that will be important in evaluating impacts to human or ecological receptors. The CSM also provides a basis for evaluating data gaps. Two Operable Units have been identified at this time: the Upland OU and the River OU. Although the two OUs overlap somewhat, a separate CSM has been developed for each OU and points out where the overlaps occur.

5.1 UPLAND OPERABLE UNIT

The upland portion of the site consists of the eastern half of Bradford Island, from the dam spillway to the eastern tip of the island (Figure 5-1). The peninsula containing the site is physically isolated from the Oregon and Washington shorelines by the Bonneville Dam, associated facilities, and the Columbia River. The western half of the site is mostly paved and has offices, an equipment storage area, and a service building for dam maintenance. The eastern half of the site is undeveloped and has a relatively flat meadow on the north side of the island fringed with clumps of shrubs and trees. Very steep, nearly vertical banks border the north, east, and south sides of the island tip.

5.1.1 Physical Setting

Physical characteristics of Bradford Island that are relevant to the discussion of site transport mechanisms are summarized below.

- Figure 5-2 depicts the general topography of Bradford Island. There are two areas of higher elevation in the center of the island that range from 170 feet to 195 feet above msl. For reference, the Landfill is at elevation 120, the Sandblast Area is at elevation 98, and the Pistol Range is at elevation 94 feet above msl.
- North of the Landfill, the land surface drops steeply by approximately 30 to 35 feet to the Columbia River. The topography east of the Landfill also drops steeply to the Columbia River. The land rises moderately south and southwest of the Landfill. West of the Landfill, the topography slopes gently to the west-northwest. Surface water drainage at the Landfill generally follows the topography as sheet flow, which trends to the north-northwest.
- Bedrock outcrops of conglomerate, sandstone, and limited siltstone are exposed along the north slope of the island. The potential for bedrock failure is low. The shoreline along the north slope near the Landfill is vertical to over-vertical.
- Precipitation that infiltrates the soil at the island may percolate to groundwater. Under both wet season and dry season conditions, shallow groundwater at the island likely flows to the north on the north half of the island and to the south on the south half of the island. Groundwater discharge to surface water occurs as diffuse flow in the high permeability materials in the steep slopes on the northern edge of the island as well as in seeps located in vertical fractures in the underlying low-permeability materials. Groundwater may enter the river through bottom sediments or above-water surface seeps.
- River stage elevation upstream of the dam at the island averages 74 feet above msl.

5.1.2 Potential Contamination Sources

Potential or known sources of contamination are summarized in this section. Section 4 provides the background information from which the sources were identified. Figure 5-1 depicts the location of each of the potential sources.

5.1.2.1 Bradford Island Landfill

The primary sources of chemical release at the Bradford Island Landfill are trash pits, Landfill mixed-waste disposal areas, and the pesticide mixing area. Chemicals have been released from these primary sources into the surface and subsurface soil (secondary sources). During wet portions of the year, the water elevation can rise high enough to encounter waste materials in a small portion of the Landfill.

Based on the investigations to date, the COIs identified for the Landfill are presented and described in Section 5.3.

5.1.2.2 Sandblast Area

The Sandblast Area consists of the following subareas that are associated with different sources of contamination: the hazardous waste storage area, a transformer release area, a former burn pit, and a spent sandblast media disposal area.

Blast media used in former sandblasting operations has the potential to result in impacts from metallic and organometallic constituents in paint. From approximately 1958 to 1988, painting and sandblasting operations took place within the sandblast building. Various types of materials and equipment were stripped and painted in this building, and paints containing metallic and organometallic constituents were used. Painting operations at the Bonneville Dam complex involved the use of a minimal amount of paint containing antifouling agents. This type of paint was used only on the bottoms of small boats. Application of lead-based paints has reportedly not occurred at the dam complex since the early 1980s.

Based on the investigations to date, the COIs identified for the Sandblast Area are presented and described in Section 5.3.

Hazardous Waste Storage Area

Hazardous waste generated at the Bonneville Dam complex is currently stored at the hazardous waste temporary storage area located approximately 50 feet southeast of the sandblast building (Figure 5-2). This storage area consists of an approximately 2,000-square-foot concrete pad that is partially covered with a steel-framed canopy. An approximately 100-square-foot enclosed volatile materials storage building is located on the western edge of the storage pad. Approximately 100 55-gallon steel drums of hazardous and nonhazardous waste were observed in the storage area during a previous site reconnaissance. Investigations in the storage area vicinity have identified a localized VOC plume in soil and groundwater.

The current hazardous material storage area was constructed in the early 1990s. Prior to its construction, hazardous materials were stored on a pad located approximately 175 feet to the south (see Section 5.3). An approximately 300-gallon aboveground storage tank (AST) was formerly located on the current hazardous material storage area pad in the location of the volatile materials storage building. Waste paints were temporarily stored in this AST until the fall of 1992, when the tank was cleaned and recycled. Six drums of paint were disposed of as hazardous waste in 1992 under contract 92-F-0340.

Transformer Release

In 1995, a rehabilitation project for 19 transformers from Powerhouse No. 1 was conducted. The rehabilitation work was conducted on the paved area located approximately 40 feet east of the sandblast building. During the project, on November 22, 1995, PCB-contaminated oil was released from three transformers. At the time of the release, the transformers were located approximately 50 to 75 feet east of the sandblast building. The release is documented in the December 6, 1995, *Spill Emergency – After Action Report* prepared by USACE for DEQ. An estimated one quart of PCB-contaminated oil was released and spread northward by stormwater runoff. Runoff from the area is captured by a storm drain system and conveyed to the Columbia River by underground pipes. At the time of the release, a sheen of oil was observed on the Columbia River below the outfall. The release was contained using booms placed on the upland areas of the release and below the storm drain outfall in the river.

5.1.2.3 Pistol Range

The USACE used the Pistol Range for small arms target practice from the late 1950s to the late 1960s or early 1970s. No other land use associated with the Pistol Range is known. Based on the historical land use of the Pistol Range, the potential exists for soil to be impacted with metals associated with firing range activities. The areas potentially impacted by this land use are expected to be localized in areas immediately adjacent to the firing shed, backstop, and areas downgradient of the shed and backstop, where surface water runoff could have transported and deposited contaminants.

Based on the investigations to date, the COIs identified for the Pistol Range Area are presented and described in Section 5.3.

5.1.2.4 Bulb Slope

The Bulb Slope is a fan-shaped accumulation of glass and electrical light bulb debris that extends across approximately 1,900 square feet of a steep slope between the Columbia River and the Landfill access road. The debris is concentrated in the center of the slope.

The types of glass observed included internal/external lightbulbs, fluorescent lightbulbs, automobile lightbulbs, 1- to 1.5-inch-diameter glass tubes, clear window pane glass, white-colored molded glass (possibly lamppost light covers), and miscellaneous glass beverage containers. The source of impacts along the Bulb Slope is the discarded lightbulbs.

Based on the investigations to date, the COIs identified for the Bulb Slope are presented and described in Section 5.3.

5.1.3 Release Mechanisms and Transport Media

Given the physical characteristics of the site described above, the following mechanisms may transport site contaminants:

- Volatilization of contaminants in soil to air, or dust generation and release of contaminants in particulate form to air.
- Soil erosion to surface water.
- Overland runoff of contaminants in soil to surface water.
- Leaching and infiltration of contaminants from soil or trash pits to groundwater.
- Discharge of contaminants in groundwater to surface water (via seeps).
- Sorption of surface water contaminants to sediments.

5.1.4 Exposure Media

The exposure media for the Upland OU include:

- Surface (0 to 3 feet bgs) and subsurface (0 to 10 feet bgs) soil
- Shallow groundwater
- Indoor air

When COIs present in the exposure media come in contact with human or ecological receptors, a complete exposure pathway is created. An exposure pathway is considered complete when, and only when, the following components are present:

- A source of contamination (e.g., waste disposed in Landfill)
- A mechanism of release and transport pathway to an affected medium (spills and leaks to soil)
- A receptor (e.g., excavation worker)
- An exposure route (e.g., ingestion, dermal contact with soil)

When any of these elements is missing, the pathway is considered incomplete. By definition, there is no risk where there is no complete pathway.

A schematic representation of complete and incomplete exposure pathways for a site is called an exposure-based CSM. CSMs for the Upland OU for human and ecological exposures are described in detail and presented in Figure B-1 in Appendix B and Figure C-1 in Appendix C, respectively. Potentially exposed human receptors and exposure routes were identified based on current and likely future land use. They consist mainly of people who work at Bradford Island and occasional visitors. Potentially exposed ecological receptors were identified based on habitats present in the Upland OU and include the terrestrial plant and invertebrate communities as well as avian and mammalian populations residing or foraging on Bradford Island.

When an exposure pathway is considered complete, additional characterization of the exposure medium as well as an assessment of the risks associated with that pathway for that receptor may be needed. A risk assessment requires data of the appropriate nature, quality, and quantity to evaluate risks with a sufficient degree of confidence. The remaining sections in the RI Management Plan describe the quality and availability of existing data and the gaps and uncertainties in the existing data. The proposed approach and rationale for additional data collection to fill data gaps and reduce uncertainties are also described. Finally, the plan describes how the data will be used in the delineation of the nature and extent of contamination and in human health and ecological risk assessments, and how the results of the risk assessment will be used to make site-related decisions.

5.2 RIVER OPERABLE UNIT

This section presents the known primary sources of contamination, transport mechanisms, and potential exposure pathways to human and ecological receptors for the River OU.

5.2.1 Physical Setting/Sources

Sources of contamination from both in-water placement of debris and runoff from upland areas on Bradford Island have likely impacted sediments in the nearshore areas of the island. The sources of contamination are listed below and shown in Figure 5-3.

In-Water

- In-water debris (removed in 2002). A detailed description of the debris removed in 2002 is provided in *Technical Memorandum, In-Water Removal Work, Bradford Island Landfill, Cascade Locks, Oregon* (URS 2002e).

Upland

- Electrical transformer release of PCB-containing oil near the sandblast building (URS 2002b).
- Landfill debris disposed of in below-surface pits on the eastern end of Bradford Island. The debris has contaminated nearby surface and subsurface soil and groundwater. However, the Landfill releases do not appear to significantly contribute to sediment impacts.
- Discarded lightbulbs (mostly fluorescent) and other waste was discovered upland of Debris Pile #3 (also referred to as the Bulb Slope). The waste has contaminated nearby soil with low levels of lead, mercury, and PCBs.
- Historical stormwater runoff of contaminated soil and spent sandblast grit in the sandblast building area. The soil and grit is now prevented from migrating through the storm drains into the river by the placement of filter socks in the catch basins. USACE Bonneville Dam project employees replace the socks on a periodic basis.

5.2.2 Release Mechanisms and Transport Media

Upland and in-water sources may contribute to sediment impacts in the Bonneville forebay. Given the source areas described above, the potential transport mechanisms fall into three general categories: overland transport, groundwater transport, and sediment transport.

5.2.2.1 Overland Transport

Surface water may erode and mobilize impacted soil in the Landfill, Bulb Slope, and Sandblast Areas. Surface water may also contain other compounds impacted by miscellaneous operations and activities in the area drained by the outfalls in the Sandblast Area.

Bradford Island Landfill

North of the Landfill, the land surface drops steeply by approximately 30 to 35 feet to the Columbia River. The topography east of the Landfill also drops steeply to the Columbia River. Surface water drainage at the Landfill generally follows the topography as sheet flow, which trends to the north-northwest. Site contaminants in Landfill area surface soil may be transported by overland runoff to the river. However, the comparison of soil and sediment contaminants and concentrations indicates that this contaminant transport mechanism is not significant. A limited investigation of the shoreline soils between the Landfill and the river was completed in April 2007 to determine if source control measures need to be implemented prior to the sediment removal action. The results of this sampling will be used to confirm if the overland transport pathway is complete and requires evaluation in the risk assessment.

Sandblast Area

South of the Landfill and north of the sandblast building the land surface slopes toward the Columbia River. Surface water drainage in the sandblast building vicinity is mostly directed to in one of two ditches ending at two catch basins. Both catch basins contain a ‘sock’ to catch soil that is transported in the surface water drainage. Surface water entering the catch basins drains to the river. Historically, the sediments offshore of the stormwater drains have been impacted through this transport mechanism. This is confirmed by the presence of sandblast grit in the sediment sampled near the drain outfalls. Although concentrations of lead were elevated in the soils and catch basin sediments (as high as 630 mg/kg), lead was only detected in one drain outfall sediment sample above its screening level value (SLV) (Sample S1-43 at 120 mg/kg).

The upland source of phthalates that were detected in the drain outfall area has not been determined.

Pistol Range

The Pistol Range is located on the south side of Bradford Island, adjacent to the First Powerhouse forebay. Based on existing data, lead and zinc detected in surface soils (0 to 2 feet bgs) were at concentrations that may need further evaluation. If the portions of the Pistol Range area that are closest to the shoreline are considered sources of erosion to the river, pathways to aquatic receptors may be complete. Chemicals leaching into groundwater and subsequently discharging to surface water may also constitute a complete pathway. Groundwater was not sampled during the previous investigation.

Bulb Slope Area

The analytical results show that the sediment sample collected nearest to the slope (S1-41) contained the highest concentration of copper detected at the site and one of the highest concentrations of lead. However, the concentrations decrease significantly in the surrounding samples. Given these data, it appears that the impacted soil within the Bulb Slope area (which contains low levels of lead, mercury, and PCBs) does not appear to have affected a large area within the former bounds of Debris Pile #3.

5.2.2.2 Groundwater Transport

Groundwater in the Landfill area flows to the north under both wet season and dry season conditions. Groundwater may discharge directly to the river or through seepage (observed along the north slope of Bradford Island). The comparison of contaminants in the groundwater at the Landfill with sediments indicates that the groundwater-to-sediment pathway is likely insignificant. The significance of transport of contaminated groundwater to surface water is unknown.

Groundwater hydrogeology in the Sandblast Area and Pistol Range has not been characterized. However, the groundwater flow is likely similar to the topography in the area, therefore groundwater from these areas flows either north (Sandblast Area) or south (Pistol Range) toward the river.

5.2.2.3 Sediment Transport

Sediment transport above and below the dam are markedly different and are discussed separately below.

Sediment Transport Above the Dam

Sediment transport above the dam is affected by the variable flow conditions that may be present. This area is affected by several conditions that influence flow velocity and direction including time of year, powerhouse operation, spilling (allowing water to run over the dam's spillway), and navigation lock operation. Sediment also has been moved anthropogenically due to dredging on the south side of Bradford Island. The dredged materials were placed onto Goose Island.

The effects of the dam and powerhouses on flow direction and velocities have been evaluated by the USACE using 3D hydraulic modeling. Potential depositional areas indicated by lower river current velocities are downstream of Picture Rock and offshore of the stormwater drain outfalls under all flow conditions (URS 2003c). Most other areas are considered erosional, in particular given the velocities at the tip of Bradford Island (1 to 3 feet per second) at which a grain size of 2 millimeters (sand) is expected to erode (Boggs 1987).

Sediment transported from the source areas has the potential to move upstream due to an eddy effect when spilling is not occurring. The estimated extent of potential upstream sediment transport is approximately the eastern tip of Goose Island. PCB Aroclors have not been detected in samples collected upstream of Goose Island.

PCB Aroclors were detected in depositional samples taken just upstream of the spillway, indicating that sediment from the former debris piles has been transported downstream to this point. Testing has not been done to determine if source area sediment has been transported through the spillway. PCB Aroclors detected in depositional samples on the south side of

Bradford Island, but not detected in samples near the First Powerhouse, indicate that sediment has been transported around the eastern tip of Bradford Island but has not been transported as far as the powerhouse.

Sediment characteristics also indicate that the eastern/northern area offshore of Bradford Island is erosional with some redeposition in the area offshore of the drain outfalls. Sediment at the former debris piles consists of concentrated areas of fine-grained material located between cobbles and boulders. Sediment from beneath the outfalls and near Goose Island is medium sand, with some fines.

Sediment Transport Below the Dam

The Columbia River below Bonneville Dam is classified as a lowland river with a low gradient approaching 0.001 percent. The river stage is affected by tidal impacts from the mouth up to the tailrace of the Bonneville Project, and flow reversals have been detected as far upstream as RM 95 (Tetra Tech 1992). Although major flow reversals are not expected upstream of RM 72 recent studies have indicated that localized flow reversals are present and may be important to sediment transport and deposition (Battelle 1999). Since 2004, the daily mean discharge below the dam has ranged from 70,000 cfs in August 2005, to 410,000 cfs in May 2006 (USGS 2007).

Downstream of the dam, the geomorphology of the lower Columbia River has been characterized as a straight alluvial channel with numerous midchannel bars and islands. Most of the bank material immediately downstream of the dam is silty sand and is susceptible to bank erosion, while the riverbed is mostly gravel and basaltic rock. Due to the high velocities associated with the dam, there are not many areas of sediment deposition near the tailrace of the spillway or the powerhouses. These conditions, coupled with virtual elimination of natural sediment load replenishment from upstream of Bonneville Dam, have resulted in an increased rate of bank erosion (Tetra Tech 1992).

The area downstream of the dam has been investigated by the USACE and others to assess the impact of dissolved gas generated from the dam on ESA-listed species. This information includes bathymetry and flow velocity measurements. This information, along with the above geomorphic discussion, can be used to assess where relative flow velocities differ, thereby suggesting a sediment depositional area. Assuming that sediment that may have been impacted from Bradford Island moved though the spillway or the First Powerhouse; the following areas show relatively low velocities over a range of flow conditions:

1. Upstream of the confluence of the old lock and the main river
2. Upstream of the confluence of the new lock and the main river
3. Directly across the river from the downstream end of Cascade Island on the Washington shore
4. The area between Hamilton Island and Ives Island
5. The south side of Pierce Island
6. A deeper portion of the river around RM 140.

These areas are shown on Figure 5-4. It does not appear that appreciable amounts of sediment from upstream would be deposited in the area north of Pierce and Ives Islands (at the mouth of

Hamilton and Hardy Creeks). This is because the river velocities between Hamilton Island and Ives Island are lower and the riverbed elevation is higher, thereby preventing sediment migration.

5.2.2.4 PCB Aroclor 1254 Transport and Fate

A more detailed analysis of sediment characteristics and corresponding locations/concentrations of PCB Aroclor 1254 was conducted, since Aroclor 1254 is considered the site human health and ecological risk “driver.” Transport by possible receptors was not considered in this analysis.

Source Area

The highest concentrations of Aroclor 1254 are in the former Debris Pile #1 area where river velocities are also highest. Aroclor 1254 is detected throughout the source area, including the drain outfall area for which an upland source for this contaminant does not exist. However, there was historically an upland source of Aroclor 1260 due to a release of transformer oil in 1995 near the sandblast building (URS 2003c). Although both Aroclor 1254 and 1260 are detected in the drain outfall area, Aroclor 1260 was not detected in the “S2” or transect samples collected within the drain outfall area.

Percent fines also increase west of former Debris Pile #1, indicating that Aroclor 1254 is likely being transported from Debris Pile #1 (the source area with the most elevated concentrations) west to the redeposition zone in the drain outfall area.

Depositional Areas – Dam Forebay

Percent fines are highest in the sample locations modeled at lower relative velocities indicating that these areas are, in fact, redeposition areas (e.g., percent fines in the range of 20 to 80 percent). Total organic carbon results are at or near 1 percent for these samples. In the forebay area, Aroclor 1254 was detected at a very low level in two samples (DP-121 at 1.5 µg/kg and DP-129 at 2.9 µg/kg).

Depositional Areas – First Powerhouse Forebay

Aroclor 1254 was detected south of Bradford Island along the shore in an area characterized by three samples (SE-117, DP-124, and a sample collected by the USACE in 2002 [BF-BC-07]). All three of these locations were inferred to be depositional areas based on the results of the river velocity modeling. As a result, this suggests that PCBs are likely transported from former Debris Pile #1 and redeposited in the First Powerhouse forebay. The nondetects west near the First Powerhouse (in areas modeled to be depositional and exhibiting high percent fines) indicate that the contaminant is not being transported further west.

Goose Island

Aroclor 1254 was detected during a previous investigation in one sediment sample at the west tip of Goose Island, and crayfish tissue analyzed from this location also exhibited Aroclor 1254 concentrations (URS 2002b). Hydraulic modeling indicated that during some operational scenarios, sediment from former Debris Pile #1 could be transported upstream as far as Goose

Island. Goose Island upland soil samples analyzed for PCBs were nondetect, indicating that upland soil is not a source for this contaminant; therefore, the most likely source for the PCBs detected near Goose Island is the former debris piles.

Water Column

SPMDs were deployed during a 2001 investigation prior to the equipment removal to simulate passive diffusion of contaminants from wastes into the water column. PCBs were not detected at an estimated reporting limit of 0.2 nanogram per liter (ng/L) (URS 2002b). This is below the USEPA ambient water quality criteria of 14 ng/L (USEPA 2006).

Water column samples were collected between April 3 and 9, 2006, to support the design analysis for the sediment removal action (USACE and URS 2006). Surface water and sediment samples were collected from within the area where the removal action will occur. One surface water sample was also collected as a river background location upstream of Goose Island and outside of the potential backwater influence of Bonneville Dam. Water was collected by both grab surface water sampling and high-volume surface water sampling. The surface water samples were analyzed for total and dissolved metals (copper and lead), PCB Aroclors, total suspended solids, and total and dissolved organic carbon.

The data show similar concentrations of total copper, total lead, turbidity, and TSS for both the background sample collected upstream of Goose Island and the sample collected within the area of the former debris piles. Similarly, the high-volume surface water data show comparable results for Goose Island and former debris pile samples for PAHs and for PCB Aroclors, with the exception of slightly higher concentrations of Aroclor 1254 near the former debris piles.

While the PCB Aroclor data for the grab water samples were nondetect, the high-volume surface water sampling analysis technique detected picogram levels of PCB congeners in the river water.

5.2.2.5 Summary

The results indicate that the source of PCBs in the sediment was the debris formerly in Debris Piles #1 through #3. Although the sediment at the piles is generally coarser and has less TOC than the surrounding areas, the highest concentrations of PCBs in sediments are found within the limits of the former piles and within the area identified for the sediment removal action. The PCB-impacted sediment has migrated downstream as far as the dam spillway and the south side of Bradford Island. Several areas where sediment may be deposited downstream of the dam have been identified and will be sampled during implementation of this RI. In water column sampling conducted in 2006, PCBs were detected in the water column at a reference site but do not appear to be migrating through the water column at appreciable levels.

5.2.3 Exposure Media

The exposure media in the River OU include:

- Sediment
- Surface water

The highest beneficial uses of surface water in the River OU are aquatic habitat, recreational fishing, and subsistence fishing. Figure B-2 in Appendix B and Figure C-2 in Appendix C provide illustrations and discussions of the exposure-based CSMs for human and ecological receptors, respectively.

Potentially exposed human receptors were identified based on designated beneficial uses for the River OU. No changes in use are anticipated between current and future conditions with respect to beneficial uses. The primary human receptors are a variety of anglers (tribal, nontribal, recreational) who may consume fish from the River OU and, secondarily, recreationists who may engage in contact activities such as swimming and wading near Goose Island and Eagle Creek.

Potentially exposed ecological receptors were identified on the basis of beneficial uses as well as habitats present in the River OU. Ecological receptors identified include the sediment-associated benthic community; water-column associated aquatic community (plankton, invertebrates, fish); and avian and mammalian wildlife that may feed on benthic or water-column resources. The River OU supports a variety of ESA-listed and nonlisted anadromous and resident fish species that are of value to anglers and wildlife.

The primary source of site-related exposure for both human and ecological receptors associated with the River OU is through food-web transport of bioaccumulative COIs (i.e., PCBs). Anadromous fish have the potential to be present in the Bonneville Dam Forebay at some stage of their migration but are not expected to remain in the Bradford Island vicinity for extended periods (URS 2000). Resident fish species (e.g., walleye and bass) are likely to forage in the Bonneville Dam Forebay adjacent to Bradford Island. Note that the potential or actual concentrations of bioaccumulative chemicals that may have been transported from the Landfill into the river are expected to be small given the relatively small source volume, the volume of the river, and the migratory nature of the most popular sport fishing species.

5.3 CONTAMINANTS OF INTEREST

This section describes the process used to identify COIs in environmental media for which potentially complete exposure pathways are present and data are currently available. A discussion of how the lists of COIs for the relevant media in each OU will support the RI is also included.

5.3.1 Selection Approach

According to DEQ guidance (2000a), COIs are chemicals that are present or may be present at a site based on historical information or analytical data. COIs may be subjected to a screening process to identify those chemicals potentially associated with an unacceptable risk to human receptors (COPCs) or ecological receptors (CPECs).

An abundance of environmental data have been collected from the Upland and River OUs during several investigations over the past 10 years (Section 4). Although it is premature to identify COPCs (or CPECs) prior to the upcoming data collection effort and combining of new and existing data sets, the focused list of COIs developed for each medium and OU will be used to identify data gaps and facilitate sampling efforts in this RI Management Plan and forthcoming QAPPs. The list of COPCs will be further refined for purposes of the human health and ecological risk assessments, as described in Appendices B and C.

The following steps comprise DEQ's general screening criteria to identify COPCs (DEQ 2000a, 2001b, 2003). COIs for which any of these criteria are met need not be retained as COPCs:

1. COIs detected at less than a 5 percent detection frequency, assuming adequate nature and extent delineation and acceptable reporting limits (i.e., below benchmarks protective of human and ecological receptors);
2. Inorganic COIs with maximum detected concentrations below naturally occurring levels that are either site-specific or derived from regional concentrations;
3. COIs that are below toxicity-based criteria established for human and ecological receptors based on exposure to individual COIs, as well as cumulative exposure to all COIs and all possible media available to a given receptor.

Although these criteria may be met, a COI may be retained as a COPC under the following two circumstances:

1. COIs that are detected at least once and are bioaccumulative require further investigation for their potential to impact humans (under appropriate exposure scenarios) and upper-trophic-level ecological receptors through the dietary pathway (if a bioaccumulation-based benchmark is not available);
2. COIs that lack toxicity-based criteria (e.g., PRGs or SLVs) require further consideration, such as a qualitative assessment of risk.

The objectives for screening the existing data to identify COIs were as follows:

- To identify data gaps in characterization of soil and groundwater for the Upland AOPCs;
- To identify data gaps in characterization of sediment and surface water for the River OU;
- To focus data collection efforts for evaluation of the potential for transport of chemicals from soil or groundwater to sediment or surface water of the River OU; and
- To focus data collection for evaluation of the potential for transport of chemicals from sediments of the Forebay to areas further downstream of the Dam.

The first two steps of the COPC selection process were performed for all media associated with each OU, including the individual AOPCs of the Upland OU for which data are currently available. Since not all of the steps to select COPCs were completed, the term COI will be used to represent the chemicals that fail the first two steps of the screening process. In addition to the first two steps, an initial toxicity screening was performed for soil and sediment as one line of evidence to identify COIs in the media that may require further investigation for their migration potential. The results of the toxicity screening are one element considered in the development of COIs that warrant further investigation for their migration potential. Other lines of evidence, including spatial trends in the COI concentrations (e.g., near the river shoreline), were also considered.

The following sections present a more detailed description of the methods used to screen analytical data in the development of COIs specific to each OU.

5.3.2 Upland Contaminants of Interest

Based on the presence of potentially complete exposure pathways and associated analytical data, COIs in the Upland OU were identified for the following media:

- Soil and groundwater of the Bradford Island Landfill
- Soil and groundwater of the Sandblast Area
- Soil of the Pistol Range
- Soil of the Bulb Slope

5.3.2.1 Soil

This section describes COIs identified for soils in the Upland AOPCs and COIs in soil that may have the potential for overland transport to the River.

COIs in Soil at Upland AOPCs

Tables 5-1 through 5-4 present the COIs for in-place soils at each of the Upland AOPCs and their associated summary statistics (i.e., sample size, detection frequency, and minimum and maximum detected concentrations). These represent COIs in soils collected from 0 to 10 feet bgs that were detected in 5 percent of available samples or more and with a maximum detected concentration above background (inorganics only), but have not been evaluated with regard to the toxicity screening. Inorganics with maximum concentrations above the Regional 90^{th} percentile values developed for Clark County (Ecology 1994) were retained as COIs. It should be noted that a site-specific soil background dataset will be obtained through sampling efforts performed as part of the RI, which will then be used to identify COIs for the RI and associated risk assessments.

Soil COIs with Potential for Migration

The COIs identified in Tables 5-1 through 5-4 were further evaluated in terms of their migration potential, as described above. Similar to the approach used in the Portland Harbor Joint Source Control Strategy (DEQ 2005), the COIs in soil were screened against risk-based concentrations in sediment protective of human and ecological receptors (DEQ 2001a, 2007b). Tables 5-5 through 5-8 present the subset of COIs in the in-place soil that are considered potentially migratory to the River OU and the screening process used to identify these COIs. First, maximum detected concentrations of COIs in soil collected from 0 to 1 foot bgs, i.e., the depth interval at which erosion was assumed to be possible, were compared to the lowest sediment screening level available. Then, a spatial evaluation of the data for each COI was performed to identify the distance it was detected from the river. In the final step, it was determined if the potentially migratory COI has already been detected in sediment of the river.

In general, the COIs identified for in-place soil that were demonstrated to be present in sediment at concentrations above sediment screening levels, in close proximity to the source areas along the shore of Bradford Island (e.g., former debris piles, drain outfall area), were identified for further investigation in terms of the overland runoff pathway to the river. However, several COIs were identified as warranting further investigation even if only one or two of these criteria were met. Figure 5-5 is a flow chart illustrating the stepwise process used to select soil COIs that may contribute to contamination of the River OU. An effort was made to err on the conservative side at each decision point, such that only those COIs for in-place soil indicating little evidence of migration to the river were dismissed as COIs potentially associated with this transport pathway. The COIs for which no SLVs are available but were detected at the shoreline ***or*** in forebay sediment were identified as candidates for a qualitative analysis in the uncertainties section of the risk assessment.

Evaluation of the overland runoff pathway for VOCs detected in soil of the Landfill and Sandblast Area was limited to those VOCs for which sediment SLVs were presented in the Portland Harbor Joint Source Control Strategy report (DEQ 2005), i.e., trichloroethene (TCE) and PCE. No DEQ Level II SLVs protective of a freshwater benthic community are available for the detected VOCs, and the actual potential for these chemicals to erode into the river is expected to be low given their low persistence in surface soil, sediment, and surface water. The sediment SLVs for these two VOCs are drawn from the USEPA Sediment Quality Advisory Levels (Macdonald et al. 1999).

5.3.2.2 Groundwater

Tables 5-9 and 5-10 present the COIs for groundwater of the Landfill and Sandblast Area, respectively, and their associated summary statistics. Due to the small number of samples, the COI list for groundwater was not screened based on detection frequency (sample size was generally less than 20). In the absence of a background data set for groundwater, no detected inorganics were eliminated. Based on the constraints of the groundwater data evaluation, all detected analytes were retained as COIs. In addition, a toxicity screening was performed under the assumption that groundwater at the Landfill and Sandblast Area represent hypothetical potable water supply sources. The COIs in groundwater for which the maximum detected concentration is above the USEPA Region 9 PRGs for tap water (2004a) were retained as COIs. These COIs will be included in the analyte list for surface water sampling and will be evaluated further for direct contact exposures in surface water, as part of the groundwater-to-surface water discharge pathway.

Because the USEPA Region 9 PRGs are no longer being updated regularly, DEQ now recommends that human health-based screening values be selected from DEQ's risk-based concentrations (DEQ 2007a), when available, or screening values from USEPA Region 6 (USEPA 2007a). Screening values for soil and groundwater will be drawn from these sources for comparisons in the future.

5.3.3 River Contaminants of Interest

Based on the presence of potentially complete exposure pathways and associated analytical data, COIs in the River OU were identified for sediment and surface water of the forebay. The list of COIs for the river will be refined subsequent to the additional sampling of sediment, tissue, and surface water that will be performed as part of the RI. The concern that polychlorinated dioxins and furans may be present in the sediment due to fires associated with the disposal of the capacitors (electrical equipment removed from river) was investigated during earlier sampling. No dioxins or furans were detected in the four samples analyzed from within the former debris piles. Therefore, polychlorinated dioxins and furans will not be investigated as part of the RI.

5.3.3.1 Sediment

Table 5-11 presents the COIs and their associated summary statistics for sediment of the Bonneville Dam Forebay. These represent COIs in sediment that were detected in 5 percent of available samples or more and with a maximum detected concentration above upstream reference concentrations (inorganics only), but were evaluated with regard to the toxicity screening. Note that the reference data set will be revised upon development of a more robust reference data set subsequent to the upstream sample collection that will occur as part of the RI.

The COIs identified in Table 5-11 were further evaluated in terms of their migration potential, as described above (Section 5.3.1). The COIs in forebay sediment were screened against risk-based concentrations in sediment protective of human and ecological receptors (DEQ 2001a, 2007a). Table 5-12 presents the subset of COIs in forebay sediment that are considered to have the potential to migrate further downstream of the Forebay and the screening process used to identify these COIs. First, maximum detected concentrations of COIs in sediment collected from the forebay were compared to the lowest sediment screening level available. Then, a spatial evaluation of the data for each COI was performed to examine the distribution of its concentrations in the forebay and distance it was detected from the Bradford Island shoreline.

The COIs identified in forebay sediment were further investigated for downstream migration potential if the COIs were demonstrated to be present at concentrations above sediment screening levels and with spatial trends that indicated widespread distribution through the forebay area, or for which the extent did not appear to be defined. The COIs for which no SLVs are available but were detected in forebay sediment included aluminum, barium, beryllium, thallium, and vanadium. Among these, aluminum and barium are generally considered to have low potential for toxicity. Maximum concentrations of aluminum and barium were only slightly above reference levels. They were identified as candidates for a qualitative analysis in the uncertainties section of the risk assessment. Beryllium, thallium and vanadium were referenced due to the lack of screening levels. The COIs selected for downstream sediment include arsenic, cadmium, cobalt, copper, mercury, thallium, vanadium, zinc, beryllium, Aroclor 1254, Aroclor 1260, TPH. The COIs not selected are shown in Table 5-12 along with figures illustrating spatial trends of decreasing concentrations away from the island (Figures 5-6 through 5-13). The Stage 2 report (URS 2004c) contains figures for the remaining COIs not selected for downstream analysis.

5.3.3.2 Surface Water

Table 5-13 presents the list of COIs in surface water. Similar to groundwater, small sample size and lack of background data for inorganics precludes the first two steps of the COPC selection process described in Section 5.3.1. To gain perspective on the levels of contaminants measured in surface water of the river, maximum detected concentrations were compared to toxicity-based criteria represented by the lowest of the available DEQ Water Quality Criteria (OAR) 340-041, Tables 33A, 33B, and 33C). The COIs in surface water for which the maximum detected concentration is above the lowest WQC were retained as COIs. These COIs will be included in the analyte list of surface water sampling in the RI.

This section presents the management approach and an overview of the RI/FS process up to obtaining a ROD for the Bradford Island site. The section describes the steps in the RI/FS process, the objectives for the Bradford Island RI/FS, the technical approach, the regulatory requirements, the process for identifying areas of potential concern, and the milestones to be reached. Figure 6-1 depicts the projected milestones and their interdependanices.

6.1 GENERAL APPROACH

The RI/FS process, as defined in USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988), involves the following steps: scoping, site characterization, development and screening of remedial alternatives, treatability investigations, and detailed analysis of remedial alternatives. These steps address the requirements of CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA), and modified by the OAR 340-122-0010 through 340-122-0115.

According to USEPA guidance (USEPA 2005), the general objectives of the RI portion of an RI/FS are to:

- Characterize site conditions
- Determine the nature of the waste
- Assess risk to human health and the environment
- Conduct treatability testing to evaluate the potential performance and cost of the treatment technologies that are being considered

The objective of the FS portion of an RI/FS is to present the development, screening, and detailed evaluation of remedial alternatives. RAOs will be developed for the FS and alternatives will be developed to meet the RAOs. Alternatives will be screened against the three primary criteria of effectiveness, cost, and feasibility, followed by a detailed evaluation of alternatives against the nine CERCLA evaluation criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The results of the RI/FS will be evaluated in the remedy selection stage, which is chiefly a risk management decision that balances the acceptable range of values for protectiveness with costs and other important considerations that bear on the acceptability of the action. The preferred alternative will be presented in a Proposed Plan, which will be made available for public comment. Once the public has had an opportunity to comment on the Proposed Plan, the USACE will select a remedy.

The selected remedy will address specific objectives developed by DEQ for an RI/FS (DEQ 2002), including:

- Identify the hazardous substances that have been released to the environment
- Determine the nature, extent, and distribution of hazardous substances in affected media
- Determine the direction and rate of migration of hazardous substances
- Identify migration pathways and receptors
- Determine the risk to human health and the environment
- Develop the information necessary to identify and evaluate potential Interim Removal Measures
- Develop the information necessary to evaluate remedial action alternatives and select a remedial action
- Generate or use data of sufficient quality for site characterization, risk assessment, and the subsequent analysis and selection of remedial alternatives

This RI Management Plan functions as the umbrella document under which the above work will be conducted. As the project progresses and new information is introduced, any changes to this RI Management Plan will be documented in an appropriate plan or report.

6.2 INVESTIGATION GOALS AND OBJECTIVES

The specific objectives for the Bradford Island RI/FS are:

- Identify source areas
- Identify nature and extent of contamination in the upland and in-water areas
- Identify current on-site upland source contribution to sediment contamination
- Identify the contribution of off-site sources to sediment contamination
- Collect data necessary to evaluate potential cleanup alternatives, both in the upland and off-shore areas
- Develop RAOs
- Evaluate and rank potential cleanup alternatives

To most efficiently meet these objectives, the project area has been divided into two operable units based on media affected and geographical area: the Upland OU and the River OU.

Within the Upland OU, a number of source areas of contamination are known to exist. The sources and source areas have been operationally grouped into AOPCs, based on similar anticipated actions or conceptual processes. Each AOPC will be evaluated individually for risk to human health and ecological receptors. Where the same receptor may be exposed to multiple

AOPCs or there is transfer of COIs from one OU to another, the risk assessments will include consideration of expanded exposure areas or inter-operable unit pathways.

The locations of the OUs and AOPCs for the site are shown on Figure 5-1.

6.2.1 Upland Operable Unit

As presented in Section 4, a significant amount of investigation and risk assessment work has been completed for the AOPCs in the Upland OU.

The AOPCs for the Upland OU are:

- Landfill
- Sandblast area
- Pistol range
- Bulb slope

The Upland OU and AOPCs are defined based on existing sampling information. The objectives for additional work in the Upland OU are:

- Plan for and collect data for the RI/FS.
- Complete the RI/FS.
- Develop the Proposed Plan for Upland OU and make the Plan available to the public.
- Develop the ROD for the Upland OU (as part of the overall ROD for the entire site) incorporating comments on Proposed Plan.
- Develop remedial design.
  - Implement cleanup actions and long-term monitoring requirements.
  - Close out site.

6.2.2 River Operable Unit

The River OU has a single AOPC: water and sediment in the forebay of the dam (Figure 5-1). However, the water and sediment downstream of the dam may be included within the River OU as information is gathered and assessed during the RI. Furthermore, a reference area has been selected to provide background concentrations. Figure 6-2 depicts the downstream and reference areas relative to the forebay.

A removal action of hot spots of contaminated sediment is currently in the planning phase and is scheduled to occur between October 1, 2007, and March 1, 2008. The details of the sediment removal are discussed in the *Engineering Evaluation and Cost Analysis, Bradford Island Disposal Site* (URS 2005).

The QAPP for the River OU is being developed concurrently with this RI Management Plan and will be implemented prior to the removal action. Additional details of the staged analysis approach for the River OU, is provided in the QAPP. The data collected as part of this work will characterize the forebay, including the sediment removal area. The benthos tissue data and sediment data in particular will populate a trophic model that relates the two with adequate confidence. The model will support a baseline risk assessment that characterizes conditions after the interim removal action. The area proposed for interim removal will be characterized prior to removal. The removal area will be characterized again, after removal, as part of the characterization of the forebay and the reference areas.

The objectives for additional work to be completed in the River OU are:

- Collect benthic, fish tissue, and sediment data to populate a trophic model that will support a baseline risk assessment documenting conditions after the removal. The model also will enable predictions of steady-state conditions following removal.
- Perform and document the removal action (not part of the RI).
- Determine the post-removal baseline risk estimate using the trophic model as well as measured tissue data.
- Evaluate if additional sediment and benthos data are necessary to reduce uncertainty of risk estimates.
- Collect remaining data if necessary and/or complete RI/FS.

In accordance with current approaches to PCB contamination, the data collection efforts will include analyses of sediment, clam tissue, and crayfish tissue samples for Aroclors, with a subset of samples in each medium (minimum of 8 samples) analyzed for the 209 PCB congeners. Tissue data for the higher trophic levels (sculpin, smallmouth bass, and crayfish) will be analyzed for congeners, with a subset also analyzed for Aroclors. Surface water samples will be analyized for both Aroclors and congeners. Each RI task will use the Aroclor and congener data as appropriate for that task. Site characterization and delineation of the nature and extent of contamination will use both the Aroclor and congener data.

If possible, functional relationships between Aroclor and congener concentrations will be developed. The use of such relationships may assist in the development of Aroclor-based, as well as congener-based, remediation goals, with resulting time and cost effectiveness, as described below and also described in Appendices B and C.

Total PCBs as congeners are generally considered to provide a more accurate measure of the total amount of weathered Aroclor mixture in a given sample, than is an Aroclor-specific analysis. Laboratory results are typically available for Aroclor analyses in approximately four weeks, while congener analyses on average take eight to ten weeks. In addition, the cost of congener analysis is greater than that of Aroclor analysis.

Paired samples for each medium (e.g., sediment, water tissue by species), analyzed for both Aroclor and congeners, can be used to evaluate correlations between Aroclor and congener data. A reasonable strength of correlation between these two estimators may possibly enable a regression estimator to be applied to enhance interpretation of the much more spatially and temporally comprehensive Aroclor data. The stronger the correlation and model fit, the stronger the confidence in predictions using this correlation. Regression estimators for sampling data are described in Cochran (1977).

The summed concentrations for Total PCBs as congeners, based only on the limited number of samples having congener results, may not directly provide an adequate estimation of the exposure concentration representative of a particular spatial area. If appropriate, as indicated by the strength of correlation, a regression estimator may allow estimation of an exposure concentration for Total PCBs that utilizes the more spatially representative Aroclor data and yet results in a Total PCBs that has been appropriately adjusted to reflect what would have been attained from a more detailed sampling and analysis of congeners in this area. The strengths and weaknesses of using data for all 209 congeners or data from a reduced set of congeners are discussed in Sather et al. (2001, 2003).

The same reasoning applies to the potential correlation between TEQ summations (for dioxin-like PCB congeners) and Total PCBs terms. TEQ summations may be used directly to characterize exposure concentration in environmental media, or indirectly via their regression relationship to other summation terms. Again, the advantage of a regression estimator is that Aroclor results are generally more abundant and may more accurately represent the observed spatial or temporal variation for a given medium and study area, than the congener data itself.

Thus, all paired samples (i.e., those samples analyzed for both Aroclors and congeners), will be statistically analyzed to assess the strength of correlation between each of the three types of PCB summations for each environmental medium. Appropriate statistical error models will be evaluated and documented as to the rationale for a final choice. This general approach has been used most recently to identify functional relationships between Aroclor and congener data collected for two PCB-contaminated sediment sites in the Pacific Northwest: Portland Harbor (Lower Willamette Group 2007) and Lower Duwamish Waterway [Windward Environmental 2005]). Although the habitat types between these projects and the Upland portion of the site are notably different, the statistical procedures and ultimate goal of the statistical evaluation are the same. Some examples are provided below to offer some perspective on the range of coefficients of determination (R^2) that have been considered adequate for identifying a reliable relationship between Aroclor and congener data:

> Total PCBs (as Aroclors) and congeners (as PCB toxicity equivalent quotients [TEQs]) were highly correlated in sediment analyses ($R^2 = 0.96$) and in tissue analyses ($R^2 = 0.95$) (Windward Environmental 2005).
>
> Strong correlations were also found in sediment Aroclor and congener data in Portland Harbor (Surface sediment $R^2 = 0.62$, Subsurface sediment $R^2 = 0.85$) (Lower Willamette Group 2007).

There is no known state or federal guidance document that provides a range of R^2 that are deemed acceptable for denoting a significant functional relationship between variables associated with environmental data. In general, correlations (or “r”) greater than 0.8 ($R^2 = 0.64$) are described as strong, and correlations less than 0.5 ($R^2 = 0.25$) are described as weak.

The following regressions are anticipated to test for functional relationships between Aroclor and PCB congener concentrations measured in the River OU media:

Regression Groups: 1, and 2: Total PCBs as congeners versus Total PCBs as Aroclors for each of three abiotic media: sediment and surface water. The data sets will also be investigated for differences in relationship for different study areas (upstream and Forebay), and combined to produce a single medium-specific model if appropriate. Strength of correlation, significance of model, and influence of any outliers will be discussed, as well as alternate statistical error assumptions for the variables.

Regression Groups 3 and 4: PCB TEQ versus Total PCBs as Aroclors for each of the media, as described above.

Tissue Regression Groups: The site tissue data will allow correlations to be evaluated between Total PCBs as Aroclors, Total PCBs as congeners, PCB TEQ, and potentially a subset of dominant individual congeners, if they are of interest. These regression studies may enhance interpretation of the tissue data used for estimating biota uptake factors for some biota groups. The characterization of biota uptake also applies literature values and other risk assessment modeling practice, and is addressed further in Appendix C.

One of the main reasons for performing these regression analyses is to potentially improve risk estimations in cases where Aroclor-analyzed samples provide better spatial representation than congener-analyzed samples. Perhaps even more importantly, once remediation activities begin, Aroclor analysis will provide a considerably more feasible and timely process for obtaining verification sample results as phased cleanup activities progress. If Aroclor results can be reliably correlated with congener results, then any future sample collection and analysis related to remediation may be limited to faster and less expensive Aroclor analysis."

The rationale for how archived tissue samples were selected for additional Aroclor analysis will be communicated in a memorandum.

The human and ecological risk assessments will use the congener data to estimate food-web-related risks and may use both the Aroclor and/or congener data to estimate risks by direct contact. Development of sediment remediation goals, if necessary, will be based on Aroclors, if a reliable predictive relationship can be established between Aroclor and congener distributions in sediment. More detailed discussion of these data uses is presented in Appendices B and C.

6.3 GENERAL RISK ASSESSMENT APPROACH

This section provides an overview of how the human health and ecological risk assessment for the Upland and River OUs will be used to meet the decision-making and site management goals of the RI process. It describes how the findings and conclusions will be incorporated into the overall characterization and decision-making process for the multiple AOPCs and OUs at the site.

This section, therefore, does not include the technical details of the methodology for the risk assessment. Detailed descriptions of the technical approach for the risk assessment are provided in Appendices B and C as the Human Health and Ecological Risk Assessment Work Plans, respectively.

The purpose of a baseline risk assessment is to provide site decision makers with an understanding of the actual and potential risks to human health and the environment posed by site contamination in the absence of any remedial action. A risk assessment also can be used to propose cleanup levels that will adequately protect public health and the environment, and to document uncertainty associated with the assessment. The information from the assessment is then used to determine whether remedial action is warranted and to evaluate the protectiveness of remedial alternatives. Baseline for this risk assessment is defined as existing conditions in the Upland OU and post-removal action conditions (i.e., interim removal action planned for late 2007) for the River OU.

Some of the AOPCs have already undergone some risk evaluation while risk assessments are yet to be initiated at other AOPCs. Table 6-1 provides a summary of the status of risk evaluations for each AOPC and OU.

USACE has identified management goals for the Upland and River OUs that are described later in this section. The objectives of the risk assessment for each OU will be to evaluate risks in a manner that supports the management goals and is in agreement with established regulatory guidance and approaches.

6.3.1 Regulatory Framework and Guidance

To achieve the objectives mentioned above, the methodology for the baseline HHRA and ecological risk assessments (ERA) will be based on USEPA and DEQ guidance (USEPA 1989, 1997a, 1997b; DEQ 2000a, 2000b, 2001a, 2001b, 2007b). DEQ guidance will take precedence with regard to the nature of the risk assessment process and the format and presentation of results. DEQ risk assessment protocols can be found in OAR Section 340-122-0084.

The content of USEPA CERCLA and DEQ guidance for HHRA and ERA is generally similar although minor differences exist in format and organization. DEQ guidance varies from CERCLA guidance in a few areas such as those listed below:

- Formal determinations of beneficial uses of land and water
- Tiered approach to ecological risk assessment
- Screening out of naturally occurring inorganics by comparison with background
- Use of a 90% upper confidence limit (90%UCL) value to represent exposure point concentrations
- Definition of acceptable risk levels, and
- Performance of hot spot evaluations

These issues will be addressed as described below.

For Bradford Island, the HHRA will include an evaluation of current and potential or likely future uses of land and water at the site. However, for purposes of clarity and agency review, formal land and water use determinations may be included as separate attachments in the RI and may not be included in the HHRA.

The ERA process recommended by DEQ guidance consists of a four-tier process: Level I Scoping, Level II Screening, Level III Baseline, and Level IV Field Baseline Assessment. While the content of the DEQ and CERCLA processes are similar, the DEQ process allows for more explicit “off-ramps” at the end of each tier if a site or AOPC is evaluated as not posing a threat to ecological receptors. The DEQ process is particularly appropriate for the Upland OU, where different AOPCs may require different levels of ecological risk assessment.

Site-specific or regional background concentrations of inorganics will be used as one of the factors in determining COPC identification for the Upland and River OUs. The lower of the maximum or 95 percent upper confidence limit (95% UCL) will be used to represent the exposure point concentration (EPC) for the reasonable maximum exposure (RME) estimate for the HHRA and the ERA, using USEPA methodology (USEPA 2002; see Appendix A for the methodology that will be used to calculate the 95% UCLs). This approach is proposed because it is the most recently available and updated guidance representing the currently accepted approach to the appropriate use of statistical methods for estimating the EPC.

To provide flexibility in site management decision-making, the HHRA will identify chemicals, pathways, and receptors for which individual or cumulative risks lie in the following ranges: less than 1E-06, 1E-04 to 1E-06, and greater 1E-04. Non-cancer hazard quotients (HQs) and hazard indices (HIs) will be identified as less than or greater than 1.0. The ERA will identify risks that are lower than an HQ or HI of 1.0, and greater than 1.0.

The site characterization and risk characterization processes will also evaluate spatial trends in chemical distribution in site media and identify localized areas of elevated chemical concentrations. The objective will be to determine if there are areas of higher or lower concentrations present within the overall site boundary. This will be useful in identifying areas that may be targeted for risk reduction in the future. Risk management decisions may then be considered in the FS.

Other approaches that may be appropriate for estimating risks for this site may also be considered. Examples of other approaches are the sediment evaluation guidelines being developed by the Regional Sediment Evaluation Team (2006), the risk assessment being conducted for the Portland Harbor Superfund site (Lower Willamette Group 2004, 2007) and the trophic model approaches developed for the Lower Duwamish Waterway Group (Windward Environmental 2005, 2006). These are described in more detail in Appendices B and C.

In determining need for remedial action, differences exist in acceptable risk levels between CERCLA and State of Oregon guidance. USACE will identify Applicable and Relevant and Appropriate Requirements and To-Be-Considered guidance as well as baseline risks, and will consider USEPA's (1991) OSWER Directive 9355.0-30, by Don Clay, entitled "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," quoted below.

> "Generally, where the baseline risk assessment indicates that a cumulative site risk to an individual using reasonable maximum exposure assumptions for either current or future land use exceeds the 10^{-4} lifetime excess cancer risk end of the risk range, action under CERCLA is generally warranted at the site. For sites where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, action generally is not warranted, but may be warranted if a chemical specific standard that defines acceptable risk is violated or unless there are noncarcinogenic effects or an adverse environmental impact that warrants action. A risk manager may also decide that a lower level of risk to human health is unacceptable and that remedial action is warranted where, for example, there are uncertainties in the risk assessment results. Records of Decision for remedial actions taken at sites posing risks within the 10^{-4} to 10^{-6} risk range must explain why remedial why remedial action is warranted."

The risk assessment will provide estimates of risk for the various pathways and receptors. Interpretation of the estimates and evaluation of whether they represent acceptable risk levels or fall into risk management ranges will be performed in the context of the nature and magnitude of risks, spatial trends in site characterization, and the uncertainties identified in the risk assessment.

6.3.2 Risk Assessment Approach for Upland Operable Unit

The USACE management goals for the Upland OU that are relevant to the risk assessment are:

i. Continued use of Bradford Island for occupational/ industrial uses in support of operations at Bonneville Lock and Dam

ii. Protection of the health of on-site workers and visitors who may be present at the Upland OU

iii. Protection and maintenance of the eastern portion of the island as habitat for geese and other wildlife

iv. Protection of the only ESA-listed species with potential to frequent the Upland OU (bald eagle)

v. Protection of the River OU from upland sources of contamination

The objectives of the risk assessment for the Upland OU and AOPCs have been developed based on the management goals and are to:

1. Evaluate if risks to human or ecological receptors exceed unacceptable levels at any of the upland AOPCs or the Upland OU overall (applicable to Management Goals i to iv)
2. Evaluate if the upland to river transport pathway represents an unacceptable risk to receptors in the River OU (applicable to Management Goals iv and v)

Based on the results of the risk assessment, additional evaluation, risk management or response actions may be needed to meet the management goals listed above. The status of risk evaluation and availability of data for completion of baseline risk assessments varies among the different AOPCs and OUs at this site and is summarized in Table 6-1. While site characterization is nearly complete for some upland AOPCs, additional data collection is planned for other areas. Therefore, the human health risk and ecological risk assessments will proceed along different timelines for various portions of the overall site.

The CSM for the Upland OU outlining the complete and potentially complete exposure pathways to human and ecological receptors was presented in Section 5 (see Figure B-1 in Appendix B and Figure C-1 in Appendix C, respectively). An overview of the data quality objectives, proposed data collection, and evaluation methods is presented in Section 8.0 and in Table 8-2.

6.3.2.1 Human Health Risk Assessment

Problem formulation and, if warranted, a baseline HHRA will be performed on an AOPC-specific basis. A draft baseline HHRA was conducted for the Landfill AOPC (URS 2004b). However, because additional groundwater information needs to be collected and because DEQ made comments that remain to be addressed, this will be finalized once the additional information is available. Although COIs and COPCs are present or may be present at all of the upland AOPCs known to date, some AOPCs (e.g., Bulb Slope, Pistol Range area) may not require detailed baseline risk assessments. The receptors of interest and the details of the HHRA approach are presented in Appendix B.

6.3.2.2 Ecological Risk Assessment

A simplified model of the terrestrial food-web for the Upland OU is presented in Figure C-4 in Appendix C. The ERA process for the Upland and River OUs reflect the likelihood that both investigations and remedial activities are likely to occur at different stages in the OUs.

Problem formulation for the ERA occurred in several meetings during 2005 and early 2006 with the TAG for Bradford Island and in response to comments received from DEQ (DEQ 2004). The receptors of interest and the details of the ERA approach are presented in Appendix C.

6.3.2.3 Transport Pathway from Upland to River

As noted in the CSM, COIs from the Upland OU may enter the river through overland washoff and through seepage of groundwater. These pathways will be evaluated in a manner similar to the Portland Harbor Joint Source Control Strategy (DEQ 2005) for upland sources and are included in this RI Management Plan (Section 5.3). The evaluation process may be summarized as follows:

- COIs in soil and groundwater that have the potential to enter the River OU were identified on the basis of detection frequency, comparison to background and to screening levels, and presence or absence at the shoreline and in the River OU sediments (Section 5.3)
- The identified COIs will be evaluated against risk criteria (e.g., sediment screening values or preliminary remediation goals) and the resulting COPCs included in the risk assessment for the River OU.
- If these COCs are associated with unacceptable risks to River OU receptors, risk management or remediation decisions will include consideration of upland source control.
- If these COPCs are not associated with unacceptable risks to River OU receptors, the upland-to-river pathway will be considered as not posing a threat to human or ecological receptors and no further evaluation or action will be proposed.

6.3.3 Risk Assessment Approach for River Operable Unit

Although the downstream boundaries of the River OU have not been fully defined, the River OU is expected to include, at a minimum, the Bonneville forebay, which comprises the extent of the river from the downstream tip of Goose Island to the Bonneville Dam.

The USACE’s management goals for the River OU that are relevant to the risk assessment are:

i. Continued safe maintenance and operations of the Bonneville Lock and Dam complex

ii. Support of and protection of the health and livelihood of people who may utilize the area for contact recreation, fishing recreation, or subsistence fishing purposes

iii. Support of the beneficial uses of the Columbia River in this segment including the protection of anadromous and resident fish species utilizing the area

iv. Protection of ESA-listed and nonlisted wildlife species that may utilize or be dependent on the resources of the River OU

The forebay is located downstream of several other potential sources of COIs that may overlap with the COIs for the River OU. One of the objectives of the RI is to better define the spatial extent of the River OU downstream of Bonneville Dam. The results of the definition will be incorporated into the HHRA and ERA. Since one of the goals of the baseline risk assessment is to evaluate risks due to site-related COIs, the objectives of the risk assessment for the River OU will be threefold:

1. Evaluate if COIs in the forebay should be identified as COPCs based on comparison with both risk screening values and upstream (ambient) conditions (applicable to Management Goals i to iv)
2. Evaluate if risks to human receptors due to site-related COPCs are at unacceptable levels (applicable to Management Goal ii)
3. Evaluate if risks to ecological receptors due to site-related COPCs are at unacceptable levels (applicable to Management Goals iii and iv)

The CSMs illustrating potentially complete pathways to human and ecological receptors for the River OU are presented in Figures B-2 and C-2 of Appendix B and C, respectively. The DQOs for identifying proposed data collection and evaluation strategies are presented in Section 8.0 and in Table 8-3.

As noted earlier, no risk evaluations have been performed for the River OU to date. Although the problem formulation for the River OU has not been formalized, it is expected to warrant a baseline HHRA since some COIs are known to exceed risk-based screening values (that is, are likely to be COPCs), and potentially complete pathways are believed to be present. The baseline risk assessment for the AOPCs in the river will focus primarily on the fish consumption pathway. Relatively minor pathways such as direct contact with sediment and surface water also will be evaluated on a quantitative basis.

6.3.3.1 Objective 1 – Identification of COIs and COPCs

The approach proposed for evaluation of the River OU with respect to Objective 1 is based on DEQ and USEPA guidance and similar to approaches pursued at Portland Harbor and elsewhere. It is based on the recognition COIs can be narrowed to a smaller subset of COPCs for inclusion in the risk assessment and also that site management decisions can benefit by distinguishing between site-related COPC contributions and those from naturally occurring inorganic chemicals and anthropogenic organic chemicals from upstream sources. The proposed approach for statistical comparison and evaluation of forebay concentrations and upstream concentrations is described in detail in Appendix A. A data set based on comparable sample sizes to characterize upstream and site-related chemical distributions is proposed, in order to facilitate robust statistical comparisons for the identification of COPCs. Following analysis of the initial forebay and reference results, a memorandum will be developed to communicate the rationale for selection of archived samples (if necessary) to meet the appropriate power for the comparisons.

6.3.3.2 Objective 2 - Human Health Risk Assessment

Based upon extensive review of available information and discussions with the TAG, the primary human receptors of concern are Native American fish harvesters and recreational fishers. In the downstream area, non-tribal high consumption fishers may also be present.

A high degree of variability and uncertainty is likely in accurately quantifying site-related contributions to COPC concentrations in fish tissue as well as in characterizing the fish consumption patterns of humans. Native American fish harvesters have high consumption rates but favor anadromous fish species such as salmon or large home range species such as sturgeon (CRITFC 1994) which would be likely to have limited exposure to site-related COIs. Recreational sport fishers appear to favor resident species as well as anadromous species but have lower consumption rates (ATSDR 2006). There is also considerable uncertainty as to whether non-tribal high-consumption fishers are actually present in the Bonneville area (Weaver, pers. comm., 2007).The fish species themselves also vary widely with regard to home range, abundance and residence status in the forebay, trophic level and guild, lipid content, and other factors.

The primary goal of the evaluation of the fish consumption pathway in the baseline risk assessment is to characterize the potential for maximal exposure to site-related COIs. The greatest degree of human exposure to site-related COIs is likely to be associated with upper-bound estimates of consumption rates of resident, small home-range fish and shellfish. Data collection efforts will include characterizing COI concentrations in sediments (including areas where direct contact with sediments may occur), near-sediment surface water and in tissues of resident finfish and shellfish species with small home ranges and high site fidelity. These species include the clam, crayfish, sculpin and smallmouth bass. At the request of DEQ, limited sampling of large-scale sucker will also be attempted, although data associated with this wide-ranging species may be subject to a high degree of site-related uncertainty. Quantification of the exposure dose for the fish consumption pathway will be accomplished by a combination of trophic modeling and direct measurements of fish and shellfish tissue collection, as described in Appendices B and E.

6.3.3.3 Objective 3 - Ecological Risk Assessment

A simplified food web illustration for the River OU is presented in Figure C-5 in Appendix C. The receptors of interest were identified and selected after numerous discussions with agencies and stakeholders. They are indicated in the CSM (Figure C-2).

As noted in many guidance documents and case studies, the ecological evaluation of contaminated sediments is a complex and challenging task involving the potential for multiple types of impacts (e.g., direct toxicity, bioaccumulative toxicity) associated with multiple COPCs and expressed at multiple trophic levels. The most effective and commonly used evaluation strategy is a weight-of-evidence approach whereby multiple lines of evidence are evaluated either sequentially or in parallel. The weight-of-evidence approach can be used at several spatial scales. It can be used to evaluate the potential for impacts to the individual components of the ecological community (e.g., lines of evidence for the benthic community may include comparison of sediment concentrations to SLVs, toxicity test results, and tissue residue analyses), as described in Appendix C.

The weight-of-evidence approach can also be to characterize impacts to the site as a whole (Ingersoll and MacDonald 2002; USEPA 2004b; Wenning and Ingersoll 2002). The results of the ecological evaluation will be integrated to characterize the potential for presence or absence of impact and degree of impact to some or all of the ecological community at the site. The results of this evaluation will be used to help make site management decisions regarding next steps in the RI/FS process for the site. If the baseline ecological risk assessment (BERA) indicates the potential for unacceptable risks to one or more components of the community, USACE will evaluate the benefits and costs of additional evaluation to further refine risks or may choose to proceed to developing sediment remediation goals and planning response or risk management actions.

The overall integrated approach is summarized below.

LINES OF EVIDENCE					INTERPRETATION	
COPCs in Sediments below direct toxicity and bioaccumulative SLVs	**COPCs in Surface Water below water SLVs**	**Benthic Community below SLVs and tissue residue benchmarks**	**COPCs in fish tissue below tissue residue benchmarks**	**Wildlife (osprey, bald eagle, mink) at acceptable risk levels**	**Evaluation**	**Management Action**
√	√	√	√	√	No ecological impacts	No further action
X	√	√	√	√	Low potential for impacts to benthic community	Confirm lack of impacts
X	X	√	√	√	Low potential for impacts to benthic and water column community	Confirm lack of impacts
X	X	X	√	√	Potential exists for impacts to benthic community	Further evaluation OR develop benthic SRGs
X	X	X	X	√	Potential exists for impacts to benthic and fish communities	Further evaluation OR develop benthic and fish SRGs

LINES OF EVIDENCE					INTERPRETATION	
COPCs in Sediments below direct toxicity and bioaccumulative SLVs	**COPCs in Surface Water below water SLVs**	**Benthic Community below SLVs and tissue residue benchmarks**	**COPCs in fish tissue below tissue residue benchmarks**	**Wildlife (osprey, bald eagle, mink) at acceptable risk levels**	**Evaluation**	**Management Action**
X	X	X	X	X	Potential for impacts to benthic and communities and wildlife	Further evaluation OR develop benthic, fish and wildlife SRGs

COPCs – Site-related inorganic chemicals that occur at greater than 5% detection frequency and exceed background/ ambient levels and site-related organic chemicals occurring at greater than 5% detection frequency; SLV – Screening Level Values; AWQC – Ambient Water Quality Criteria; WQC – Oregon Water Quality Criteria; SRG – Sediment Remediation Goals; √ - Passes risk threshold; X – Fails risk threshold.

6.3.4 Use of Baseline HHRA and ERA in the Remedial Investigation Report

At the end of the baseline HHRA and ERA, risk characterization will be available for the Upland and River OU as follows:

- Risk levels associated with each COPC, exposure medium, pathway and receptor
- Risk levels in the context of acceptability ranges
- Risk-driving COPCs, media and pathways
- Contributions to risk estimates from upstream and other sources
- Uncertainty associated with risk estimation and characterization
- Preliminary remediation goals for soil, groundwater, sediment and surface water, as necessary
- Recommendations for additional evaluation, uncertainty reduction or refinement of risk estimates relative to the management goals and objectives for each AOPC and OU

The results and recommendations of the baseline risk assessment will be considered in context with the results of the other components of the RI as part of the overall decision-making process for the site.

6.4 REGULATORY REQUIREMENTS

The National Contingency Plan and CERCLA require that remedial actions meet federal standards, requirements, and criteria that are determined to be ARARs. State, tribal, or local requirements also must be met where applicable if they are more stringent than the corresponding federal requirements

6.5 FEASIBILITY STUDY

The information generated during the Remedial Investigation will be used to evaluate alternatives for cleanup, including the No Action alternative required by Superfund. The feasibility study will identify remedial action objectives, which are the goals for protecting human health and the environment at the site. The remedial action objectives will specify contaminants and media of concern, potential exposure pathways, and preliminary remediation goals. The preliminary remediation goals can be either ARARs or other federal and state laws.

Once the remediation goals have been established, general response actions and potentially suitable technologies will be identified. General response actions are actions that will satisfy the remedial action objectives. Possible general response actions include:

- No Action
- Monitored natural recovery
- Containment (i.e., capping)
- In-place treatment
- Complete or partial removal (dredging) of PCB-contaminated sediments with on-site or off-site treatment or disposal.

Potentially suitable treatment technologies and process options will then be screened for effectiveness, implementability, and relative cost.

After screening the treatment technologies and process options, USACE will develop and screen (again, using effectiveness, implementability and cost) various scenarios or alternatives to evaluate which will best achieve the remedial action objectives for the site. The alternatives will then be evaluated and compared to one another using seven of the USEPA's nine criteria for selecting a remedy at Superfund sites. Two criteria, state acceptance and community acceptance, will be evaluated after the USACE has received public comment on its preferred alternative and before the USACE selects its final remedy.

6.6 SITE CLOSURE APPROACH

The closeout of sites under CERCLA follows the process defined in the implementing regulations (the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300]) and related USEPA guidance (USEPA 2000a). For this site, "site closeout" refers to the point at which the USACE will no longer engage in active management or monitoring at the Bradford Island site unless the need for additional remedial action is demonstrated.

Since the USACE is performing this work under Executive Order 12580 (as modified by Executive Order 13016 of 1996), the USACE is designated as the lead agency. Executive Order 12580 is summarized below:

> Executive Order 12580 Delegates to Federal departments and agencies the responsibility for implementing remedial actions for hazardous releases or threatened releases that are not on the National Priorities List (NPL). The order clarifies that federal agencies and departments are responsible for waste removal

actions when releases come from facilities that are under the jurisdiction of a Federal agency or department.

As the lead agency, the USACE is authorized to conduct removal actions, remedial actions, and any other response measures consistent with the National Oil and Hazardous Substances Pollution Contingency Plan. The USACE will issue the ROD for the site.

Following the ROD, the site closure approach will involve the following steps:

- Implementation of the removal or remedial action
- Implementation of monitoring, if necessary
- Documentation of site completion
- Site closeout

Site completion occurs when no further response is required at the site, all cleanup goals have been achieved, and the site is deemed protective of human health and the environment (USEPA 2000a).

A risk-based approach to site closure is proposed for the both the Upland and River OUs. This approach will be implemented by defining a site as ready for closure when any of the following conditions are met:

- Screening level or baseline risk assessments indicate that site conditions meet acceptable risk levels for human and ecological exposures, as defined by DEQ and USEPA.
- Residual concentrations of site-related COPCs in site media (soil, sediment, groundwater or surface water) are equal to or lower than risk-based remediation goals, following remedial activities.
- Risk management actions, such as source control, exposure controls, or engineering controls, are successful in rendering exposure pathways incomplete or lower risks to acceptable levels for site-related COPCs.

The identification of projected future land use at the site will play an important role at two key points in the cleanup process. First, current and future land uses are evaluated to determine the need for cleanup action. The NCP indicates that the baseline risk assessment should be based upon current and potential exposures under “reasonable maximum exposure scenarios.” Second, risk management decisions in the ROD are designed to protect current and future users from exposure (USEPA 1996). For the Bradford Island site, the projected future land use at the site is industrial. Therefore, the site closure approach will consider this.

If the River OU removal action is the final remedial activity to be taken for that OU, a formal closeout of the removal action will be necessary (e.g., a No Action ROD if appropriate). Regardless of the specifics, the TAG will review and decide on a mechanism for documenting the decision that no further action is needed for a site.

The following points lists the process the USACE will follow for site closeout:

- USACE will select the remedy,
- DEQ, the Tribes and other Stakeholders will be provided an opportunity for review and comment,

- USACE will provide opportunity for public comment in accordance with CERCLA and the NCP,
- USACE will issue the ROD,
- USACE will implement the remedy, and
- USACE will determine when no further action is appropriate.
- Although not required, the DEQ has elected to implement a parallel process to what USACE is proposing, including public review, issuance of a ROD and site closeout

6.7 REMEDIAL INVESTIGATION/FEASIBILITY STUDY MILESTONES

This section describes important RI/FS milestones.

6.7.1 Quarterly Status Reports

The quarterly status reports will be submitted to the TAG members by the 15th day of the month following the reporting period. In general, the status reports will be submitted prior to the quarterly TAG meeting to allow discussion by TAG members at the meeting if necessary. These reports are intended to be status reports only and will include brief discussions of the following issues:

- Investigation or cleanup activities that occurred during the past quarter
- Documents or meeting summaries that occurred during the past quarter
- Data collected or received during the past month
- Description of any problems or difficulties experienced during the past quarter
- Discussion of how any problems or difficulties experienced were resolved or will be resolved and their impact on the schedule, if any
- Description of activities planned for the upcoming quarter

6.7.2 Quality Assurance Project Plan: Upland and River Operable Units

The River OU QAPP will address sediment, surface water, and fish/shellfish tissue. This QAPP is being developed together with the RI Management Plan and will be submitted to the TAG and stakeholders for review and comment prior to implementation.

A separate QAPP will be developed to describe the data gathering requirements for the Upland OU. The QAPP may be specific to a particular AOPC, depending on the similarities between the data needs, or may be written to cover all data needs for the Upland OU. Section 8.2 identifies existing data gaps for the Upland OU. QAPPs will be submitted to the TAG and stakeholders for review and comment prior to implementation.

6.7.3 Technical Memorandum: Post Investigation Data Gaps Analysis

Current data are being screened in the RI Management Plan as part of the data gaps assessment. Once the RI data collection is finished, the data will be evaluated against the objectives used to identify the data needs to determine completeness. The memorandum will also determine whether additional data are necessary to characterize the site (e.g., determine the nature and extent of contamination and determine the fate and transport mechanisms), refine the site's conceptual model, and/or focus preliminary remedial alternatives.

This memorandum is a key point in the RI process, since it will review all of the data collected and support a recommendation for proceeding with the RI and risk assessment.

This memorandum will be submitted to the TAG upon acquisition of the upland and the river data collected in accordance with the QAPPs described above. There will only be a draft memorandum; comments received from the TAG will be used to complete the RI Report or addend the QAPPs for additional sampling, if necessary.

6.7.4 Report: Draft and Final Remedial Investigation (Including Risk Assessment)

The Draft and Final RI Reports will address the nature and extent of contamination and characterize the risks in a baseline risk assessment for both the Upland and River OUs. The baseline risk assessment also will discuss the ambient risks that appear to be unrelated to Bradford Island releases to the Columbia River. These reports will be submitted to the TAG for review.

6.7.5 Technical Memorandum: Feasibility Study Data Needs Evaluation

To the extent practicable, engineering-related data will be collected in the RI phase of work. However, upon approval of the Final RI Report, USACE will complete this technical memorandum, which will outline additional data needs relating to the progress of the FS and inform the sampling design and methods to support the data acquisition program.

6.7.6 Report: Draft and Final Feasibility Study

The Draft and Final FS Reports will define site contamination in relation to legal requirements for remediation and unacceptable risks for both the Upland and River OUs. RAOs will consider specific constituents and media of concern, potential risks to human health and the environment, and PRGs. Remedial technologies will be screened and candidate technologies will be assembled into remedial alternatives for evaluation in accordance with seven of the nine CERCLA criteria. The USACE will then publish the reports. As part of the FS process, two technical memoranda will be developed to document the analysis that was used to identify RAOs and remedial alternatives.

6.7.7 Proposed Plan

The Proposed Plan will describe the FS alternatives, evaluate the regulatory and risk basis for alternative selection, and recommend an alternative. A Proposed Plan draft will be submitted to the TAG for comment prior to release for public comment. The Proposed Plan updated with TAG comments, as applicable, will be published for public comment.

6.7.8 Record of Decision

The ROD will be written following the public response to the Proposed Plan and will complete the activities described in the RI Management Plan.

6.8 SCHEDULE

A tentative schedule for the RI/FS work is provided below. All dates are estimates. Work will be prioritized based on the availability of project funds.

Project Milestone	Estimated Date
Draft RI Management Plan	2 QTR 2007
Final RI Management Plan	3 QTR 2007
River OU - QAPP	4 QTR 2007
River OU Data Collection	4 QTR 2007/1 QTR 2008
Upland OU Data Collection - QAPP	TBD
Post Investigation Data Gaps Analysis – Draft TM	TBD
Draft RI Report	TBD
Final RI Report	TBD
FS Data Needs – QAPP	TBD
Draft FS Report	TBD
Final FS Report	TBD
Proposed Plan	TBD
ROD	TBD

Notes:
FY– Fiscal Year (ends September 30)
OU – operable unit
QAPP – Quality Assurance Project Plan
QTR – quarter
RI – remedial investigation
ROD –Record of Decision
TBD – to be determined
TM – technical memorandum

This section presents the data review and management approach for the Bradford Island RI/FS.

7.1 DATA REVIEW

The field method review process for this project will include Field Investigation Manager supervision and review of the procedures being implemented in the field for consistency with the established protocols. The PM will review completed field forms on a daily basis.

The chemical data review process for this project will include data generation, data reduction, and two levels of QA review. The first level of QA review will be conducted by the laboratory prior to submittal of the electronic and hard copy data to URS. After receipt of data packages, a data quality review will be performed in accordance with the project QAPP.

Laboratory analytical reports will be subjected to a data validation review per Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD 2006), or the requirements outlined in USACE's Engineer Manual 200-1-10 (*Guidance for Evaluating Performance-Based Environmental Data*), including confirming the laboratory QA/QC procedures, comparing original and duplicate sample results, and ensuring spike recoveries are within acceptable ranges. Where appropriate, the report will be reviewed in accordance with the following EPA documents as well: USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA 1999), USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 2004c). The data review report will evaluate the precision, accuracy, representativeness, comparability, and completeness for the project. The data review will also include a data usability assessment that determines if the laboratory and field results are of sufficient quality to support the project objectives. This will be summarized within the main body of the RI report.

7.1.1 Field Measurement Quality Assurance

The Field Investigation Manager is responsible for field quality assurance. They will review the procedures being implemented in the field for consistency with the established protocols. The Field Investigation Manager is responsible for supervising and checking that samples are collected and handled in accordance with this RI Management Plan and that documentation of work is adequate and complete. Sample collection, preservation, and labeling will be checked for completeness. Field notes will be reviewed and checked for completeness and legibility. Where procedures are not strictly in compliance with established protocol, the deviations will be field documented and reported to the QA Manager. Corrective actions will be defined and implemented by the Field Investigation Manager and documented as appropriate.

7.1.2 Laboratory Quality Assurance and Reduction

The laboratory will perform in-house analytical data reduction and quality assurance under the direction of the laboratory QA manager. Data quality assurance and reduction will be conducted as outlined in a QAPP. The laboratory data reports will consist of data packages that will contain complete documentation and all raw data to allow independent data verification and validation of analytical results from laboratory bench sheets, instrument raw data outputs, chromatograms, and mass spectra.

7.1.3 Laboratory Assessments and Response Actions

Activities for assessing the effectiveness of project implementation and associated QA/QC will be presented in a QAPP. Response actions will include both field and laboratory corrective actions.

7.2 DATA INTERPRETATION

Site investigation results will be presented in text, tables, and graphics. Text will be in Microsoft Word format. Tabular data will be presented in Microsoft Excel format. Computer-aided drafting of site plans and other scale-intensive graphics will be performed using AutoCAD. The final document deliverable also will be provided in PDF format.

7.3 DATA MANAGEMENT AND REPORTING

This section of the RI Management Plan describes the flow and management of data that will be collected. Two primary categories of data will be generated for this project: field data, laboratory data. The procedures to be used for each type of data are described below.

7.3.1 Field Data

Field measurements and observations will be recorded by field team members in logbooks, on the appropriate field forms, and in photographs. All field data will be transferred to the Field Investigation Manager. A temporary file will be established and maintained to ensure proper hardcopy storage during field operations. These files will be added to and used by the field team as data are generated. Incoming project-related material, including correspondence, authorizations, chain-of-custody forms, or other information will be marked with the date received and the project name.

Upon completion of the field program, the temporary file will be incorporated into the URS permanent project file. The URS PM will oversee the input of project records. Copies of all field documents may be made and retained by the originator for use in report preparation and later reference. The originals will be filed in the office project file.

On-site field measurements will be transferred from field logs to an excel spreadsheet and directly entered into the project database. Electronic versions of the field files will be checked against the hard copies for errors. All review documentation will be initialed and dated by the reviewer, then filed with the project quality review documentation.

7.3.2 Fixed Laboratory Data

The laboratory will maintain and follow its own detailed procedures for laboratory recordkeeping to support the validity of all analytical work. However, procedures shall be in accordance with the DoD Quality Systems Manual for Environmental Laboratories (DoD 2006). Each data package submitted to the URS PM will contain the laboratory's written certification that the requested analytical method was employed and that all QA/QC checks were performed as specified in the QAPP. An electronic data deliverable (EDD) will be generated by the laboratory and submitted to URS along with a Portable Document Format (PDF) file of the laboratory report on a compact disc, in addition to the hardcopy deliverable.

7.3.3 Electronic Data

The URS Project Chemist will provide an EDD template to the laboratory prior to any sample submittal. Following sample analysis, the laboratory will generate and review all data according to the steps detailed in Section 7.1.2. The URS Project Chemist will check imports of electronic laboratory data into the project database against the hardcopy reports for errors and completeness.

This section summarizes the data quality objective (DQO) elements in terms of the DQO process steps. It also describes the data gaps identified to date and describes the proposed data collection to satisfy data needs for completion of the RI.

8.1 DATA GAPS AND PROPOSED DATA COLLECTION

The DQO process is a structured protocol for identifying and acquiring data to fill data gaps. DQOs are quantitative and qualitative statements that ensure that sufficient data of appropriate quality are collected during field and analytical activities to make required decisions with reasonable certainty. The process also seeks to optimize data collection strategies. Table 8-1 summarizes the overall DQOs and Tables 8-2 and 8-3 summarize the DQOs for completing the Upland and River OU risk assessments, respectively.

8.1.1 The Problem

Additional data are required to characterize the Bradford Island Upland and River OUs in order to prepare a comprehensive RI Report with baseline HHRA and BERA, and to permit elaboration and evaluation of engineering alternatives to address contamination.

The primary chemicals found at the upland sources include lead from the sandblasting and firing range activities. The investigations at the Landfill have found one solvent (PCE) and other metals (lead, zinc, and chromium) that are potential concerns. The primary exposure media from the upland sources for humans or ecological receptors are surface and subsurface soil, although the potential for impacted soils to erode to the river is a viable transport mechanism and will be evaluated further during the RI.

Although other chemicals are found associated with the river source, it appears that PCBs are the most widespread COI based on past investigations in the Bonneville Dam Forebay. COIs for the RI have been selected and are discussed above in Section 5.3. The potential for COI-containing sediments to have been eroded and transported downstream of the dam will be evaluated during the RI. The primary exposure media from the river source for humans or ecological receptors include sediment, surface water and fish/shellfish.

8.1.2 Goals of the Study and Principal Study Questions

The principal study goal for the RI is to characterize potential impacts in environmental media that may pose a risk to upland and river receptors, after the in-water interim removal action has been completed. Individual goals are summarized below.

- Characterize the potential for contaminant contribution from upland sources to site sediment.
- Delineate the nature and extent of site-related sediment contamination in the forebay.
- Delineate the nature and extent of sediment impacts related to releases from the site downstream of the dam.
- Characterize contaminant concentrations in soil and groundwater of the Upland AOPCs to provide information for estimation of risks to human and ecological receptors of the Upland OU.

- Characterize contaminant concentrations in sediment, surface water and tissues of selected biota to provide information for estimation of risks to human and ecological receptors of the River OU.

The principal study questions are:

- What COIs in soil, groundwater, sediment, surface water and tissues are considered as site-related COIs and should be included for analysis in this study?
- What COIs are of direct toxicity concern to human and ecological receptors and should be included for analysis in the media for each AOPC and OU?
- Which COIs are of bioaccumulative concern to human and ecological receptors and should be included for analysis in the media for each AOPC and OU?

8.1.3 Decision Statements for the Study

The study decisions are related to the major goals of the RI process outlined above.

- Decide whether the nature and extent delineation indicates that site-related contamination exists in the media of the upland AOPCs or the River OU.
- Decide whether transport of contaminants from soil or groundwater in the upland AOPCs contributes to potential for unacceptable risks to human or ecological receptors in the River OU.
- Decide whether concentrations of site-related chemicals in upland soils and groundwater have the potential for unacceptable risks to human and ecological receptors in the upland OU
- Decide whether concentrations of site-related chemicals (particularly PCBs) in sediment, water or tissue have the potential for unacceptable risks to human or ecological receptors in the River OU.
- Decide if the potential risk is of a magnitude that merits additional investigation, evaluation or remedial action.

8.1.4 Inputs to the Study Decisions

The inputs used to address the principal study problem and decisions will consist of existing data, archived samples and new data. Existing data (both from USACE and others) will be reviewed prior to incorporation into the RI. New data will consist of physical as well as chemical data for the following media: soil, soil gas, groundwater, surface water, sediment, and fish/shellfish.

Some modeling will be used to meet the goals of the study. A trophic model will be used to estimate the potential for PCBs to transfer through the food web. Existing river hydraulic modeling data has been used to identify depositional areas downstream of the site.

Tables 8-2 and 8-3 provide a more detailed listing of the data inputs by medium for each OU.

8.1.5 Boundaries of the Study

The study area is generally the reach of the Columbia River upstream of the Bonneville Dam and Lock complex (the forebay) to RM 147. A reference area has been identified upstream of Cascade Locks, Oregon (RM 150). Little to no environmental data have been collected downstream of the spillway and powerhouses. A focused study will be performed downstream of the spillway to determine if the study boundaries need to include this area.

The boundaries of the study were influenced by the goal to provide sufficient protection for the receptors with the highest potential exposure to site contaminants. Therefore, the ERA and HHRA will focus on receptors and target species whose likely exposure area (i.e., home range) is similar to or smaller than the Bradford Island site area.

Additionally, the boundaries were influenced by the goal of determining the contaminant contribution from upstream sources. The forebay data set (following the removal action) is expected to be similar in nature and the decision about contaminant contribution from upstream sources will be based on a comparison between the entire forebay and reference area data sets. Localized areas of elevated concentrations or localized areas contributing to elevated risk will also be identified.

8.1.6 Decision Rules

Decision rules have been developed related to the determination of nature and extent, the migration of impacted soil or groundwater to the river, and risk decisions. These are described below.

8.1.6.1 Determination of Nature and Extent

The determination of nature and extent will be based upon the following three factors:

1. Comparison to measured concentrations in the reference area for all media
2. Comparison to appropriate screening levels
3. Rationale for selection of a remedial action is supported, if necessary

If COI concentrations exceed reference area concentrations and appropriate screening levels, then the COIs will be considered site-related COPCs and will be included in further investigations and risk assessment.

8.1.6.2 Migration of Soil and Groundwater to the River

Decision rules for determining if impacted soil and groundwater is migrating to the river at levels that require analysis in the risk assessment are presented below.

- COIs in soil or groundwater are present at the shoreline of the island at concentrations greater than the appropriate sediment or surface water screening levels.
- The compounds that exceed the screening levels are found above corresponding screening or reference area concentrations in sediment/surface water.

- The human or ecological risk assessment for the River OU identifies chemicals of concern (COCs) that are the same as upland COIs with the potential for transport.

If COCs in the River OU are determined to originate from upland soil or groundwater, then the feasibility study will identify means of minimizing this transport pathway.

8.1.6.3 Decision Rules Relating to Risk Determinations

Decision rules regarding risks to human health will be based upon DEQ and USEPA guidance.

Decisions related to ecological risk assessment. For food-web-based ecological receptors, exceedance of an HQ or HI of 1 will be evaluated as warranting additional assessment or response actions. These may be modified, as appropriate, on whether the receptor to be protected is an ESA-listed species or a non-listed species. For ecological communities, exceedances of the media-specific screening levels for threshold and/or probable effects will be evaluated as warranting additional study or response action. A weight-of-evidence approach will be used to evaluate the potential for impacts to the ecological community.

Decisions related to HHRA. For noncarcinogenic effects to humans, an HQ or HI of 1.0 will be evaluated as warranting additional evaluation or response actions. For carcinogenic compounds, exceedance of either 1×10^{-6} incremental lifetime cancer risks for single compounds, or 1×10^{-5} for mixtures of individual compounds may be the basis for additional evaluation or remedial action decision. As noted earlier, estimated risks will be reviewed with regard to site characterization trends, nature and magnitude of risks and uncertainties in the HHRA. Decisions regarding additional evaluation or response will be made in the context of this review.

8.1.7 Tolerable Limits on the Decision Error

Potential sources of decision errors include:

- Sampling design uncertainties associated with biasing site media concentrations by sampling in primarily unimpacted areas or primarily impacted areas or inadequate sample size for comparisons
- Analytical uncertainties associated with analysis of PCB and congener concentrations (along with other COIs) in site media
- Uncertainties associated with predicting and measuring COI concentrations in tissues, particularly tissues of upper trophic level receptors

Methods to control the decision errors include:

- Select sample locations based on a stratified random sampling grid and collect sufficient numbers of samples to enable robust statistical comparisons
- Use analytical methods to achieve appropriate reporting limits to the extent practicable
- Use both trophic model predictions and measured tissue data to evaluate food-web exposures and identify the agreement, disagreement and uncertainties in both types of data

For risk and some regulatory decision-making that involves multiple measurements for a decision, comparisons will be made at the specified statistics (e.g., 95 percent upper confidence limit on the mean). For statistical inference errors, target limits of 5% Type I (false positive) error, and 10-20% Type II (false negative) error will be used in designing sampling schemes for risk and regulatory decision-making. It may not be possible to limit errors for responsibility, as these tend to be scalar and not threshold determinations in any event.

8.1.8 Sampling Design Optimization

A general outline of the proposed sampling and data collection effort is presented in this RI Management Plan. The outline will be refined and presented in more detail in the QAPPs.

8.2 UPLAND OPERABLE UNIT DATA GAPS

The discussion of Upland OU data gaps is organized by AOPC, and further organized by four general categories of data needs for the Bradford Island RI: Nature and extent determination, migration of soil and groundwater to the river, human health risk assessment and ecological risk assessment. Data gaps are present for each AOPC except the Bulb Slope.

8.2.1 Landfill

Additional soil and groundwater/seep data are needed to complete the ecological risk assessment of the Landfill AOPC. Data are generally not needed to define nature and extent of contamination, with the exception being soil in a subarea of the landfill.

8.2.1.1 Soil

The data gaps for soil at the Landfill are as follows:

Nature and Extent – Additional data are needed to delineate the extent of contamination related to VOCs (mainly PCE) in soils of the gully area. To fill this data gap, three to seven surface soil samples will be collected in the gully area and analyzed for VOCs.

Migration to the River – The USACE has completed a preliminary evaluation of soil that may migrate to the river and will be reviewed as part of the RI. The evaluation consisted of the collection of 10 surface soil samples from the northern and eastern banks of Bradford Island near the Landfill.

Human Health Risk Assessment – None

Ecological Risk Assessment –The Level II risk assessment report concluded that risks to human health at the site were considered acceptable under current land use conditions, but there exists a concern for direct exposure toxicity for ecological receptors in the gully area. Additional data are necessary to understand the current concentration of VOCs surface soils within the gully area. An additional three to seven surface soil samples will be collected in the gully area to assess ecological risk. The results from these samples will be added to the existing dataset for the Landfill, as the gully area is a part of the Landfill AOPC. The actual footprint of the Landfill has been adequately characterized at depth for risk assessment purposes. The suite of analytes will include the COIs listed in Table 5-1.

8.2.1.2 Groundwater

The data gaps for groundwater at the Landfill are as follows:

Nature and Extent – None

Migration to the River – Additional groundwater and surface water data are needed to evaluate this pathway. Although groundwater samples have been collected from the Landfill, the Landfill groundwater well network has not been monitored since 2003, and the last seep sample was collected in 2001. Groundwater samples have not been collected that would be unaffected by the past releases to allow an understanding of background concentrations of metals. The suite of analytes will include the COIs listed in Table 5-9.

The investigation strategy for this pathway includes the following points:

- If practicable, one up-gradient well will be installed from the Landfill. (The most up-gradient well is in the former pesticide mixing area of the Landfill footprint.)
- Conduct quarterly monitoring of the wells for 1 year.
- Conduct quarterly surveys for seeps and collection of seep or overland runoff samples when present.
- Conduct quarterly surface water sampling to coincide with the monitoring well and seep sampling.

The specific sampling design for evaluating groundwater at the landfill AOPC will be presented in the Upland QAPP.

Geochemical characterization of groundwater from the Landfill and seep water adjacent to the Landfill will be conducted to provide additional weight-of-evidence that the seep water is similar to groundwater from the monitoring wells that has contacted Landfill wastes.

Human Health Risk Assessment – The groundwater data collected above will be used to identify COIs in groundwater that may need to be included in the HHRA for the River OU.

Ecological Risk Assessment – The groundwater data collected above will be used to identify COIs that may need to be included in the ERA for the River OU.

8.2.2 Sandblast Area

Additional samples of soil and groundwater are needed to complete the evaluation of the migration to the river pathway and assess risks for both human and ecological receptors at the sandblast AOPC. Additional samples of soil gas are also needed to complete the nature and extent determination and assess risks for human receptors at this AOPC.

8.2.2.1 Soil

The data gaps for soil at the sandblast AOPC are as follows:

Nature and Extent – None

Migration to the River – If the COPCs in soil are mobile and migrate to the river, they may pose a risk to ecological receptors. To assess if surface soils can migrate to the river, the Sandblast Area will be surveyed to develop a detailed topographic map. The survey will include a description of ground cover that may affect surface runoff. Surface soil samples will be collected from the AOPC where needed to develop an assessment of erodibility. The Upland OU QAPP will present the sampling locations and rationale. The soil erodibility will be used to develop the average annual soil loss.

A similar approach will be conducted for the other upland AOPCs. The evaluation of the potential for migration will include an evaluation of preferential pathways (i.e., storm drains, gullies/rills).

To further evaluate this pathway, a supplemental engineering evaluation of the existing water conveyance from the Sandblast Area will be conducted. The Supplemental Site Inspection for the Sandblast Area reported soil and contaminant loading on filter fabric regulating runoff from Bradford Island (URS 2006a, b).

Human Health Risk Assessment – Additional information is needed about the concentrations of lead in the surface soil of the Sandblast Area at a size fraction that would be available to humans/and or ecological receptors.

A random grid sampling approach will be used to select a number of surface soil samples in the Sandblast Area that will be adequate to meet the specified tolerance for Type I and Type II errors outlined in Section 8.1.7, using the intervals of 0 to 1 foot and 1 to 3 feet. The samples will be sieved prior to analysis in accordance with USEPA guidance (USEPA 2000b) using a 250-microgram sieve and submitted for measurement of total lead. The sieving will be done to collect soil that would represent soil that would migrate via the inhalation pathway.

Ecological Risk Assessment – See above

8.2.2.2 Groundwater

The data gaps for groundwater at the sandblast AOPC are as follows:

Nature and Extent – None

Migration to the River – Additional groundwater and surface water data are needed to evaluate this pathway. Elevated concentrations of VOCs (TCE) have been detected near the hazardous waste storage area. Although groundwater samples have been collected from the sandblast AOPC, these were grab samples from temporary well points. In addition, groundwater samples have not been collected that would be unaffected by the past releases to allow an understanding of background concentrations of metals.

The investigation strategy for these pathways includes the following points:

- Installation of a minimum of four monitoring wells in the Sandblast Area (one near the prospective source of TCE, 1 upgradient of the source, and two adjacent to the Columbia River).
- Quarterly monitoring of the wells.
- Quarterly surveys for seeps and collection of seep samples or overland runoff when present.
- Quarterly surface water sampling to coincide with the monitoring well and seep sampling.
- The suite of analytes will include the COIs listed in Table 5-10.

The specific sampling design for evaluating groundwater at the sandblast AOPC will be presented in the Upland QAPP.

Human Health Risk Assessment – The groundwater data collected above will be used to identify COIs in groundwater that may need to be included in the HHRA for the River OU.

Ecological Risk Assessment – The groundwater data collected above will be used to identify COIs that may need to be included in the ERA for the River OU.

8.2.2.3 Soil Gas

The data gaps for air at the sandblast AOPC are as follows:

Nature and Extent – Soil data in the Sandblast Area Supplemental Site Inspection (URS 2006a) indicate that TCE and PCE are present in soil and groundwater near the hazardous waste storage area, apparently from a spill prior to the construction of the existing storage pad, and these chemical signatures extend towards the river.

The sampling strategy, which will be developed further in the Upland QAPP, is to collect soil gas and subslab samples for VOCs (the USEPA Method TO-14 list includes 38 compounds on the Toxic Compounds List) in air in the sandblast building and service building using Tedlar samplers and volatiles analysis. Some soil properties may also be characterized (e.g., moisture content, bulk density, and soil type).

Migration to the River – Not Applicable

Human Health Risk Assessment – Measurements of VOCs in soil gas and subslab areas are needed to assess exposure to indoor air in the nearby sandblast and service buildings on Bradford Island for the adult site maintenance worker.

Ecological Risk Assessment – None

8.2.3 Pistol Range

Additional samples of sediment are needed to complete the nature and extent determination and assess risks for both human and ecological receptors at the Pistol Range AOPC.

8.2.3.1 Soil/Sediment

Existing data will be used to delineate the nature and extent of contamination and to evaluate risks to human and ecological receptors for the pistol range AOPC as a whole. The data gaps for soil/sediment at the pistol range AOPC are as follows:

Nature and Extent – None.

Migration to the River – Although a risk assessment has not been completed for the Pistol Range AOPC, screening of surface soils indicate that if they are mobile and migrate to the river, they may be a risk to ecological receptors. To assess if surface soils can migrate to the river, a similar approach will be used as described above for the Sandblast Area (Section 8.2.2.1).

Surface soil samples collected between the Pistol Range and the river indicated that concentrations of COIs drop several orders of magnitude demonstrating that this is not an active pathway. However, historical releases from surface soils may have been transported to the lagoon on the south side of Bradford Island. Sediment samples will be collected within the lagoon to assess the occurrence of this historical pathway. The suite of analytes will include the COIs listed in Table 5-7.

Human Health Risk Assessment – The data collected above will be used to determine if COIs from the Pistol Range should be included in the HHRA for the River OU.

Ecological Risk Assessment – The data collected above will be used to determine if COIs from the Pistol Range should be included in the ERA for the River OU.

8.2.3.2 Groundwater

Nature and Extent – To characterize the potential for leaching of soil COIs to groundwater, three grab groundwater samples will be collected. Two of these samples will be collected within the footprint of the pistol range AOPC and the third sample will be collected downgradient of the AOPC. The suite of analytes will include the COIs listed in Table 5-3, on the assumption that COIs in soil are the potential source of COIs in groundwater for this area. The details concerning the selection of background soil and groundwater samples will be presented in the Upland QAPP.

Migration to the River – The data collected will be used to determine the potential for transport to the River OU.

Human Health Risk Assessment – The data collected above will be used to determine if COIs from the Pistol Range should be included in the HHRA for the River OU.

Ecological Risk Assessment – The data collected above will be used to determine if COIs from the Pistol Range should be included in the HHRA for the River OU.

8.2.4 Bulb Slope

No data gaps are present for the Bulb Slope AOPC.

8.3 RIVER OPERABLE UNIT DATA GAPS

The discussion of the River OU data gaps is organized by area, and further organized by three general categories of data needs in the River OU for the Bradford Island RI: Nature and extent determination, human health risk assessment and ecological risk assessment.

Although a significant amount of sediment data have been collected for the River OU, the data have focused on the area next to the former debris piles. Additional sediment data that are co-located with benthic data covering the forebay are needed to assess the migration of biomagnifying COIs through the food web. To date, no data have been collected for upper-trophic-level receptors, i.e. fish, to assess risk to fish and human receptors. Three fish species (sculpin, smallmouth bass, and large-scale sucker, as available) and two shellfish species (clam and crayfish) have been selected as described in Appendices B and C.

People fishing near the mouth of Eagle Creek may wade in the river. People may also boat from the Columbia River shoreline to Goose Island for recreational purposes. No sediment data are available to evaluate direct contact exposures for sediment near Eagle Creek.

Sediment and tissue data need to be collected upstream to evaluate the contribution of ambient COIs to the site-wide risk estimate. Data is also necessary downstream to evaluate if impacted sediment from the site has migrated downstream at appreciable levels. The downstream study area will be stratified into areas that are depositional and non-depositional in nature; random samples will be collected only in the depositional areas.

8.3.1 Reference Area

Additional data in the reference area will include samples of the following media: sediment, surface water, benthic tissue, and fish. The objective of sampling the upstream reference area is twofold:

1. To provide data for the identification of site-related COPCs and evaluation of site-related contributions to risk. The relative influence of upstream sources of COIs on risks associated from the forebay will be distinguished by conducting an incremental risk analysis. The site-related contribution to risk will be estimated (if needed) by comparing forebay-specific risks with risks estimated for the upstream reference area. If the forebay risk is greater than upstream reference risk, the incremental risk will be estimated.
2. Upstream sampling results outside of the eddy area caused by the dam and powerhouses appear to indicate that COIs are present in the sediment and surface water entering the forebay. A sampling approach will be used to determine if the concentrations of chemicals detected in the forebay are statistically different from the upstream reference area.

For the comparison between forebay and upstream reference area, the hypothesis testing is as follows:

Null hypothesis, H_0: The mean concentration in the forebay is less than or equal to the mean concentration in the upstream reference area.

Alternative hypothesis, H_A: The mean concentration in the forebay is greater than the mean concentration in the upstream reference area.

A 95% confidence level (or false rejection rate, α=0.05) is selected for this study because it is a common choice in the statistical analysis of environmental data. The power of detection is set to be between 80% to 90% (or false acceptance rate, β=0.05 to 0.1), to detect at least one standard deviation above the mean upstream concentration. Given these statistical performance levels, the minimum sample size is determined to be 14 if a parametric distribution can be assumed and the lower bound of power of detection is acceptable. If data cannot be assumed to follow a parametric distribution and a higher power of detection is deemed necessary, the number of samples required to achieve the performance level described above is determined to be 21.

The QAPP will provide additional details of the sediment sampling protocol for the reference area.

8.3.1.1 Sediment

The data gaps for reference area sediment are as follows:

Nature and Extent – In part, the nature and extent of the impacts in the forebay will be influenced by concentrations found in the reference area sediment.

Human Health Risk Assessment – See discussion under ecological risk assessment below.

Ecological Risk Assessment – Sediment samples have been collected upstream during previous investigations; however, they were collected in a reach of the river that has higher velocities and no depositional areas.

Sediment samples will be collected from an area upstream of Cascade Locks in a depositional area to be more similar to the grain size in samples from the forebay.

Since one objective of the upstream data is to compare it to the forebay data, both data sets will be collected using a similar sampling scheme. This scheme will also allow the incremental risk objective to be met. The general process will include the following steps:

1. Select areas to be sampled.
2. Grid off the area using same grid size in both the reference area and forebay.
3. Select the similar number of grid nodes to be sampled in each area, i.e., 21.
4. Collect co-located benthic (clam) tissue and sediment at grid stations. Use a multi-incremental approach that consists of collecting several subsamples from within each grid station that are combined to represent that station.
5. The suite of analytes for sediment will include the COIs listed in Table 5-11. PCBs in sediments will be analyzed as Aroclors, with a subset of samples (eight or more) also analyzed for all 209 congeners.

8.3.1.2 Tissue

The data gaps for reference area tissue samples are as follows:

Nature and Extent – As with the sediment the nature and extent of the impacts found in tissue in the forebay will be influenced by concentrations found in the reference area

Human Health Risk Assessment – COPCs for the fish consumption scenario will be identified by comparison of COI concentrations in tissues of edible fish and shellfish (crayfish, smallmouth bass) between the reference and forebay areas. The rationale for the selection of these target species is presented in Appendix B.

Ecological Risk Assessment – The comparison of reference data to forebay data also includes the data needs for tissue. The rationale for the selection of the target species is presented in Appendix C. In general, the target species were resident species that represent different feeding guilds.

Tissue samples in the reference area will consist of the following:

- Co-located clam (*Corbicula fluminea*) and sediment (21 samples)
- Crayfish (*Pacifastacus* spp.) traps placed where co-located clam and sediment are collected (21 whole-body samples)
- Sculpin (*Cottus* spp.) traps placed where co-located clam and sediment are collected (21 whole-body samples)

- Smallmouth bass (*Micropterus dolomieui*), collected from across the reference area (17 whole-body samples)

The numbers of stations and of individual fish are based on the number necessary to allow a statistical comparison to forebay results. The analytes proposed for tissue samples will include all chemicals identified as bioaccumulative chemicals by DEQ (2007b) and metals and PAHs that are identified as COIs in sediment (Table 5-11). Because mercury has been detected in sediments of the forebay, the highly bioaccumulative form of this element (i.e., methylated form) will be analyzed for in tissue, as necessary. Methyl mercury biomagnifies as it is transferred up the aquatic food chain, such that less than 1 % of total mercury in sediment is methyl mercury and approximately 100% of total mercury in predatory fish is methyl mercury. For this reason, clams and crayfish will be analyzed for both total and methyl mercury, while finfish (sculpin, sucker, and bass) will only be analyzed for total mercury under the assumption that all mercury in fish tissue is in the methylated form. Based on prior experience with mercury tissue collection at other sites, it is likely that methyl mercury in the lower trophic level invertebrate tissues may range from 60-80% of total mercury. Therefore, methyl and total mercury analyses will be performed for invertebrate tissues in order to provide a more precise estimate of mercury-related risks.

The analysis of archived tissue samples for mercury may result in some uncertainty due to the limited holding time for mercury of 28 days. This uncertainty will be acknowledged in the HHRA and ERA. Non-detect observations for all analytes will be treated as recommended in USEPA (2007b, c). In addition, non-detect observations for PCB congeners may follow the procedures used at Portland harbor (Lower Willamette Group 2007).

8.3.1.3 Water

The data gaps for reference area water samples are as follows:

Nature and Extent – the selection of the nature of surface water impacts in the forebay will be influenced by concentrations in the reference area.

Human Health Risk Assessment – The environmental input parameters in the surface water required by the trophic model include dissolved organic carbon (DOC), TOC, chemical concentrations (COIs), and water temperature. Five samples will be collected for these parameters throughout the reference area. The suite of analytes will include the COIs listed in Tables 5-9, 5-10 and 5-11, match the suite of analytes planned for the Forebay surface water samples. PCBs in water will be analyzed, using XAD resins or other sensitive methods, as Aroclors, with a subset of samples also analyzed for all 209 congeners.

Ecological Risk Assessment – Same data gaps as the human health risk assessment.

8.3.2 Forebay

The majority of the sediment and benthic tissue data collected in the forebay were collected in the area next to the former debris piles. Additional co-located sediment and benthic data covering the home ranges of resident fish within the forebay is needed to assess the prospect that biomagnifying COIs could migrate through the food web. Tissue samples from three upper trophic level fish are needed to identify if COIs are present in different feeding guilds of the food web.

Focused sediment sampling is necessary in areas where anglers may access the forebay, as well as in the area of the removal action footprint to assist in understanding the relationship between sediment and clams at elevated concentrations.

8.3.2.1 Sediment

The data gaps for the forebay sediment are as follows:

Nature and Extent – a significant amount of sediment has been collected from the forebay. As presented in Section 5.3, the nature and extent appears to have been defined for several COIs. The exceptions are PCBs and several metals. Sediment results used to fill the human health and ecological risk assessment data gaps will be used to refine the nature and extent of sediment impacts within the forebay. The analyte list will be identical to that described for reference area sediments.

The sediment samples will be collected in a similar manner to the reference sediment. The exception is that the removal action footprint on the north shore of Bradford Island will be excluded from the grid for the selection of the 21 samples. The removal action footprint represents roughly 10 percent of the area to be sampled in the forebay (see Figure 4-9 and Section 5.2.2); hence, at least two samples will be collected within the removal action footprint in order to have a proportional amount of samples as in the forebay. Because of a greater interest within the removal action footprint, at least two but up to six co-located sediment and clam samples will be collected within the removal action footprint prior to dredging.

Human Health Risk Assessment – Purposive samples of sediment near the mouth of Eagle Creek and along the shoreline of Goose Island are necessary to characterize exposure for anglers through direct contact scenarios. An additional three samples of sediment will be collected from locations where wading may occur.

Ecological Risk Assessment –Sediment samples are necessary to evaluate if bioaccumulative COIs are migrating through the food web. The samples will be collected in a similar manner as the reference sediment. An additional 2 to 4 co-located sediment and clam samples will be collected within the removal action footprint prior to removal. This will allow Biota Sediment Accumulation Factors (BSAFs) to be calculated for elevated sediment concentrations.

8.3.2.2 Tissue

The data gaps for the forebay tissue are as follows:

Nature and Extent – Additional data is necessary to evaluate the presence of COIs in forebay tissue. Due to limitations on the amount and types of tissue data available from the forebay, the data gaps for nature and extent have been combined with those for human health and ecological risk assessment. In general, co-located sediment and benthic (clams and crayfish) samples will be collected at randomly selected stations throughout the forebay. Targeted fish species (sculpin and smallmouth bass) will be collected as available throughout the spillway and First Powerhouse forebay. The targeted tissue species will be collected in a similar manner to the reference area, except for the fact that archived samples of smallmouth bass will be used in the forebay. Where available, finfish samples for analysis will consist of more than one individual, preferably of similar age and size classes. The analyte list will be identical to that proposed for tissue samples for the reference area. PCBs in clam tissues will be analyzed as Aroclors with a subset of samples analyzed for all 209 congeners. To ensure an adequate dataset is achieved for purposes of statistical analysis, a minimum of eight clam and crayfish samples from each AOPC (i.e., forebay and reference area) will be analyzed for congeners. All fish tissues will be analyzed as PCB congeners and, a minimum of eight samples of each fish species from each AOPC will be analyzed for Aroclors. The use of Aroclor and congener data to develop functional relationships between the two types of data is described in further detail in Appendix B. The number of samples analyzed for Aroclors and congeners will be sufficient to allow for the identification of functional relationships.

One sample of largescale sucker will be analyzed on archived fish collected within the Bonneville Juvenile Bypass Facility by a USACE biologist. The sample will consist of several individual fish. The home range of the largescale sucker, which is reported to be greater than the forebay, will result in uncertainty during the interpretation of the results.

Human Health Risk Assessment – Data is needed to evaluate the human health risk from ingestion of fish, and possibly shellfish, with trophic uptake of COIs from sediment and water. An attempt will be made to collect more than 17 specimens of smallmouth bass. The targeted edible fish species will be stored and analyzed initially, on a whole-body basis. If the baseline risk assessment identifies unacceptably high risks due to consumption of these fish species by humans, the archived fish may be analyzed on a fillet basis, in order to provide additional information for the risk assessment. Smallmouth bass will be analyzed as single specimens. Clams, crayfish and sculpin will be composited to obtain sufficient wet weight for laboratory analyses.

Ecological Risk Assessment – See above. Data is needed to evaluate risks from consumption of fish and shellfish for piscivorous and aquatic-dependent wildlife. The target fish and shellfish species will be analyzed on a whole-body basis.

8.3.2.3 Water

The data gaps for the forebay surface water are as follows:

Nature and Extent – The nature and extent of surface water impacts within the forebay will be determined by comparison to reference concentrations and filled using the data needs for human health and ecological risk assessment. The analyte list will be identical to that proposed for water samples in the reference area.

Human Health Risk Assessment – Five surface water samples will be collected from within the forebay in a similar method as in the reference area to evaluate human health risks from the contact and ingestion pathways and to assist in preparing the trophic modeling risk hypotheses. The surface water data may be used as direct inputs to the trophic model as well as to calibrate the sediment to water partitioning section of the model. The surface water data will not be used to support a statistical evaluation.

Ecological Risk Assessment – Same as human health risk assessment.

8.3.3 Downstream

The data gaps for the downstream sediment are as follows:

Nature and Extent – No data have been collected downstream of Bonneville Dam as part of the investigations associated with Bradford Island. A focused sampling effort is needed to determine if additional investigation is warranted in this area. URS will collect up to six surface sediment samples to determine if further assessment is required. The locations of the sediment samples are based on identifying areas of lower relative velocity that correspond to depositional areas in the river (see Section 5.2.2.3). The laboratory analyses are based on the COIs in the forebay where the extent has not been defined as presented in Section 5.3 (Table 5-12).

The results will be compared to screening levels, as well as the reference area and forebay results to determine if it is necessary to collect additional sediment and/or tissue samples downstream of the dam.

Human Health Risk Assessment – None at this time.

Ecological Risk Assessment – None at this time.

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