



Portland Harbor Superfund Site Natural Resource Damage Assessment Plan Addendum 2: Phase 3 Damage Assessment Plan

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LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
DIVER	NOAA's Data Integration Visualization Exploration and Reporting database
DOI	United States Department of the Interior
ECSI	Oregon DEQ's Environmental Cleanup Site Information database
EPA	United States Environmental Protection Agency
FCA	Fish Consumption Advisory
HEA	Habitat Equivalency Analysis
MGP	Manufactured Gas Production
NOAA	National Oceanic and Atmospheric Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Site	Portland Harbor Superfund Site
PI	Principal Investigator
PRP	Potentially Responsible Party
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
REA	Resource Equivalency Analysis

RI/FS	Remedial Investigation / Feasibility Study
PEIS/RP	Programmatic Environmental Impact Statement and Restoration Plan
RM	River Mile
ROD	Record of Decision
U.S.	United States

CHAPTER 1 | INTRODUCTION

1.0 BACKGROUND AND PURPOSE

For decades, the Willamette River near Portland, Oregon, including the Portland Harbor Superfund Site (Site), has been contaminated by oil and hazardous substances.^{1,2,3} To address injuries to natural resources resulting from exposure to these contaminants, and identify the scale and scope of restoration sufficient to compensate for natural resource service losses, the Portland Harbor Natural Resource Trustee Council (Trustee Council) is conducting a Natural Resource Damage Assessment (NRDA). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 et seq.; the Oil Pollution Act of 1990, 33 U.S.C. §§ 2701 et seq.; the Clean Water Act, 33 U.S.C. § 1251; the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. 300, Subpart G; Executive Orders 12580 and 12777; and other applicable Federal and state laws and regulations provide a legal framework for the Trustee Council's actions.

The Trustee Council is comprised of representatives from the Confederated Tribes of the Grand Ronde Community of Oregon, Confederated Tribes of Siletz Indians, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, Nez Perce Tribe, United States Department of the Interior (DOI), acting through the U.S. Fish and Wildlife Service, U.S. Department of Commerce, acting through the National Oceanic and Atmospheric Administration (NOAA), and State of Oregon. The trustees are authorized under both Federal and state regulations to conduct a NRDA (NCP 40 Code of Federal Regulations (CFR) Subpart G, §300.600, 300.605, 300.610).

In 2010, the Trustee Council released to the public the Portland Harbor Superfund Site Natural Resource Damage Assessment Plan (2010 Plan; Stratus 2010).⁴ The 2010 Plan was developed to guide the Trustee Council in performing the NRDA in a systematic

¹ Oil, for purposes of this document means "oil" as defined in 33 U.S.C. § 2701(23): "oil of any kind or in any form, including petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil...".

² For purposes of this document, the term "Hazardous Substances" is defined in 42 U.S.C. § 9601(14).

³ See 65 Fed. Reg. 232, 75,179 et seq. (Dec. 1, 2000) for description of the Site.

⁴ The Trustee Council released a draft of the Plan for public review and comment in November 2009. The final version of the Plan, released in 2010, addressed the comments received during the comment period (2010 Plan Appendix D) and included Addendum 1 Inclusion of Navigational Services in the Portland Harbor Superfund Site Natural Resource Damage Assessment (Appendix E).

manner at reasonable cost. It lays out an iterative, four-phased approach to encourage participation by parties potentially responsible for releases of contamination and discharges of oil (potentially responsible parties; PRPs) to the lower Willamette River. Each assessment phase outlined in the 2010 Plan builds upon preceding phases (2010 Plan Section 1.5).

The purpose of this Addendum is to provide an update on the current status of the NRDA, as well as more detailed information regarding the Trustee Council's proposed focus for conducting the remaining phases. This includes the Trustee Council's emphasis on specific natural resources and hazardous substances; methods and metrics for quantifying contaminant-related injuries; and the specific studies that the Trustee Council has identified to-date to support injury determination and quantification and damage determination. Phase 3 efforts will build upon the substantial volume of information and data that have been generated through Phase 2, the remedial process, and other studies.

1.1 STATUS OF NRDA PHASES

As mentioned above and described in Section 1.5 of the 2010 Plan, the Portland Harbor NRDA consists of four Phases, which may overlap in their implementation.

Phase 1 – Development of the Assessment Plan. This phase of the Portland Harbor NRDA process is complete, and included:

- Development of the 2010 Plan with an Addendum (Addendum 1) regarding navigational services in Appendix E of the 2010 Plan.
- Implementation of scientific studies to fill data gaps related to salmon and osprey (NOAA 2009, Buck and Kaiser 2011).
- Initiation of public outreach efforts (e.g., comment period on the draft 2010 Plan and a Trustee Council website:
<https://www.fws.gov/oregonfwo/Contaminants/PortlandHarbor/>).
- Review of data collected as part of the remedial process as well as other relevant data and literature to determine preliminary injury and damages and evaluate data gaps.
- Development of an outline for the scope of Phase 2 (Phase 2 Framework). This is included as Appendix B of the 2010 Plan.

Phase 2 – Implementation of the Settlement-Oriented Work Plan. The goal of Phase 2 is to conduct a settlement-oriented assessment, including restoration planning, to enable the Trustee Council to settle PRPs' natural resource liability near the time that the United States Environmental Protection Agency (EPA) issues the Record of Decision (ROD) for the Site. To support these efforts, the Trustee Council is using the extensive breadth of existing information, including the results of studies conducted under Phase 1; the results of additional studies conducted under Phase 2; reasonably conservative, simplifying assumptions to the extent practicable; and guidance in the Federal regulations. The Trustee Council quantified or qualitatively characterized natural resource injuries and lost

services using methods typically applied in the context of NRDA, and identified the type, scale, and cost of restoration sufficient to compensate the public for these losses.

Some efforts have been completed, while others are ongoing. Specifically, during the Phase 2 assessment:

- The Trustee Council defined the Phase 2 Assessment Area (i.e., the area within which natural resource exposure to and injury from contaminant releases are being assessed) as the Willamette River from approximately river mile (RM) 12 to RM 1, and the upper one mile of Multnomah Channel.
- Efforts to assess key resources, including juvenile salmon, Pacific lamprey, white sturgeon, sediment, benthos, piscivorous birds (i.e., osprey and bald eagle), piscivorous mammals (i.e., otter and mink), and other fishes covered by advisories or having recreational value were completed (e.g., Buck and Kaiser 2011, Stratus 2011, Stratus et al. 2013), along with evaluations of pathway and confirmation of exposure of resources to Site-related contaminants.
- The Trustee Council conducted a settlement-oriented assessment of contaminant-related injury to natural resources and corresponding ecological and recreational losses. This assessment used existing information and habitat and resource equivalency analyses (HEA/REA) and benefit transfer to quantify ecological and recreational losses, respectively (methods are described in Chapter 5 of the 2010 Plan).
- The Trustee Council confirmed the importance of specific natural resources such as salmon, lamprey, and sturgeon to the tribal Trustees and evaluated potential compensatory restoration projects to address losses of such natural resources.
- Cooperatively with PRPs, the Trustee Council is engaging in settlement discussions and assessment efforts.
- The Trustee Council completed the Phase 2 restoration planning process, culminating with the release of the Final Programmatic Environmental Impact Statement and Restoration Plan (PEIS/RP) in 2017. The PEIS/RP identifies Integrated Habitat Restoration Planning as the Trustee Council's preferred alternative and lists a suite of potential restoration projects both within the Study Area and the Broader Focus Area (see the PEIS/RP (NOAA 2017) and the 2010 Plan Chapter 5).

The Trustee Council continues to work towards completion of the Phase 2 process. Once Phase 2 is concluded, the Trustee Council will develop a Phase 2 Assessment Report, which describes the Phase 2 process in more detail and will be released to the public for review.

Phase 3 – Completion of the NRDA. Phase 3 will fill remaining data gaps, as needed, to refine injury determination and quantification, damage determination, and restoration planning sufficient for the Trustee Council to pursue litigation-based natural resource damage claims against PRPs who do not settle during Phase 2. This Addendum is the first

step in the Phase 3 planning process, and lays out a framework that the Trustee Council intends to pursue when implementing Phase 3.

The Trustee Council does not yet have a firm timeline for the completion of Phase 3 of this NRDA. A timeline may be accelerated or slowed depending on variables such as further refinement of remedial design by EPA, public comment on this Addendum, and environmental conditions (e.g., weather and flooding) that could restrict ancillary study plan implementation. Even with these areas of uncertainty, the Trustee Council believes that the bulk of the injury assessment work could be completed within the next five years.

Phase 4 – Recovery of damages from non-settling potentially responsible parties. The purpose of Phase 4 is to recover from non-settling Portland Harbor PRPs, jointly and severally, natural resource damages including the costs of assessment, resulting from the release of hazardous substances in the Assessment Area. This phase will include litigation, if appropriate.

Information regarding the NRDA process in general, the legal authority of trusteeship, and the Trustee Council's decision to perform a Type B assessment can be found in the 2010 Plan (Sections 1.2, 1.3, and 1.4, respectively).

1.2 COMPARISON OF REMEDY AND NRDA

With oversight from EPA and the Oregon Department of Environmental Quality (DEQ), a variety of remedial efforts have occurred and are planned for the Site (see Section 2.1 for current status of the Site remedy). The distinction between remedial activities and NRDA is an important one, particularly since both sets of activities often operate concurrently and overlap in geographic scope. Remedial actions aim to remove and/or reduce to acceptable levels the human health and ecological risks associated with hazardous substances at a site. This process is described in CERCLA (42 USC §9601(24)). These efforts are typically funded by the PRPs, the Superfund program, or a combination of both. Remedial activities range from dredging and capping contaminants in place to removal and disposal of contaminated materials in landfills, all of which can, for a short time period re-expose natural resources to the hazardous substances of concern and can physically impact habitat. It is an anticipated risk that is tempered by the knowledge that long-term benefits will be obtained through reduction of human and natural resource exposure to the hazardous substances.

Also under CERCLA, NRDA is a process by which natural resource trustees can determine compensation (i.e., restoration, replacement, or acquisition of equivalent lost resources or resource services) for injuries to natural resources (43 CFR Part 11; see Section 1.1 for current status of the Portland Harbor NRDA). NRDA can take into account the interim losses that the public has incurred due to the release of hazardous substances as well as the release of hazardous substances and physical injuries resulting from remedial activities. The assessment aims to compensate the public for ecological losses as well as potential lost human services including, but not limited to, foregone or diminished recreational fishing and boating trips and lost tribal services. The damages recovered through the NRDA process are then translated into actions in order to restore

the resources and/or services that have been lost, including those resources injured or lost as a result of remedial actions (43 CFR §11.15(a)(1)).

Despite the different goals and timeframes, the Trustee Council and their remedial counterparts are coordinating efforts to the extent practicable in accordance with the CERCLA NRDA regulations (43 CFR §11.31(a)(3)) to avoid situations where natural resources are unnecessarily injured by the remedy and to maximize potential efficiencies (e.g., sampling).

1.3 USE OF EXISTING INFORMATION

The CERCLA NRDA regulations require that the assessment be conducted in a planned, systematic manner and at a reasonable cost (43 CFR §11.13(c)). The Trustee Council prioritizes cost effectiveness. As such, the Trustee Council will review existing data prior to undertaking any new data collection, including data collected as part of remedial and restoration efforts. Where existing data do not allow for the determination of the nature or extent of injuries, the Trustee Council will implement studies that will focus on filling those data gaps. These studies will be designed and implemented in phases to allow for subsequent adjustments in study design based on initial findings.

1.4 COORDINATION WITH OTHER PARTIES

As stated in the 2010 Plan, the Trustee Council will coordinate NRDA activities with ongoing remedial actions to conduct the NRDA efficiently, cost effectively, and with minimal duplication of effort (43 CFR §11.31(a)(3)). Therefore, the Trustee Council will continue to work with EPA, DEQ, and PRPs.

In addition, under CERCLA the parties responsible for releases of hazardous substances were invited to participate in a cooperative NRDA effort (43 CFR §11.32(a)(2) & (d)). For example, the Trustee Council has signed Phase 2 Funding and Participation Agreements with dozens of PRPs, with the goal of relying on existing information for the purpose of early (i.e., prior to litigation) settlement of the cooperating PRPs' natural resource damages liability.

1.5 COORDINATION WITH THE PUBLIC

The Trustee Council will continue to actively encourage public participation and considers such participation to be an important component of the NRDA process. Comments on this draft of the Addendum will provide valuable assistance in planning a cost-effective and technically rigorous assessment. This process will include an opportunity for review and comment by PRPs as well as affected Federal, state, or tribal entities in addition to any interested members of the public (43 CFR §11.32(e)(2)(i)).

Therefore, the Trustee Council will make this draft of the Addendum available for review for a period of thirty days in accordance with 43 CFR §11.32(e)(2)(i). Comments must be submitted in writing to:

Rob Neely
NOAA Office of Response and Restoration
7600 Sand Point Way NE
Seattle, WA 98115
or via email: robert.neely@noaa.gov

All comments should include “2018 Addendum” in the title or subject line.

A copy of this document is available for review online at:

<https://www.fws.gov/oregonfwo/Contaminants/PortlandHarbor/>

and

<https://darrp.noaa.gov/hazardous-waste/portland-harbor>

Other previously prepared Trustee Council documents, some of which are referenced in this Addendum, are also available on these websites.

Interested parties may obtain a hard copy of this Addendum from the Trustee Council by submitting a written request to the address listed above.

The Trustee Council will address public comments and will document responses to those comments as part of the final Addendum.

As the Trustee Council moves forward with this NRDA, there will be additional opportunities for public participation. Examples include review of additional substantial changes to the 2010 Plan, future restoration plans, and proposed settlements. The Trustee Council will provide sufficient notification to the public in advance of these opportunities.

1.5.1 ADMINISTRATIVE RECORD

Pursuant to 43 CFR §11.91(c), the Trustee Council maintains a publicly available Administrative Record for the Portland Harbor NRDA, which includes documents relied upon for the NRDA as well as this draft Addendum and subsequent restoration planning documents. The Administrative Record will soon be available electronically at: <https://www.fws.gov/oregonfwo/Contaminants/PortlandHarbor/#arec>. It is currently available in hard copy at the Portland Harbor NRDA Reading Room, located at the U.S. Fish and Wildlife Service Office (2600 SE 98th Avenue, Suite 100, Portland, Oregon). Visitors may access the Reading Room by appointment. To schedule an appointment, please contact Ted Buerger at ted_buerger@fws.gov.

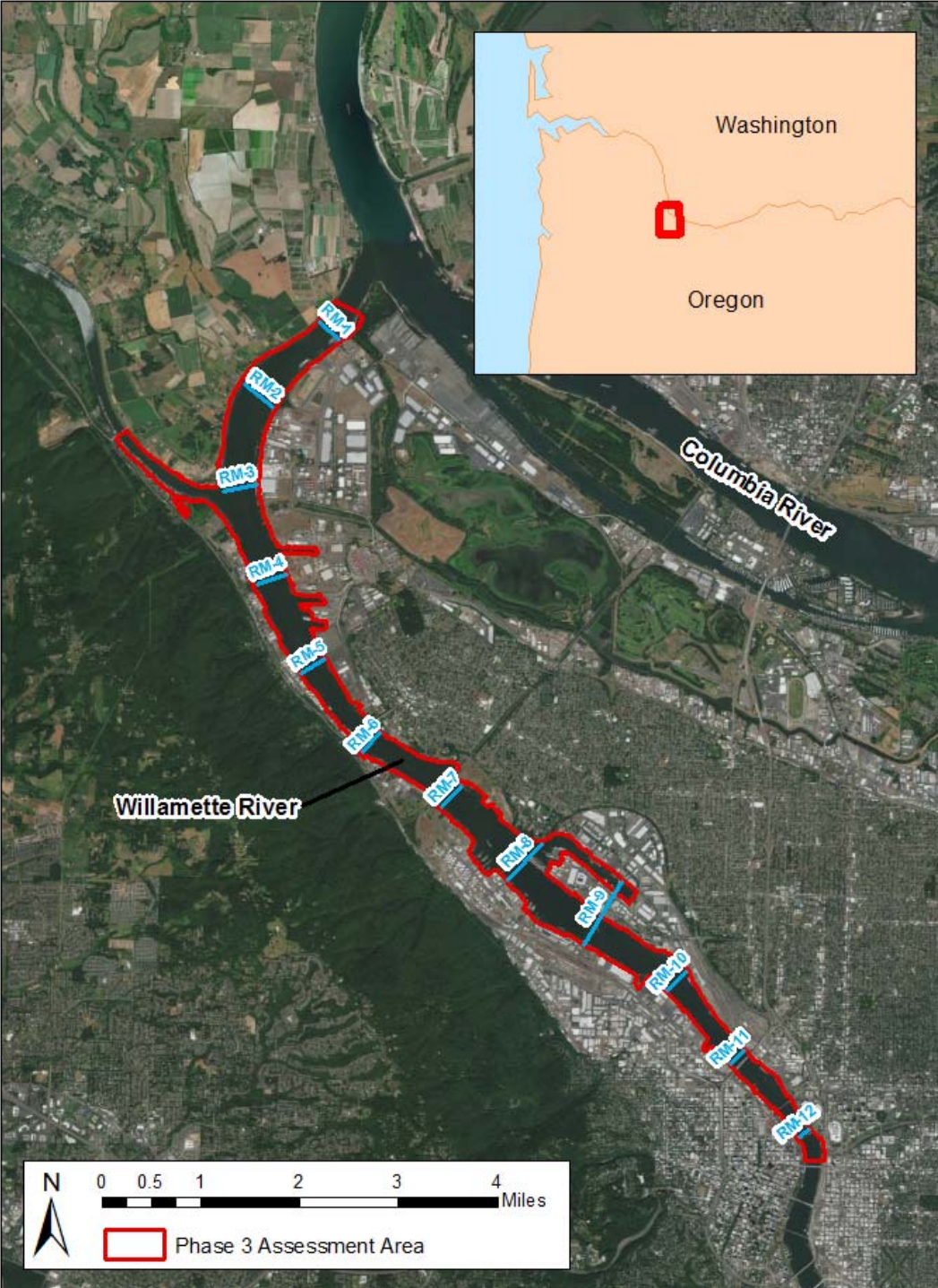
CHAPTER 2 | UPDATE TO PORTLAND HARBOR ASSESSMENT AREA BACKGROUND AND CONFIRMATION OF EXPOSURE

This chapter defines the assessment area for Phase 3 and summarizes the Site history, including the remedial process and current status. It also reviews the sources of hazardous substances and oil, pathways, and natural resources and resource services within that geographic scope. Lastly, this chapter summarizes information indicating that natural resources have been exposed to contamination within the Assessment Area.

2.0 ASSESSMENT AREA

Based on the industrial history of the Portland Harbor area, the 2010 Plan, the geographic scope defined under Phase 2 (NOAA 2017), remedial actions (ongoing and planned), and the CERCLA NRDA regulatory definition of an assessment area (“the area or areas within which natural resources have been affected directly or indirectly by the discharge of oil or release of a hazardous substance” (43 CFR §11.14(c)), the Trustee Council identified the assessment area for Phase 3 of the Portland Harbor NRDA as the Willamette River, including Swan Island Lagoon, from approximately RM 12 to RM 1 near the confluence with the Columbia River, as well as the upper one mile of Multnomah Channel (Assessment Area; Exhibit 2-1). A detailed description of the physical, biological, tribal, and economic characteristics of the Assessment Area is provided in Chapter 2 of the 2010 Plan.

EXHIBIT 2-1 PHASE 3 ASSESSMENT AREA



2.1 PORTLAND HARBOR SUPERFUND SITE HISTORY AND PORTLAND HARBOR REMEDIATION

The Willamette River drains 11.7 percent of the area in the State of Oregon during its meandering 309-mile route, which terminates at the confluence with the Columbia River (EPA 2017). Since the late 1800s, the Portland Harbor section of the lower Willamette River has been widely modified to allow for shipping, manufacturing, and other industries.⁵ This includes the creation of a Federally authorized navigation channel and other maintenance dredging areas.⁶ Wharves, piers, floating docks, and pilings are commonly observed throughout this reach and support shipping activities in addition to stabilizing riverbanks for development (EPA 2017). Hazardous substances entered, and continue to enter, the Willamette River through a variety of historic and current activities, including ship building and repair; ship dismantling; wood treatment and lumber milling; storage of bulk fuels; manufactured gas production (MGP); chemical manufacturing and storage; metal recycling, production, and fabrication; steel mills, smelters, and foundries; and electrical production and distribution (EPA 2017). More detail is provided in Section 2.2 of the 2010 Plan.

In May 1998, the EPA conducted a Preliminary Assessment and Site Investigation, which resulted in the addition of the Site to the National Priorities List (NPL) in December 2000 (EPA 2017). On September 28, 2001, a subset of the approximately 150 PRPs, called the Lower Willamette Group, entered into an Administrative Settlement and Order on Consent with EPA to conduct the Remedial Investigation and Feasibility Study, which collected a substantial amount of data to characterize the physical and chemical characteristics of the lower Willamette River (EPA 2016a, 2016b).

In January 2017, EPA issued the ROD for the Site, which presents the Selected Remedy for clean-up of the in-river portion of the Site from approximately RM 1.9 to RM 11.8. A combination of technologies will be used to address areas where contaminant concentrations in sediment exceed cleanup levels, including capping, dredging/excavation, enhanced natural recovery, and monitored natural recovery (Exhibit 2-2). EPA estimates that construction of the selected remedy will be complete approximately 13 years after the initiation of cleanup. Concurrently, the upland areas adjacent to the Willamette River are undergoing site-by-site cleanup under the authority of DEQ, following the Portland Harbor Joint Source Control Strategy (DEQ and EPA 2005). Remediation of source control locations (e.g., contaminated riverbanks) that are adjacent to in-water cleanup areas may be coordinated with EPA as part of the Site

⁵ See Chapter 2 of the 2010 Plan for more information.

⁶ The Federal navigation channel extends from the confluence of the Willamette and Columbia Rivers to Willamette River RM 11.6 and is authorized to a depth of -40 feet Columbia River datum (U.S. Army Corps of Engineers 2018).

remedy. All other upland source control efforts are expected to be completed prior to in-water remedy implementation.⁷

EXHIBIT 2-2 SUMMARY OF SELECTED REMEDY TECHNOLOGIES (EPA 2017)

TECHNOLOGY	NEARSHORE HABITAT*	NAVIGATION CHANNEL	TOTAL	UNITS
Capping and dredging of in-water contaminated sediment	326	38	365	acres
Monitored natural recovery	675	1,100	1,775	acres
Enhanced natural recovery (Swan Island Lagoon)	28		28	acres
<i>Note:</i>				
* Nearshore habitat includes active channel margin and other shallow water habitats.				

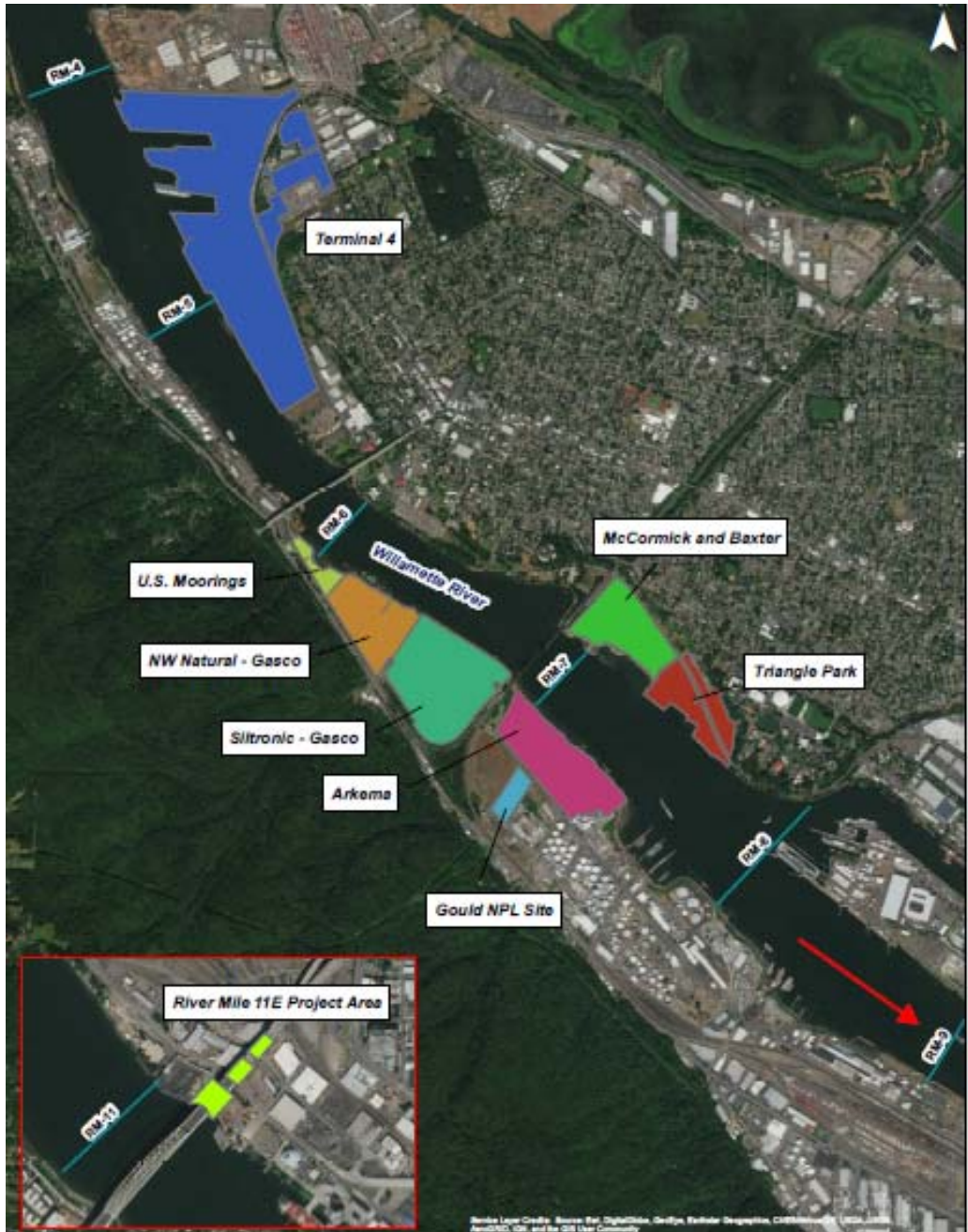
Ongoing remedial work at the Site includes baseline and pre-remedial design sampling as well as DEQ's upland source control efforts, which are being conducted through agreements between EPA and several PRPs. Baseline sampling will provide a point of reference for assessing the long-term success of the remedy, while remedial design sampling will provide information sufficient for drafting engineering designs to implement the remedy (e.g., dredge prisms and cap designs). To the extent practicable, the Trustee Council plans to utilize information gathered during the remedial process in assessing injury.

In addition to this work, a number of enforcement and cleanup actions have occurred or were initiated throughout the Site (Exhibit 2-3; EPA 2017), including at:

- Terminal 4 (RM 4.5 East) – Work completed in 2008 included dredging and off-site disposal of contaminated sediment, capping contaminated sediment in-river, and riverbank capping and stabilizing. Additional cleanup actions are ongoing.
- Triangle Park (RM 5 East) – This remedial action consisted of institutional controls, groundwater monitoring and in-river sediment excavation and capping.
- Gould NPL Site (RM 5 West) – An upland remedy addressed soils at this site in 2000 and the site was removed from the NPL in 2002. Five year reviews of the remedy are ongoing.

⁷ Additional details regarding upland source control work can be found in the Portland Harbor Upland Source Control Summary Report (DEQ 2016).

EXHIBIT 2-3 SITES ASSOCIATED WITH SUBSTANTIAL IN-RIVER REMEDIAL ACTIONS (EPA 2017)



- U.S. Moorings (near RM 6 West) – In June 2007, EPA issued a Resource Conservation and Recovery Act order to the United States Army Corps of Engineers to conduct an upland source investigation. The U.S. Moorings Remedial Investigation/Feasibility Study (RI/FS) for upland sources identified where potentially erodible, contaminated soils were located; these soils were remediated in 2013.
- NW Natural (RM 6 West) – In 2005, tar-like material and tar-like contaminated sediment were dredged from the riverbank and nearshore areas adjacent to the Gasco facility. These materials were disposed of off-site and a cap was constructed over the dredged area.
- Gasco (RM 6.5 West) – NW Natural and Siltronic are conducting site characterization and design evaluations in-water, adjacent to their two facilities. The information collected through these efforts was incorporated into the Site RI/FS, and the remedy will be implemented as prescribed in the ROD.
- Arkema (near RM 7 West) – Site characterization and preliminary design evaluations were conducted, but no cleanup actions were taken.
- River Mile 11E Project Area (RM 11 East) – Characterization efforts for this area were conducted from 2013 to 2015, and the remedy will be implemented as prescribed in the ROD.
- McCormick and Baxter NPL Site (RM 7 East) – Completed in 2005, the selected remedy addressed in-river and upland areas of this site. It included a 23-acre cap on nearshore and submerged lands adjacent to the facility. The most recent five-year review indicated that the remedies for soil, sediment, and groundwater are functioning as intended.

2.2 SOURCES OF HAZARDOUS SUBSTANCES AND PATHWAYS

As described above and in Sections 2.2-2.4 of the 2010 Plan, industrial and municipal activities have resulted in the discharge and release of hazardous substances (e.g., polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, metals, pesticides) to the lower Willamette River. Such releases have occurred through spills, permitted and non-permitted discharges, stormwater runoff from contaminated upland facilities, and movement of contaminated groundwater to Willamette River surface water and sediment. Once contamination reaches the river, it may remain in surface water and be transported away from the location of entry, or adsorb to sediment particles. Organisms are then exposed to these contaminants through direct contact or ingestion of contaminated water, sediment, and prey, moving the contaminants through the food web.

Extensive information regarding contaminant pathways to and movement within the Willamette River has been collected through the remedial and upland source control processes (e.g., as cited in the 2010 Plan Sections 2.3.1 and 2.4).⁸ This includes documentation of facility-specific hazardous substance and oil releases, area-related parameters (e.g., groundwater flow patterns), physical transport mechanisms (e.g., in-river sediment movement, transition zone water characteristics), and contaminant concentrations in various media. For example, Site-related contaminants have been measured in surface water, groundwater, sediment, soil, invertebrates, fishes, birds, and mammals collected from the Willamette River. The Trustee Council will utilize this information to help document the connections between releases, natural resource exposure, and injuries.

2.3 NATURAL RESOURCES AND RESOURCE SERVICES

The Assessment Area is comprised of interconnected and interdependent structures, organisms, and processes, and supports a suite of aquatic-related habitats such as wetlands, shoreline, active channel margin, and other nearshore and shallow water habitat (together, aquatic habitat complex). This aquatic habitat complex includes surface water resources (shallow, pelagic, and benthic waters and sediments); geologic resources, such as soil; and biological resources. Substrates vary from natural rock, silt, and sand to artificial riprap and sheet piling, and may be unvegetated, or vegetated with either native or non-native species.⁹ Biological resources include, but are not limited to, aquatic invertebrates, aquatic and terrestrial plants, reptiles and amphibians, anadromous and resident fish, birds (e.g., osprey, bald eagle, spotted sandpiper), and mammals (e.g., mink, river otter). Some of these species are listed by state and/or Federal agencies as threatened, endangered, or species of concern.

The aquatic habitat complex provides physical structure to the Assessment Area; offers wildlife access to food, water, and shelter; and enables services such as sediment and pollution control, localized microclimate and shading, and provision of wintering and breeding services for waterfowl, shorebirds, and migrating birds. Though parts of the Assessment Area have been modified to accommodate industrial activities (e.g., armored riverbanks), the majority of the Willamette River shoreline within the City of Portland is part of the Greenway overlay, whose purpose is to protect, conserve, enhance, and maintain lands within the aquatic habitat complex, increase public access to the river, and protect and improve water quality (NOAA 2017). The aquatic habitat complex provides structure and vegetation that supply important services to the biological resources in the Assessment Area. For example, because beaches accumulate large woody debris, the

⁸ The CERCLA NRDA regulations define a pathway as: “[t]he route or medium through which oil or a hazardous substance is or was transported from the source of the discharge or release to the injured resource” (43 CFR §11.14(dd)).

⁹ This NRDA will focus on biological species and other natural resources that may have been injured by hazardous substance releases. The dredged navigation channel, rip-rap, sheet piling, and other anthropogenically-altered areas (e.g., parking lots or mowed lawns) are not being considered.

adjacent in-water areas are used by species such as salmon, shad, and white sturgeon. Man-made construction, including pilings and overwater structures (e.g., floating or permanent docks), also influences the quality of the aquatic habitat complex and may provide points of attachment for invertebrate communities and nesting sites for birds (e.g., osprey, cliff swallows; Adolfsen Associates 2009, NOAA 2017).

Together, the components of a habitat support both ecological and human use services. The CERCLA NRDA regulations define services as, “the physical and biological functions performed by the resource including the human uses of those functions,” which can be used as, “a metric for measuring resource conditions and resource restoration” (43 CFR §11.14(nn); 73 Fed. Reg. 57,259 at 57,263-57,264). Some examples of services include, but are not limited to:

- Ecological functions such as nutrient cycling and predator-prey interactions;
- Recreational activities such as hunting, fishing, swimming, boating, and wildlife viewing;
- Cultural, spiritual, and religious purposes; and
- Subsistence and general food sources.

The resources that comprise and utilize the aquatic habitat complex are essential for the sustainable provision of services. Because of the interrelatedness and interdependence of resources within a given habitat, impacts to one component (e.g., individual species or species group) may cause cascading impacts to the natural resource services provided by other resources and the habitat as a whole. Additional descriptions of resources and resource services are provided in Sections 2.5 and 2.6 of the 2010 Plan and Chapter 3 of the PEIS/RP (NOAA 2017).

2.4 CONFIRMATION OF EXPOSURE

As stated in the CERCLA NRDA regulations, “whenever possible, exposure shall be confirmed using existing data,” (43 CFR §11.37(b)) where exposure “means that all or part of a natural resource is, or has been, in physical contact with oil or a hazardous substance, or with media containing oil or a hazardous substance” (43 CFR §11.14(q)). Pursuant to these regulations, in the 2010 Plan the Trustee Council confirmed exposure for a suite of natural resources within the Assessment Area, including surface water (and transition zone water), sediment, groundwater, soil, and biota (e.g., benthic invertebrates, fishes, birds, and mammals; see Chapter 3 of the 2010 Plan for more details).¹⁰

When the 2010 Plan was developed, data sources included key remedial documents and initial NRDA reports (e.g., Integral Consulting 2006a, 2006b; Integral Consulting et al. 2007; PHNRTC 2007). DEQ upland contaminant source investigations also supported the

¹⁰ The analysis was conducted to meet the objectives for confirmation of exposure and does not present the universe of data associated with natural resource exposure to contaminants.

confirmation of exposure for groundwater and geologic resources (DEQ 2016). Since that time, additional data related to the cleanup of the Site have been collected by PRPs (with and without EPA oversight) and DEQ, and independent scientific investigations have been conducted, which may help refine the Trustee Council's understanding of natural resource exposure and injury (e.g., Buck and Kaiser 2011, Stratus et al. 2013, McIntyre 2016, Spromberg et al. 2016). The Trustee Council will determine the relevance and quality of these data and information before relying upon them for the purposes of the NRDA.

CHAPTER 3 | UPDATE TO INJURY ASSESSMENT AND QUANTIFICATION AND DAMAGE DETERMINATION

3.0 ASSESSMENT APPROACH

The CERCLA NRDA regulations require that the assessment be conducted in a planned, systematic manner and at a reasonable cost (43 CFR §11.13(c)). Consistent with these regulations and the approach presented in the 2010 Plan (Section 4.1), the Trustee Council identified a set of contaminants, natural resources, and pathways on which to focus assessment efforts. This assessment will emphasize the use of existing information, identify data gaps, and evaluate potential methods for addressing those data gaps. Studies will be designed and implemented in phases to allow for subsequent adjustments in study design based on initial findings. In addition, the Trustee Council will consider the relationship between injury and restoration to ensure that the metrics used to assess each of these components are comparable and that restoration will provide resources of a type and quality that are consistent with what was lost.

This chapter identifies the hazardous substances and natural resources on which the Trustee Council plans to focus this assessment, discusses injury determination for biological resources, including pathways, summarizes how the Trustee Council will evaluate remedial-related impacts, and describes injury quantification and damage determination methods.

3.1 HAZARDOUS SUBSTANCES

As described in Section 2.2, dozens of hazardous substances and oil have been measured in natural resources from the Assessment Area (more information is available in the 2010 Plan, Section 2.3.2, and remedial documents such as the RI/FS (EPA 2016a, 2016b)). In order to conduct Phase 3 of this NRDA at a reasonable cost, the Trustee Council plans to select a subset of these contaminants on which to focus. At this time, the contaminants of concern (COCs) warranting immediate action by the Trustee Council include PAHs, PCBs, and dichlorodiphenyltrichloroethane (DDT) and its metabolites due to their elevated concentrations, widespread presence in sediments throughout the Assessment Area, and connection to industrial sources. Other COCs may warrant further examination as additional information becomes available.

3.2 NATURAL RESOURCES

For this NRDA, the Trustee Council is prioritizing the assessment of impacts to the aquatic habitat complex within the Assessment Area (including shoreline, active channel margin, and shallow water areas). As described in Section 2.3, the aquatic habitat

complex is comprised of a combination of interdependent natural resources, including surface water, groundwater, sediment, soils, and biological resources. Changes in habitat functionality, or services, can be informed by the health of those resources and/or the measured levels of contaminants in a particular resource. Changes to the condition of individual organisms or the health and survival of populations that utilize a habitat reflect the services provided by that habitat as a whole. Thus, habitat services and biological resources are linked, and impacts to one will influence the other. Specifically for Phase 3, the Trustee Council is initially focusing their assessment of COC-related injury on organisms mostly likely to use the aquatic habitat complex, including benthic invertebrates (e.g., amphipods, midges), forage fish (e.g., sculpin), and Chinook salmon. These resources are key elements of the aquatic ecosystem, have been exposed to Site-related contaminants (as detailed in the 2010 Plan, Sections 3.3 and 3.6), are representative of impacts to habitat within the Assessment Area, and may also be resources of particular significance to both the general public and tribal members. The Trustee Council is also evaluating potential injuries to birds and mammals that utilize the Assessment Area to determine if additional assessment is warranted.

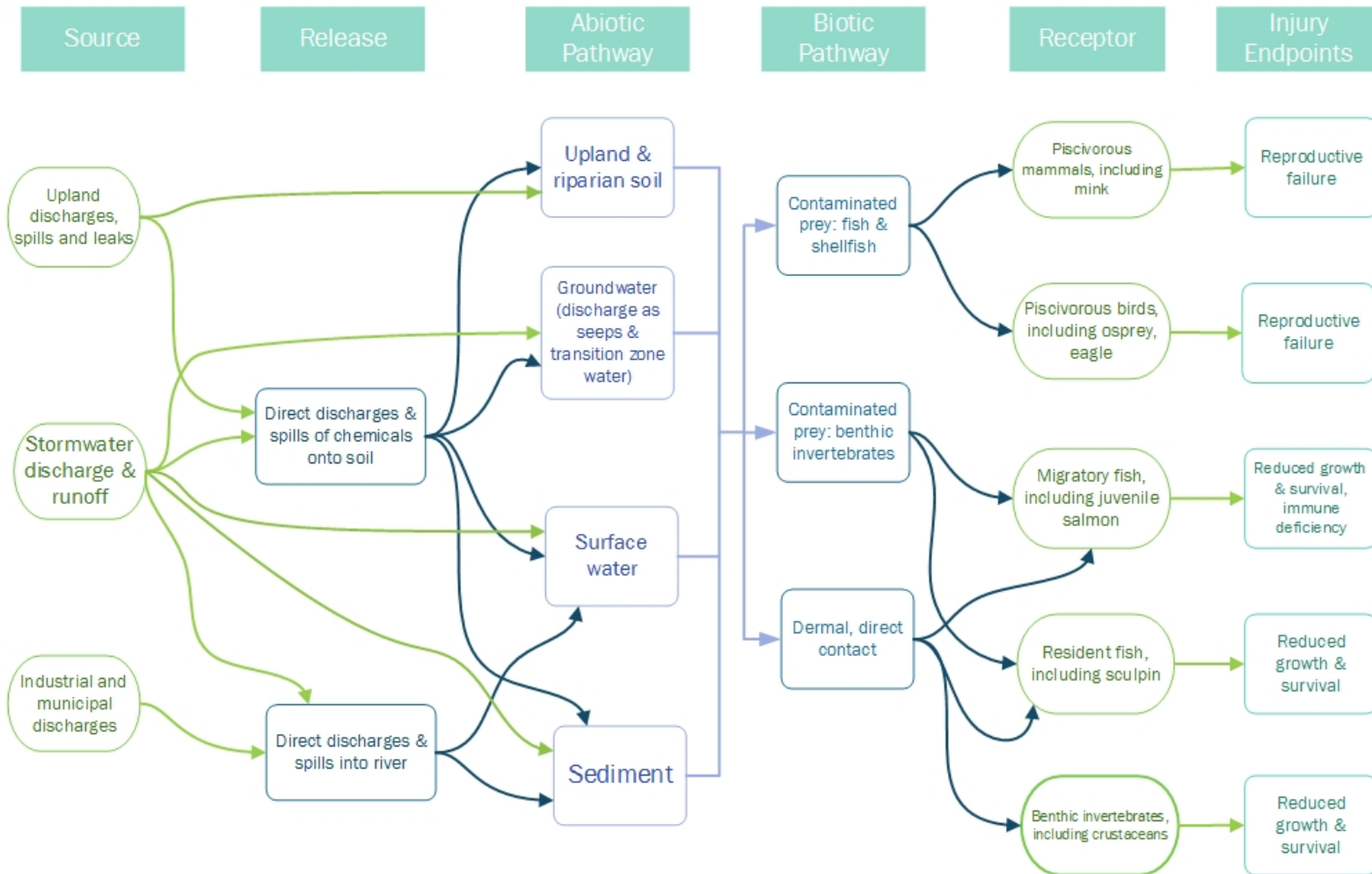
3.3 INJURY DETERMINATION

Determination of injury to natural resources under the CERCLA NRDA regulations consists of documentation that: (1) there is a pathway for the released hazardous substance from the point of release to a point at which natural resources are exposed to the released substance (43 CFR §11.61(a) & (b)), and (2) injury of a natural resource of interest (in this case, biological resources) has occurred, as defined in 43 CFR §11.62. Exposure pathways and injury categories are described below.

3.3.1 PATHWAY

An important step in determining injury to natural resources is to establish a pathway from a known release of a hazardous substance or oil to exposure of a natural resource. At this time, the Trustee Council is focusing on sediment and biological pathways. Direct contact with sediment may expose resources to contaminants. Food web transfer is also important due to the potential of some Site-related contaminants to biomagnify (e.g., PCBs). As noted in Section 2.2, there is an extensive body of available information regarding contaminant fate and transport, both generally in aquatic systems and accounting for Assessment Area-specific characteristics. The conceptual site model in Exhibit 3-1 summarizes the Trustee Council's current focus on specific pathways, biological receptors, and endpoints of injury for the Portland Harbor NRDA. As the NRDA proceeds, the Trustee Council may identify additional pathways of concern.

EXHIBIT 3-1 PRELIMINARY PHASE 3 CONCEPTUAL SITE MODEL



3.3.2 INJURY TO BIOLOGICAL RESOURCES

Because the Trustee Council is focusing on biological resources, injury will be determined based on the CERCLA NRDA regulations as, “a measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a discharge or oil or release of a hazardous substance” (43 CFR §11.14 (v)). Specifically, injury to biological resources has occurred if exposure to Assessment Area-related contaminants:

- 1) “Cause[s] the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations” (43 CFR §11.62(f)(i)). The Trustee Council will focus on metrics that are relevant for a particular ecosystem, habitat, or resource. For example, site-specific toxicity tests could indicate a significant reduction in survival or growth of a species, constituting an injury under this definition.
- 2) “Exceed[s] levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism” (43 CFR §11.62(f)(iii)). Fish consumption advisories are currently in place for the Portland Harbor stretch of the lower Willamette River due to PCBs.¹¹ The Oregon Department of Health advises people to avoid eating carp, bass, and catfish, and to limit consumption of other resident fishes to one meal per month. Vulnerable populations, which include young children, women of childbearing age, and people with compromised immune systems, are advised not to consume any fish from the area (OHA 2018).

The Trustee Council will prioritize the use of existing data and information to the fullest extent possible, including to establish metrics of injury. Additionally, the Trustee Council will consider a phased approach for developing studies or analyses, as necessary, to address data gaps in the assessment. These are cost effective strategies that are expected to satisfy the standard of reasonable cost described in 43 CFR §11.13(c).

3.3.3 INJURY CAUSED BY REMEDIAL ACTIONS

Remedial actions often do not fully return natural resources and/or lost services to baseline conditions (i.e., the conditions that would have existed had the release of the hazardous substances not occurred) because remedial actions are designed to manage unacceptable risks to human health and the environment. Further, remedial actions that involve, for example, dredging and other physical alterations of the environment, may also result in unavoidable, additional injury that is compensable under 43 CFR § 11.15(a)(1). The Trustee Council may identify and quantify the extent to which

¹¹ There is also a fish consumption advisory (FCA) for the Willamette River from the confluence with the Columbia River southward to Eugene for mercury.

remediation affects natural resources by assessing both physical injuries and injuries resulting from residual contamination throughout the documented or expected timeframe of those injuries. This evaluation would be based on a review of remedial documents, when available, including documents that describe where remediation has been completed, or that reasonably estimate the result of the remedy (i.e., habitat condition and level of contamination) (See 43 CFR § 11.15(a)(1)).

In 2017, the EPA issued the ROD for remedial actions in the Site. Consistent with Section 1.2, The Trustee Council will look for opportunities to coordinate remedial actions and NRDA assessment and restoration efforts. This coordination will both increase efficiencies (i.e., cost and time) as well as benefit the natural resources within the Assessment Area. Restoration work conducted in conjunction with the remedy and proposed as compensation for natural resource injuries will be reviewed for approval by the Trustee Council before compensation is accepted, and may also be reviewed by the public as part of restoration planning.¹²

3.3.4 SUMMARY OF INJURY DETERMINATION

Currently available data and information demonstrate that natural resources in the Assessment Area have been exposed to and injured by the release of Site-related hazardous substances (e.g., studies and analyses conducted under Phase 2). The Trustee Council has identified specific categories of injury and corresponding habitat and resources that will be the focus of Phase 3 efforts to refine the determination of injury in the Assessment Area. Studies will build on Phase 1, Phase 2, remedial, and other studies, and potentially include, but are not limited to:

- Comprehensive review of existing exposure and effects data;
- Documentation of the pathways from the Site-related source(s) of the COCs to the point at which biota are exposed to those contaminants;
- Documentation of the exposure of natural resources to COCs and corresponding injury, including through sample collection and analysis and laboratory tests;
- Determination of the type and extent of the public's use of Assessment Area resources.

As part of the injury determination process, study efforts will include the data collection and analyses necessary to further characterize baseline conditions (i.e., natural resource conditions but for the contamination; see Section 3.5). These studies and any considerations to be implemented within each study work plan are further discussed in Chapter 4.

¹² Interested PRPs must obtain the approval of the Trustee Council prior to project implementation in order to receive credit against potential liability.

3.4 INJURY QUANTIFICATION AND DAMAGE DETERMINATION

Once injury to natural resources has been documented, the CERCLA NRDA regulations state that:

...the authorized official shall quantify for each resource determined to be injured and for which damages will be sought, the effect of the discharge or release in terms of the reduction from the baseline condition in the quantity and quality of services...provided by the injured resource (43 CFR §11.70(a)(1)).

The purpose of the injury quantification step is to define the scope of natural resource injuries and lost services, and to allow for selection and scaling of restoration projects that will adequately and appropriately compensate the public for those injured resources and lost services. The Trustee Council may quantify and value injuries through time, utilizing metrics and units that will depend on how the injury is characterized (see also 2010 Plan Section 4.9). For example, the units could be a quantity of resource (e.g., number or biomass of fish lost); quantity or quality of habitat (e.g., acres of wetland injured); quantity of services (e.g., number of fishing days lost or impaired); or a value (e.g., in dollars) for losses in natural resource services.

An additional parameter in the injury quantification, per the CERCLA NRDA regulations, is a preliminary determination of the recovery period for the resources and habitat within the relevant geographical area (43 CFR §11.31(a)(2)). Recovery period, as defined in 43 CFR §11.14(gg), “means either the longest length of time required to return the services of the injured resource to their baseline condition, or a lesser period of time selected by the authorized official and documented in the Assessment Plan.” The Trustee Council will consider factors such as proposed or implemented remedial and restoration activities, natural attenuation, and species’ habitat use and sensitivity to contaminants when estimating the recovery period in the Assessment Area. Due to the nature of the contaminants in the Assessment Area (e.g., chemicals with bioaccumulative properties), at this time the Trustee Council anticipates that it will take many decades for some natural resources and resource services in the Assessment Area to reach baseline conditions. Other natural resource services may never return to baseline. The Trustee Council will refine these estimates based on the results of relevant assessment studies.

Once injury is quantified, the Trustee Council will determine the damages required to compensate the public for losses to natural resources and resource services. Damages can be measured as the cost to restore, replace, or acquire the equivalent of lost resources, or the lost value associated with the reduction in resource services (43 CFR §11.80). The CERCLA NRDA regulations identify a list of relevant cost- and value-estimating methodologies for determining natural resource damages (43 CFR §11.83).

Based on current knowledge and understanding of the Assessment Area and the CERCLA NRDA regulations, the Trustee Council anticipates utilizing the following approaches for injury quantification and damage determination. The Trustee Council may consider different approaches if new information becomes available as the assessment proceeds.

- **Ecological:** Exposure to contamination can cause toxic effects on biota, resulting in a loss of resources and resource services. The Trustee Council anticipates using resource equivalency methods (described in more detail in 2010 Plan Section 5.1) to refine the Phase 2 assessment of ecological injuries. As such, the Trustee Council will quantify ecological injury in terms of the loss of specific resources of concern (e.g., threatened or endangered species, species of cultural importance), and will determine damages as the cost of implementing sufficient habitat restoration to generate resources equivalent to those lost.
- **Recreational (human use):** Contamination and associated fish consumption advisories can cause adverse changes to available services in terms of recreational quality, public access, or recreation demand. The Trustee Council will rely on existing information, as well as interviews with key informants and focus groups with recreationists, to determine if implementing survey-based methods for quantifying recreational losses due to contamination is warranted. The Trustee Council may base damages either on the lost value of recreational use services (value-to-cost) or the cost of implementing sufficient restoration such that the amount of recreational use value created is equivalent to the value lost (value-to-value).
- **Tribal lost services:** The Trustee Council expects to quantify the change in services provided by natural resources and corresponding impacts to tribal communities due to contamination of Assessment Area resources through a cultural assessment. The Trustee Council will evaluate methods to refine their determination of tribal-related damages when more information on the types and scale of losses is available. For example, REAs that support the safe continuation of traditional uses by tribal members may be utilized to support tribal service loss assessments.

These anticipated approaches to injury quantification are discussed in greater detail in the following sections.

3.4.1 ECOLOGICAL INJURY QUANTIFICATION AND DAMAGE DETERMINATION APPROACH

The Trustee Council anticipates quantifying injury to natural resources that utilize the aquatic habitat complex within the Assessment Area. Ecological losses may result from the direct (e.g., toxic) or indirect (e.g., remedial) effects of hazardous substances and oil on natural resources, including biological organisms. The Trustee Council will apply a variant of resource equivalency analysis for Portland Harbor. This method is identified in the CERCLA NRDA regulations (43 CFR §11.83(c)(2)) and is commonly applied in the context of NRDA, as it not only provides quantitative measures of lost natural resources, but also can be used to scale restoration projects to compensate for natural resource service losses.

The Assessment Area's aquatic habitat complex supports key resources that are essential to habitat health, viability, and sustainability and are of specific concern for this assessment (Section 2.3). For each resource of focus (e.g., salmon), the Trustee Council

will identify an appropriate metric(s) to assess the degree of contaminant-related injury (e.g., percent reduction in growth or survival), and will identify the locations within which the injury has occurred in the past and/or is expected to occur in the future. Existing data (e.g., developed under Phase 2 and related efforts), in combination with the studies described in Chapter 4, will generate data appropriate for application in a REA, and injury will be quantified for each species and metric over time. Each species/metric combination will be considered an independent indicator of the quality of the aquatic habitat complex. Studies will include field-based studies (e.g., to confirm exposure to Site-related contaminants and assess the type and magnitude of effect resulting from that exposure), laboratory studies to confirm that Site-related contaminants cause the field-based observations on relevant endpoints, and studies to verify the completeness of contaminant pathways.

To determine the damages required to compensate for ecological injuries, the Trustee Council will use REA to calculate the quantity of habitat, of a certain type and quality, expected to create additional resources equivalent to the quantity of injured resource(s). The benefits of habitat restoration projects (consistent with the Integrated Habitat Restoration Alternative in the PEIS/RP (NOAA 2017)) to each of the indicator species will be quantified using the same metrics as those used to quantify injury. This comparison will inform the scale of required compensatory restoration. For all species that utilize or benefit from the same habitat type, the total quantity of required restoration will be based on the species requiring the most restoration. This approach assumes restoration will also fully compensate for the service losses associated with an indicator species requiring less restoration. By calculating restoration in this manner, the Trustee Council accounts for lesser quantities of damages and avoids double counting. Damages will be calculated as the cost to implement that restoration.

3.4.2 RECREATIONAL USE INJURY QUANTIFICATION AND DAMAGE DETERMINATION APPROACH

There is a broad range of services that humans derive from natural resources. Recreational use loss is a common category of human use losses associated with releases of hazardous substances for which trustees typically seek compensation. With parks and access points along the Willamette River, there are many recreational opportunities for millions of users within a short distance from the Assessment Area. Fishing is a popular activity in this region, both by boat and from the bank. Species targeted include spring Chinook salmon, steelhead trout, coho salmon, shad, white sturgeon, and bass. Members of the public also use the lower Willamette River for motor boating, sailing, jet skiing, kayaking, rowing, paddle boarding, and windsurfing. Waterskiing, tubing, and swimming are also common, and beaches are found both upriver of downtown Portland and below Portland at the confluence of the Willamette and Columbia Rivers.

Contamination may affect recreationists in a number of ways. Some recreationists may forgo visits due to the presence of hazardous substances. Others may proceed with a visit, but the visit may have a diminished value due to the presence of contaminants. Preliminary investigation of potential recreational losses by the Trustee Council indicates

that recreational use losses have likely occurred as a result of hazardous substances releases to the Assessment Area (e.g., fish consumption advisories have been in place for the Willamette River since 2001; OHA 2017). During Phase 2, the Trustee Council developed an estimate of recreational use damages for impacts to fishing and pleasure boating, and identified potential impacts to other activities from Site-related contamination.

Under the CERCLA NRDA regulations, to the extent that the release of hazardous substances causes changes to available services in terms of recreational quality, public access, or recreation demand, these changes are compensable (43 CFR §11.71(e)). To assess the magnitude of this potential loss, the Trustee Council plans to implement a phased approach, with the scope and implementation of each phase dependent on the results of the previous phase. Part 1 will consist of a comprehensive review of existing information, building on Phase 2 efforts. Part 2 would involve interviews with key informants and focus groups with recreationists, for which the Trustee Council will develop specific questions and elicit feedback regarding recreational use and preferences in the Assessment Area. Based on the results of Parts 1 and 2, the Trustee Council will determine whether further evaluation of recreational loss is appropriate. If so, they will likely implement a primary study of recreational activity using one of the survey-based methods listed in the CERCLA NRDA regulations (e.g., revealed preference or stated preference; 43 CFR §11.83).

3.4.3 TRIBAL LOSS QUANTIFICATION APPROACH

Tribal loss refers to a loss in natural resource services of importance to the governments or members of tribal communities, for which separate natural resource restoration actions may be needed. Due to the differences in the nature and extent of services tribal members derive from the environment and the corresponding impacts of those changes, it may be necessary to describe and quantify service losses to tribal communities separately from service losses to the non-tribal general public. For example, the cultural significance of a particular natural resource, its traditional collection, and/or use may differ from that of the non-tribal general public. Thus, specific restoration actions may be required to fully compensate for losses in tribal services.

Examples of methods that trustees have applied to measure service losses to tribal communities in the context of NRDA include, but are not limited to:

- Assessment of changes in tribal services. This includes assessment and analysis of changes in levels of traditional knowledge, cultural practices, and relationships resulting from shifts in the use of natural resources caused by the presence of hazardous substances. Such an analysis is generally based on applied anthropological and ethnographic approaches (e.g., community-based research).
- Direct assessment of lost resource use. This can involve application of revealed preference techniques, user surveys, and existing data. Data can include the number of individuals who previously used a site, the nature and frequency of that

use, substitution or alternative behaviors, and the expected recovery period for the activity.

- REA. This involves the use of resource-based measures to quantify the level of resource-specific losses given the assumption that ecological service losses are a proxy measure of tribal service losses. For example, REA can be applied to estimate losses due to decreasing/eliminating collection of culturally important species due to consumption guidelines (43 CFR §11.62(f)(1)(iii)).
- Stated preference and other survey-based techniques. This involves the use of surveys to elicit tribal attitudes and preferences toward an injured resource.

The Trustee Council may use a combination of these approaches to assess changes in services resulting from the release of hazardous substances and oil to the environment.

3.5 BASELINE

Baseline, as defined in 43 CFR §11.14(e), is;

...the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred.

Baseline data should reflect expected conditions in the Assessment Area had the discharge of oil or release of hazardous substances not occurred, taking into account natural processes and changes that result from human activities (e.g., structural alterations). The Trustee Council evaluated baseline conditions in the Assessment Area under Phase 2, using information on contaminant concentrations and other physical conditions in reference areas, data from study controls, and reasonable assumptions.

Under Phase 3, the Trustee Council plans to further refine their understanding of baseline conditions. Their approach to establishing baseline conditions may vary by natural resource or the service being assessed. In general, the characterization of baseline conditions will occur within the specific injury studies that are proposed (Chapter 4). In the context of ecological injury, the Trustee Council will define resource-specific baseline conditions by selecting appropriate reference locations that differ as little as possible from the Assessment Area, except for the presence of contamination (43 CFR §11.72(d)). Additional studies and evaluations will likely be needed to understand whether other factors could be contributing to adverse effects observed in the Assessment Area. Baseline is also a consideration when quantifying the recreational and tribal services that natural resources would provide but for the release of hazardous substances.

CHAPTER 4 | PROPOSED STUDIES

4.0 INTRODUCTION

The preceding chapters describe some of the key components of the Portland Harbor NRDA and discuss the framework and general approaches the Trustee Council plans to apply. The NRDA itself will be comprised of a series of iterative analyses aimed at assessing the severity and magnitude of natural resource injury resulting from hazardous substance releases to the Assessment Area. Efforts will focus on natural resources that are commonly found in the lower Willamette River and have likely been injured by the release of Site-related contaminants. These resources include, but are not limited to, benthic invertebrates (e.g., amphipods, midges), forage fishes (e.g., sculpin), Chinook salmon, birds, and mammals. In order to advance the injury assessment process outlined in Chapter 3, the Trustee Council plans to undertake studies that will: 1) determine and quantify injury to natural resources and lost services resulting from Site-related contamination, and 2) assist in identifying and scaling restoration projects that will compensate for natural resource injuries (including the cost of such restoration).

This work will build on previous studies investigating the effects of contaminants on Assessment Area resources and associated recreational uses and tribal services. Previous research has documented the toxic effects of COCs in relevant natural resources, such as juvenile salmonids (e.g., Meador et al. 2002a, 2002b; Meador et al. 2006; Johnson et al. 2014; O'Neill et al. 2015) and forage fishes (e.g., Kuzyk et al. 2005, Khan 2011). For instance, O'Neill et al. (2015) found that juvenile Chinook salmon residing and feeding in more urbanized and industrialized environments are exposed to higher concentrations of contaminants than salmon in less developed habitats, and Arkoosh et al. (1998) reported that chemical contaminants in a polluted estuary in the Pacific Northwest, with historical contamination of COCs, was linked to reduced immune response and subsequent survival of juvenile Chinook salmon. Meador (2013) also found that survival rates for juvenile Chinook out-migrating through contaminated estuaries were significantly lower than those utilizing relatively clean estuaries. Adverse effects, such as reduced growth, immunological impacts, and biochemical changes, have been reported in salmonids exposed to PCBs, DDTs, and PAHs (Johnson et al. 2014), including wild juvenile Chinook salmon exposed to COCs in a contaminated estuary (Varanasi et al. 1993, Arkoosh et al. 1998). A synthesis of published scientific studies associated exposure to DDT with adverse biological effects in juveniles and adult fish species, including salmonids (Beckvar et al. 2005); similarly, exposure to PCBs has been associated with adverse physiological effects in juvenile and adults salmonids (Meador et al. 2002a). The Ecological Risk Assessment portion of the Remedial Investigation for the Site also identified the potential for adverse effects (i.e., reduced survival, reduced growth, or

impaired reproduction) on benthic invertebrates, fishes, and wildlife resulting from exposure to PCBs, PAHs, and DDT compounds through multiple lines of evidence (Windward 2013 in EPA 2016a).

As described in Section 2.3, natural resources that utilize habitat within the Assessment Area not only provide ecological services, but also provide human use services to both the general public and tribal members. For example, recreational fishing has been affected by the fish consumption advisories in place for the lower Willamette River. The importance of Assessment Area resources to tribal members, their connection to and use of those resources, and the impacts of contamination on tribal practices has also been documented. For example, in 2005 the Lower Willamette Group funded a Cultural Resources Analysis as part of the RI/FS process. The report uses oral histories, interviews, and other anecdotal evidence to show that the lower Willamette River has historically been an important area for tribal fishing, gathering, trade and other traditional practices (Ellis et al. 2005). Personal Use Permit data from the Oregon Department of Fish and Wildlife also report lamprey harvest occurring at Willamette Falls. Therefore, the ongoing, planned, and potential studies summarized below focus on these natural resources.

Future efforts based on the results of initial studies may include: 1) determining that exposure of, and injury to, natural resources have occurred due to the release of hazardous substances to the Assessment Area; 2) quantifying injury to natural resources in terms of lost ecological, recreational, and tribal use services; and 3) determining damages (i.e., the amount of money sought by the natural resource trustees as compensation for injury) associated with the quantified losses. Damages collected by the Trustee Council from the PRPs will then be used by the Trustee Council to plan and implement restoration projects consistent with the PEIS/RP (as described in Section 1.1).

This chapter describes the studies that the Trustee Council is presently undertaking or considering at this time. These selected efforts represent the Trustee Council's best understanding the information that may be needed to further refine the determination and quantification of injury to Assessment Area natural resources and resource services. This Addendum is not intended to limit other studies that may be undertaken in the course of the assessment, as the Trustee Council recognizes that other studies may become necessary or advisable as the assessment proceeds and new information becomes available, or new data gaps are identified. To the extent possible, study development will be coordinated with ongoing efforts initiated by other entities (e.g., EPA and DEQ). In addition, the inclusion of a study within this Addendum does not guarantee that it will be undertaken. For example, the Trustee Council may decide that some studies may not be needed if reasonable assumptions supported by expert opinion can be made, considering the cost of additional research or sampling against the expected gain in information from a particular study. As such, this Addendum provides a starting point from which the Trustee Council will prioritize study efforts and implement the Phase 3 injury assessment process. As these efforts progress and additional information is generated, the Trustee Council may provide amendments to this Addendum or additional addendums to the 2010 Plan for public review.

4.1 STUDY PRIORITIZATION

The Trustee Council identified and prioritized a list of discrete assessment activities that are expected to assist in identifying and quantifying the scale of natural resource injury stemming from releases of hazardous substances to the Assessment Area. Study prioritization is based on:

- The review and use of existing information specific to the Assessment Area;
- Likely cost–effectiveness;
- Technical sequencing (e.g., an assessment activity may have a nearer-term priority if the analysis generates data or results upon which subsequent assessment efforts are based);
- Efforts that may be more likely to clarify the existence or extent of injury; and,
- Efforts most likely to contribute to the understanding of the appropriate scale and scope of required restoration.

Based on this prioritization, assessment activities are grouped into one of three categories:

1. Nearer-Term Priorities (Level 1). Ongoing efforts by the Trustee Council and studies that provide prerequisite data for future studies.
2. Middle-Term Priorities (Level 2). Studies that build upon the data collected in Level 1 studies with the intent of more effectively determining injury, addressing principal concerns of the public, and/or directly assisting in scaling restoration alternatives.
3. Longer-Term Priorities (Level 3). Studies that will be needed for later stages of the assessment process, depend largely on the completion of previous efforts, are expected to be subject to more difficult technical challenges, or, at this time, are less certain of satisfying the CERCLA NRDA regulatory requirement for cost effectiveness.

4.2 INJURY ASSESSMENT STUDY DESCRIPTIONS

The Trustee Council’s proposed studies are summarized in Exhibit 4-1 and presented in detail in this section. Each study description discusses the study objectives, the need/rationale for each study, and the general approach to conducting the study, which will be developed further in collaboration with principal investigators (PIs). These studies will build on previous efforts, including Phase 1, Phase 2, remedial studies, and other relevant investigations.

EXHIBIT 4-1 ONGOING AND PLANNED STUDIES

CATEGORY	STUDY NUMBER	PRIORITY	STUDY	OBJECTIVE	STATUS
Data Management	1	1	Development of database and data analysis protocols	Review and integrate data from available sources (e.g., DEQ's Environmental Cleanup Site Information Database (ECSI), remedial databases, relevant literature) into NOAA's Data Integration Visualization Exploration and Reporting database (DIVER). Work with the Trustee Council to finalize methods for handling sample results that report non-detects, lab replicates, field duplicates, and data qualifiers; and develop methodology to define and apply protocols for processing and use of the data to meet goals of the assessment.	Ongoing
Pathway	2	1	Review of existing pathway-related data	Review existing information on physical and chemical transport mechanisms within the Assessment Area to document contaminant pathways. Include spill histories and data on surface water, groundwater, flow-through infrastructure (e.g., outfalls), soil, and sediment.	Potential
	3	3	Analysis of media to support pathway analyses	Collection of Site-related soil, overland surface water runoff, outfall discharge, and/or groundwater. Analysis of COCs in these media and physical characteristics to assess connections between sources and Assessment Area resources.	Potential
Sediment	4	1	Review of existing sediment data	Based on the database (see "Data Management"), evaluate the extent, quality, and appropriateness of available sediment chemistry data, information on physical parameters, and timing of relevant remedial actions to inform benthic invertebrate and fish injury assessment and assist in study design.	Ongoing
	5	2	Analysis of Assessment Area sediment	Collection of sediments, as needed, to complement studies of benthic invertebrate and fish exposure and toxicity, and pathway. Analysis of COCs in Assessment Area sediments, and corresponding physical parameters, as compared to reference site sediments.	Potential
Benthic Invertebrates	6	1	Review of existing invertebrate data	Evaluate the extent, quality, and appropriateness of available contaminant chemistry and toxicity data associated with relevant benthic invertebrate species to inform the potential severity and magnitude of injury.	Ongoing
	7	2	Benthic invertebrate baseline parameters	Compile and review existing information to determine baseline benthic invertebrate community characteristics (e.g., abundance of target species) and habitat extent within the Assessment Area.	Potential

CATEGORY	STUDY NUMBER	PRIORITY	STUDY	OBJECTIVE	STATUS
Fish	8	1	Review of existing fish data	Based on the database (see "Data Management"), review the extent of available contaminant chemistry data measured in fish tissues and data related to fish toxicity studies to inform historic exposure and effects as well as the need for and design of subsequent primary studies.	Ongoing
	9	1	Juvenile salmonid field-based exposure and toxicity assessment	<i>In situ</i> collection of juvenile salmonids and assessment of the toxicity of Assessment Area-specific contaminant exposure. Analysis of COCs in field-collected juvenile salmonid tissues, stomach contents, and/or whole organisms to assess exposure to Site-specific contaminants.	Potential
	10	2	Juvenile salmonid laboratory toxicity testing	Laboratory study exposing juvenile salmonids to relevant COCs to confirm causality between contaminant exposure and effects on relevant endpoints.	Potential
	11	1	Forage fish field-based exposure and toxicity assessment	<i>In situ</i> collection of bottom-dwelling resident fish (e.g., sculpin) and assessment of the toxicity of Assessment Area-specific contaminant exposure. Analysis of COCs in field-collected bottom-dwelling resident fish tissues, stomach contents, and/or whole organisms to assess exposure to Site-specific contaminants.	Potential
	12	2	Forage fish laboratory-based toxicity testing	Laboratory study exposing bottom-dwelling resident fish (e.g., sculpin) to relevant COCs to confirm causality between contaminant exposure and effects on relevant endpoints.	Potential
	13	3	Baseline migratory and forage fish characteristics	Determine baseline characteristics of migratory salmonids and resident forage fish (e.g., abundance, community age structure, habitat use) within the Assessment Area.	Potential
Birds	14	1	Review of existing avian exposure, toxicity, life history, and habitat use data	Review existing data on avian exposure and toxicity (for chemical analyses and/or toxicity studies; see "Data Management"), life history information, and habitat use data to determine if additional assessment is warranted.	Ongoing
Mammals	15	1	Review of existing mammalian exposure, toxicity, life history, and habitat use data	Review existing data on mammalian exposure and toxicity (for chemical analyses and/or toxicity studies; see "Data Management"), life history information, and habitat use data to determine if additional assessment is warranted.	Ongoing
Remedial Activities	16	2	Impacts of remedial activities	Compile information on remedial activities and evaluate the severity of impacts on the aquatic habitat complex. This includes the timing, location, spatial extent, and type of remedial activities.	Potential

CATEGORY	STUDY NUMBER	PRIORITY	STUDY	OBJECTIVE	STATUS
Recreation	17	1	Review existing outdoor recreational use data and information	Review existing data and information on the types and levels of potentially affected recreational activities in the lower Willamette River through time. Review public information on and awareness of the contamination in the lower Willamette River, including via fish and shellfish consumption advisories and guidelines, news reports, and community information sources.	Ongoing
	18	2	Outdoor recreational use interviews and focus groups	Organize and implement interviews and focus groups with recreationists to gain information and insights into outdoor recreational use, including fishing, boating, and swimming in the lower Willamette River. Consider results along with previously collected information to determine if a primary recreational use study is needed.	Potential
	19	3	Outdoor recreational use survey	If necessary based on results of Study 18, implement one or more surveys to quantify lost recreational use on the lower Willamette River potentially affected by the contamination.	Potential
Tribal Loss	20	1	Assess changes in the tribal services provided by natural resources as a result of COCs	Further document the relationship between the affected Tribes and resources that utilize the Assessment Area. Identify natural resources and habitat of importance to these communities for which tribal members hold a different value than the general public, and assess changes in resource use as a result of contamination.	Potential

DATA MANAGEMENT: DEVELOPMENT OF DATABASE AND DATA ANALYSIS PROTOCOLS (STUDY #1, PRIORITY 1)

Objectives: (1) Review and integrate relevant Assessment Area-related data (e.g., sediment, fish tissue) from available sources (e.g., DEQ’s Environmental Cleanup Site Information Database (ECSI), remedial database, literature) into NOAA’s Data Integration Visualization Exploration and Reporting (DIVER) database. (2) Finalize methods for handling sample results that report non-detects, lab replicates, field duplicates, and data qualifiers, and develop an analytical methodology to determine protocols for processing and use of the data to meet assessment goals.

Need/Rationale: A substantial amount of Assessment Area contaminant chemistry and bioassay data are available in a variety of media collected under a range of efforts. Compiling and standardizing the data into one database will enable more efficient analysis of existing data to inform gaps and structure targeted studies that fill those gaps and clearly allow other researchers to understand quality of the data.

Approach: The Trustee Council will identify data repositories containing relevant data for the injury assessment (e.g., sediment, fish tissue). Qualifier codes, analytes, units, methods, sampling dates, depths, species, and other pertinent parameters will be standardized to be consistent with the DIVER format. Any metadata related to the

original sources will be retained for reference, including available documents that explain field and analytical methodologies. Data will be incorporated into DIVER such that queries are transparent, reproducible, and downloadable into analytical software (e.g., Microsoft Access or Excel). Protocols and methods for processing and use of the data to meet goals of the assessment will be developed.

PATHWAY: REVIEW OF EXISTING PATHWAY-RELATED DATA (STUDY #2, PRIORITY 1)

Objective: Review existing information on physical and chemical transport mechanisms within the Assessment Area to document contaminant pathways. Include spill histories and data on surface water, groundwater, flow-through infrastructure (e.g., outfalls), soil, and sediment.

Need/Rationale: A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to identify and review existing pathway-related information. Documentation of a complete pathway is a requirement under the CERCLA NRDA regulations for natural resource injury determination (43 CFR §11.61(c)(3) and §11.63).

Approach: The Trustee Council will review existing data sources that include, but are not limited to, information collected under EPA's remedial process (e.g., EPA 2016a, 2016b) and DEQ's upland source control process (e.g., DEQ 2016), outfall and other runoff-related information, and site-specific hydrology, geology, topography, and bathymetry data. The Trustee Council will assess the availability, quality, and comprehensiveness of existing pathway information to refine their current understanding of Assessment Area pathways. This effort will enable the Trustee Council to identify complete pathways as well as any data gaps that could inform additional data collection or studies.

PATHWAY: ANALYSIS OF MEDIA TO SUPPORT PATHWAY ANALYSES (STUDY #3, PRIORITY 3)

Objective: Collection of Site-related soil, overland surface water runoff, outfall discharge, groundwater, and other physical media, and analysis of COCs in and physical characteristics of these media to assess connections between sources and Assessment Area resources.

Need/Rationale: To the extent possible, existing contaminant chemistry data in soil, surface water, groundwater, and other matrices/media, as well as physical information (e.g., groundwater flow, soil type) will be utilized to inform planning of primary studies, as well as the determination and quantification of natural resource injuries. However, additional sampling of these media may be necessary to link pathways of exposure to natural resource injuries in the Assessment Area. Documentation of a complete pathway is a requirement under the CERCLA NRDA regulations for natural resource injury determination (43 CFR §11.61(c)(3) and §11.63).

Approach: The Trustee Council will query DIVER (Study #1) for available contaminant chemistry data in soil, surface water, groundwater, and other media, and assess whether

additional collection and subsequent chemical analysis of samples is necessary to characterize pathways of exposure from sources of contamination to natural resources in the Assessment Area. If sufficient high quality data do not exist with the appropriate characteristics and in the locations of interest (e.g., near known sources of a specific contaminant or proximate to proposed field collection sites for fish), then the Trustee Council will consider a primary study to collect and analyze these media.

SEDIMENT: REVIEW OF EXISTING SEDIMENT DATA (STUDY #4, PRIORITY 1)

Objective: Evaluate the extent, quality, and appropriateness of available sediment chemistry data, information on physical parameters, and timing of relevant remediation actions to inform benthic invertebrate and fish injury assessment and assist in study design. Based on this review, identify data gaps and uncertainties upon which the Trustee Council may choose to focus future primary studies.

Need/Rationale: A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to identify and review existing sediment chemistry data.

Approach: The Trustee Council will query the DIVER database (Study #1) for sediment chemistry data. This study will involve a detailed and rigorous review of available information, specifically evaluating the use of these data in a NRDA context. For example, data will be reviewed for relevance to COCs, quality, spatial and temporal extent, and availability of associated physical parameters by which to evaluate potential toxicity, fate, and transport of various contaminants (e.g., total organic carbon). If sufficient high quality data with the appropriate characteristics and in the locations of interest (in the case of *in situ* work) do not exist, then the Trustee Council will consider whether a primary study is warranted.

SEDIMENT: CHEMICAL ANALYSIS OF ASSESSMENT AREA SEDIMENT (STUDY #5, PRIORITY 2)

Objective: Collection of sediments, as needed, to complement studies of benthic invertebrate and fish exposure and toxicity, and pathway. Analysis of COCs in Assessment Area sediments, and corresponding physical parameters, as compared to reference site sediments.

Need/Rationale: Sediment is both a primary sink for and source of contaminants in the Assessment Area, and is one of the main pathways through which natural resources are exposed to contaminants. To the extent possible, existing sediment data will be utilized to inform planning of primary studies. However, additional sediment sampling may be necessary to link pathways of exposure to natural resource injuries in the Assessment Area, document the magnitude of exposure, and focus the design of other studies.

Approach: The Trustee Council will query the DIVER database (Study #1) for sediment chemistry data (Study #4), and assess whether additional collection and subsequent chemical analysis of Assessment Area sediments is necessary, particularly in the context of the benthic invertebrate, fishery, and pathway studies outlined within this Addendum.

If sufficient high quality data do not exist with the appropriate characteristics and in the areas of interest (i.e., near proposed field collection sites for fish), then the Trustee Council will consider a primary study to collect and analyze sediment for COCs. This study would be undertaken in tandem with the proposed field sampling efforts of studies listed below, to ensure the most relevant data are collected as efficiently as possible.

BENTHIC INVERTEBRATES: REVIEW OF EXISTING INVERTEBRATE DATA (STUDY #6, PRIORITY 1)

Objective: Evaluate the extent, quality, and appropriateness of available contaminant chemistry and toxicity data associated with relevant benthic invertebrate species (e.g., midges, amphipods) to inform the potential severity and magnitude of injury.

Need/Rationale: A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to identify and review existing data related to benthic invertebrates in the Assessment Area. These data, including sediment contaminant concentrations, benthic invertebrate toxicity studies, and other benthic parameters, can directly inform injury determination and quantification.

Approach: The Trustee Council will query the DIVER database (Study #1), remedial process documents, and other supplemental reports/studies for contaminant chemistry and toxicity data associated with relevant benthic invertebrate species (e.g., midges, amphipods) and endpoints. This study will involve a detailed and rigorous review of available information, specifically evaluating the use of these data in a NRDA context. For example, the Trustee Council will review data for species relevance, quality, spatial and temporal extent, contaminants of interest, and endpoints. The Trustee Council will use relevant data to determine and quantify injury to benthic invertebrates within the Assessment Area.

BENTHIC INVERTEBRATES: BENTHIC INVERTEBRATE BASELINE PARAMETERS (STUDY #7, PRIORITY 2)

Objective: Compile and review existing information to determine baseline benthic invertebrate community characteristics (e.g., abundance of target species) and habitat extent and quality within the Assessment Area.

Need/Rationale: Baseline data will inform the conditions and metric(s) against which the Trustee Council will measure both injury (i.e., adverse effects resulting from exposure to Assessment Area contamination) and restoration (i.e., the benefits to a species or species group resulting from habitat improvements). Understanding the baseline condition of injured natural resources is a component of the injury quantification process under the CERCLA NRDA regulations (43 CFR §11.70(a)(1)).

Approach: This study will be executed in two phases. (1) The Trustee Council will utilize existing data, publicly available documents, and site-specific and/or generic literature to establish characteristics such as benthic invertebrate abundance, community structure, and relevant habitat within the Assessment Area. (2) If the first phase reveals

substantial data gaps, the Trustee Council may consider a primary study that will fill those data gaps.

FISH: REVIEW OF EXISTING FISH DATA (STUDY #8, PRIORITY 1)

Objective: Based on the DIVER database (Study #1), review the extent of available contaminant chemistry data measured in fish tissues and data related to fish toxicity studies to inform historic exposure and effects as well as the need for and design of subsequent primary studies. Focus on salmon and forage fishes.

Need/Rationale: Understanding the extent and magnitude of contaminant exposure to trust natural resources is an essential component of injury determination and quantification. A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to review existing, available data to enable efficient analysis, identification of data gaps, and determination of direction for potential future studies.

Approach: The Trustee Council will query the NRDA database (Study #1) for contaminant chemistry and toxicity data associated with relevant species and locations within the Assessment Area, with a focus on salmon and forage fishes. This study will involve a detailed and rigorous review of available information, specifically evaluating the use of these data in a NRDA context. For example, data will be reviewed for species relevance, quality, spatial and temporal extent, contaminants of interest, and endpoints.

FISH: JUVENILE SALMONID TOXICITY ASSESSMENT (STUDY #9, PRIORITY 1; STUDY #10, PRIORITY 2)

Objective: Assess the toxicity of COCs to juvenile salmonids (e.g., Chinook) through field assessments and laboratory testing.

Need/Rationale: Salmon are anadromous, meaning they are born in freshwater, migrate to the ocean to mature, then return to their natal freshwater stream to spawn and die. Specifically within the Assessment Area, salmon (e.g., Chinook) use the aquatic habitat complex for salinity adjustments as juveniles, as a foraging area, and as a place of refuge from predation. Some salmonid species are also threatened or candidate species under the Oregon State Department of Fish and Wildlife or the Federal Endangered Species Act, including Chinook salmon, coho salmon, chum salmon, and steelhead.

Salmon can have profound differences in susceptibility to chemicals at different life stages (e.g., juveniles, spawners); as such, salmonid life history is an important determinant of chemical exposure and acute toxicity. Their extended residency in freshwater streams, particularly during a critical time of growth and development, make juvenile Chinook salmon particularly vulnerable to the effects of contaminants. In addition to direct, short-term impacts, contaminant exposure during the juvenile stage may also have long-term effects on the viability of that organism as an adult.

These studies will generate data to inform both injury determination and quantification. Field studies enable a direct measurement of the effects on salmon associated with exposure to contaminated media within the Assessment Area as compared to a reference

site. Analysis of field-collected salmon tissues and stomach contents documents exposure to the COCs. In addition, because laboratory studies are conducted in a controlled environment where many variables can be specifically defined and monitored, the proposed laboratory tests are intended to support field observations of the impact of relevant contaminants on the test organisms.

Approach: Toxicity testing of juvenile salmonids involves two interrelated studies, as well as review and analysis of the results of Study #1 (database of contaminant and toxicity data) and Study #8 (review of existing fish data). For Study #9, the Trustee Council will collaborate with a PI to design and implement a field-based study of juvenile salmonid health in the Assessment Area as compared to a reference site. Juvenile salmon will be collected from various locations throughout the Assessment Area and evaluated for growth patterns (e.g., as indicated by otolith accretion and insulin-like growth factor measurements). COCs in field-collected juvenile salmonid tissue and stomach contents will be measured, as well as sediment, to assess salmonid exposure to COCs within the Assessment Area. Concentrations of COCs in fish tissues, stomach contents, and sediment will be compared to concentrations collected at an appropriate reference location. These data will be analyzed to evaluate the statistical association between exposure and injury. Study #10 will be a laboratory exposure study in which juvenile salmonids are exposed to individual or mixtures of COCs to assess the effects on selected endpoints, such as growth and survival. This study will confirm that exposure to COCs at concentrations relevant to the Assessment Area is responsible for any observed adverse effects on chosen endpoints. Appropriate control organisms and laboratory control conditions will be used. The data obtained in these studies will be used to quantify contaminant-related losses to salmon by using organism-based metrics that reflect an impact to the overall aquatic habitat complex (e.g., lost biomass).

FISH: FORAGE FISH TOXICITY ASSESSMENT (STUDY #11, PRIORITY 1; STUDY #12, PRIORITY 2)

Objective: Assess the toxicity of COCs to bottom-dwelling fish species (e.g., sculpin) through field assessments and laboratory testing.

Need/Rationale: Forage fishes are an essential component of the aquatic food web. They link primary producers (e.g., algae) and upper trophic level species (e.g., salmon), and, in the case of species such as sculpin, are closely tied to sediment (a primary sink for and source of contaminants in the Assessment Area). Exposure and toxicity testing of forage fish species will complement the salmon studies proposed by the Trustee Council and assist in determining whether forage fish species in the Assessment Area have been injured due to exposure of Site-related contaminants. These studies will generate data to inform both injury determination and quantification. Field studies enable a direct measurement of the effects to forage fishes as a result of exposure to contaminated media within the Assessment Area as compared to a reference site. Analysis of COCs in field-collected fish tissues and stomach contents documents exposure to the COCs. In addition, because laboratory studies are conducted in a controlled environment where many

variables can be specifically defined and monitored, these laboratory tests are intended to support field observations of the impact of relevant contaminants on the test organisms.

Approach: Toxicity testing of forage fishes involves two interrelated studies, as well as review and analysis of the results of Study #1 (database of contaminant and toxicity data) and Study #8 (review of existing fish data). As part of Study #11, the Trustee Council will collaborate with a PI to design and implement a field-based study of sculpin health in the Assessment Area as compared to a reference site. Sculpin will be collected from various locations throughout the Assessment Area and evaluated for growth patterns (e.g., as indicated by otolith accretion). COCs in field-collected sculpin tissues, stomach contents, and/or whole organisms, as well as sediment, will be analyzed to assess sculpin exposure to COCs within the Assessment Area. Concentrations of COCs in fish tissues, stomach contents, and sediment will be compared to concentrations collected at an appropriate reference location. These data will be correlated to link exposure and injury. Study #12 will be a laboratory exposure study in which sculpin are exposed to individual or mixtures of COCs to assess the effects on selected endpoints, such as growth and survival. This study will confirm that exposure to COCs is responsible for any observed adverse effects on chosen endpoints. Appropriate control organisms and laboratory control conditions will be used. The Trustee Council will use data obtained in these studies to quantify contaminant-related losses to forage fishes, using organism-based metrics that reflect an impact to the overall aquatic habitat complex (e.g., lost biomass).

FISH: BASELINE MIGRATORY AND FORAGE FISHES CHARACTERISTICS (STUDY #13, PRIORITY 3)

Objective: Determine the baseline characteristics of migratory salmonids and resident forage fishes (e.g., abundance, community age structure, habitat use) within the Assessment Area.

Need/Rationale: Baseline data will inform the conditions and metric(s) against which the Trustee Council will measure both injury (i.e., adverse effects resulting from exposure to Assessment Area contamination) and restoration (i.e., the benefits to a species or species group resulting from habitat improvements). Understanding the baseline condition of injured natural resources is a component of the injury quantification process under the CERCLA NRDA regulations (43 CFR §11.70(a)(1)).

Approach: The Trustee Council will utilize existing data, publicly available documents, and site-specific and/or generic literature to establish life history characteristics such as abundance and community age structure of salmon and sculpin within the Assessment Area, as well as ecological characteristics such as habitat use by these species. If substantial data gaps are identified, the Trustee Council may consider a primary study that will fill those data gaps.

BIRDS: REVIEW OF EXISTING AVIAN EXPOSURE, TOXICITY, LIFE HISTORY, AND HABITAT USE DATA (STUDY #14, PRIORITY 1)

Objective: Review existing data on avian exposure and toxicity using the DIVER database (for chemical analyses and/or toxicity studies; Study #1), life history

information, and habitat use data. This will inform historic exposure and effects as well as the need for and design of subsequent primary studies.

Need/Rationale: Birds utilize habitats within and adjacent to the Assessment Area and are key ecological receptors in those ecosystems. Understanding the extent and magnitude of contaminant exposure to natural resources is an essential component of injury determination and quantification. A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to review existing, available data. This review will allow for more efficient analysis of existing data to identify gaps and inform potential primary studies.

Approach: This study will involve a detailed and rigorous review of available data and information relevant to bird species within the Assessment Area, specifically evaluating the use of these data in a NRDA context. Sources of information will include, but not be limited to, the DIVER database (for chemical analyses and/or toxicity studies; Study #1), life history information, and habitat use data. The Trustee Council will review information for species relevance, quality, spatial and temporal extent, contaminants of interest, and endpoints. If sufficient high quality data do not exist with the appropriate characteristics and in the areas of interest, then the Trustee Council will consider whether a primary study is warranted.

MAMMALS: REVIEW OF EXISTING MAMMALIAN EXPOSURE, TOXICITY, LIFE HISTORY, AND HABITAT USE DATA (STUDY #15, PRIORITY 1)

Objective: Review existing data on mammalian exposure and toxicity using the DIVER database (for chemical analyses and/or toxicity studies; Study #1), life history information, and habitat use data. This will inform historic exposure and effects as well as the need for and design of subsequent primary studies.

Need/Rationale: Mammals utilize habitats within and adjacent to the Assessment Area and are key ecological receptors in those ecosystems. Understanding the extent and magnitude of contaminant exposure to natural resources is an essential component of injury determination and quantification. A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to review existing, available data. This review will allow for more efficient analysis of existing data to identify gaps and inform potential primary studies.

Approach: This study will involve a detailed and rigorous review of available data and information relevant to mammalian species within the Assessment Area, specifically evaluating the use of these data in a NRDA context. Sources of information will include, but not be limited to, the DIVER database (for chemical analyses and/or toxicity studies; Study #1), life history information, and habitat use data. The Trustee Council will review information for species relevance, quality, spatial and temporal extent, contaminants of interest, and endpoints. If sufficient high quality data do not exist with the appropriate characteristics and in the areas of interest, then the Trustee Council will consider whether a primary study is warranted.

REMEDIAL ACTIVITIES: IMPACTS OF REMEDIAL ACTIVITIES (STUDY #16, PRIORITY 2)

Objective: Compile information on remedial activities and evaluate the severity of impacts on the aquatic habitat complex. This will include timing, location, spatial extent, and type of remedial activities.¹³

Need/Rationale: Impacts due to remedial activities are compensatory under the CERCLA NRDA regulations (43 CFR §11.15(a)(1)). As such, understanding the extent, duration, and magnitude of these activities allows for a complete quantification of injury.

Approach: A timeline of remediation activities will be developed based on existing information. Location, duration, spatial extent, and type of remedial activity will be documented to the extent possible. While some remedial actions in the Site have been completed, the overarching Site-wide ROD has not yet been implemented. Therefore, the Trustee Council will review previously conducted and anticipated remedial actions and any information related to those actions (e.g., timing, duration, area, type of remediation). This information may be used to spatially and temporally quantify injury to relevant natural resources using geospatial and desktop modeling software (e.g., ArcGIS, Microsoft Excel, and Microsoft Access).

RECREATION: REVIEW EXISTING OUTDOOR RECREATION USE DATA AND INFORMATION (STUDY #17, PRIORITY 1)

Objective: Review existing data and information on the types and levels of potentially affected recreational activities in the lower Willamette River through time. Review public information on and awareness of the contamination in the lower Willamette River, including via fish and shellfish consumption advisories and guidelines, news reports, and community information sources.

Need/Rationale: In order to understand the potential magnitude, extent, and duration of outdoor recreational use losses, it is necessary to review existing data and information on the types and levels of potentially affected recreational activity on the Assessment Area through time. A cost-effective assessment utilizes existing data to the extent possible prior to undertaking primary studies. As such, it is prudent and necessary to review existing, available data. This review will allow for more efficient analysis of existing data to identify gaps and inform potential primary studies.

Approach: Building on efforts conducted during Phase 2 of the NRDA, the Trustee Council will use existing information to identify the level and type of recreational activities conducted within the Assessment Area and how it may be affected by public awareness of the contamination. The Trustee Council will review fish and shellfish consumption advisories and guidelines, news reports, community information resources, and other information sources to establish the geographic extent, nature, and duration of

¹³ This study focuses on the physical impacts of remedial actions. The potential injury resulting from residual contamination or physical injury post-remedy will be incorporated into the injury assessments for individual resources.

any human use advisories that have been applied to the lower Willamette River and corresponding changes in recreational behavior. Depending on the results of this study, and/or if this effort reveals substantial data gaps, the Trustee Council may consider one or more primary studies.

RECREATION: PRIMARY STUDIES OF OUTDOOR RECREATIONAL USE THROUGH INTERVIEWS, FOCUS GROUPS, AND SURVEYS (STUDY #18, PRIORITY 2; STUDY #19, PRIORITY 3)

Objective: Refine the Trustee Council’s understanding of and quantify the effects of Site-related contamination on outdoor recreational use of the Assessment Area and the role of consumption advisories and contamination on recreationist site choice and behavior.

Need/Rationale: Based on the results of Study #17, the Trustee Council may determine that additional primary data collection regarding the potential extent of outdoor recreational use losses is appropriate. Information on outdoor recreation site choice and use/avoidance in the presence of contamination can be necessary to quantify injury and assess lost recreational use damages.

Approach: Should the results of Study #17 indicate that sufficient losses may have occurred and that information can feasibly be collected for a reasonable cost, a phased effort will be initiated. The first phase will involve organization and implementation of focus groups to gain specific feedback on outdoor recreational use on the lower Willamette River. Interviews with key informants (e.g., heads of fishing clubs or paddling organizations) and focus groups with recreationists will be conducted to collect information about current patterns of recreational use and potential behavioral impacts (e.g., substituting to alternative locations) due to contamination. The focus groups will be moderated, and brief surveys will be distributed to participants to provide a standardized framework for eliciting responses. The results of these interviews and focus groups would be considered along with similar information collected during earlier phases of the NRDA and other existing data to determine if the Trustee Council should implement one or more comprehensive use surveys (e.g., revealed or stated preference). The Trustee Council will identify in a detailed study plan the specific approach to be followed, including selection of sample frame and sample mode. The Trustee Council will need to address several challenges, including: 1) unwillingness of some recreationists to be interviewed (e.g., some recreationists may refuse to participate in surveys); 2) the need for a multilingual survey given the diverse user population; and 3) the challenge of identifying and sampling recreational users (and potential users) of the lower Willamette River.

TRIBAL LOSS: ASSESS CHANGES IN THE TRIBAL SERVICES PROVIDED BY NATURAL RESOURCES AS A RESULT OF COCS (STUDY #20, PRIORITY 1)

Objective: Further document the relationship between the affected Tribes and resources that utilize the Assessment Area. This evaluation would identify natural resources of

cultural significance that are not in common with the non-tribal general public, and assess changes in resource use as a result of contamination.

Need/Rationale: The cultural significance of certain natural resources may be uniquely tied to tribal members' way of life in a manner that is distinctly separate from the non-tribal general public. Therefore, it is necessary to further understand the changes in tribal services provided by Assessment Area resources, including resource use (e.g., changes in frequency and/or location), due to Site-related contaminants. Natural resources provide a range of services to tribal communities. These services may have been diminished in quality, or interrupted, by the presence of contaminants released into the Assessment Area. This evaluation would ensure that the Trustee Council is able to account for tribal lost services and tribal resources of concern in both the injury assessment and subsequent restoration planning process.

Approach: The Trustee Council will first compile and review existing information that describes tribal services, uses, and values associated with Assessment Area resources. This includes reports (e.g., Ellis et al. 2005), previous interviews with tribal members and natural resource managers, and other information (e.g., history, culture). Building on this information review and efforts conducted under Phase 2, the Trustee Council will identify additional information sources to fill data gaps. For example, additional interviews could be conducted with a variety of tribal members to ascertain the historical and current uses (or desired uses) of Assessment Area resources. These interviews would identify the nature and extent of services provided by natural resources that are important to the health, welfare, economy, tradition, and culture of tribal members, in terms of both use and non-use services. The Trustee Council would then develop narratives that describe tribal members' relationship to natural resources found within the Assessment Area, providing a more complete picture of the natural resources important to tribal communities. This information ultimately will be used to support decision-making regarding the scale and scope of potential primary and compensatory restoration for lost tribal services.

4.3 SHARING DATA, SPLIT SAMPLES, AND ANALYTICAL RESULTS

Section 11.31(a)(4) of 43 CFR states that, "The Assessment Plan shall contain procedures and schedules for sharing data, split samples, and results of analyses, when requested, with any identified potentially responsible parties and other natural resource trustees."

If the Trustee Council determines that a study should be implemented, that study will be developed into a full work plan in collaboration with a PI and be made available to the public. These work plans will include study objectives, approaches for sharing and publishing data and analytical results with relevant parties and the public, and conditions and procedures for sharing split samples with PRPs.

4.4 QUALITY ASSURANCE

The CERCLA NRDA regulations require trustees to develop a Quality Assurance Plan (QAP) that "satisfies the requirements listed in the National Contingency Plan and

applicable EPA guidance for quality control and quality assurance plans” (43 CFR §11.31(c)(2)). The Trustee Council recognizes the importance of data quality, given the many management decisions involved in accomplishing the NRDA that ultimately require the use of environmental data. The collection, compilation, evaluation, and reporting of environmental data are necessary to perform the assessment. The Trustee Council must therefore properly document the origin and quality of the data used to make decisions so that data limitations may be identified; and assessments of the severity, location and extent of injury are accurate. This assists the Trustee Council in making appropriate decisions regarding the type and scale of restoration actions necessary to compensate for natural resource injuries. Also relevant to this effort are the NOAA and FWS guidelines established under the Information Quality Act of 2001. All information developed and used in this NRDA will comply with these guidelines.

This Addendum includes studies that evaluate existing datasets as well as studies that generate new information. With respect to the evaluation of existing data, each study’s PI will carefully document the source(s) of all data, available information about quality assurance (QA)/quality control (QC) procedures used by the original investigator, and any data qualifiers or other information restricting application of the data. This approach will also be applied to new data and analyses developed by Federal and state agencies, tribes, academics, and information developed under the auspices of other activities or programs. For new studies that are specifically undertaken to support the NRDA process, the Trustee Council will develop appropriate study-specific QAPs according to the general principles described below.

As stated by EPA (2001), QAPs will “vary according to the nature of the work being performed and the intended use of the data” and as such, need to be tailored to match the specific data-gathering needs of a particular project (40 C.F.R. § 300.5). The NRDA will entail a variety of widely different data-gathering efforts; therefore, it is not appropriate to develop a single, detailed QAP to cover all these activities. Instead, the Trustee Council will ensure that individual study plans adequately address project-specific QA issues. The discussion in this document therefore focuses on the required elements of an acceptable study plan.

In general, a study plan must provide sufficient detail to demonstrate that:

- The study’s technical and quality objectives are identified and agreed upon;
- The intended measurements, data generation, or data acquisition methods are appropriate for achieving study objectives;
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- Any limitations on the use of the data can be identified and documented (EPA 2001).

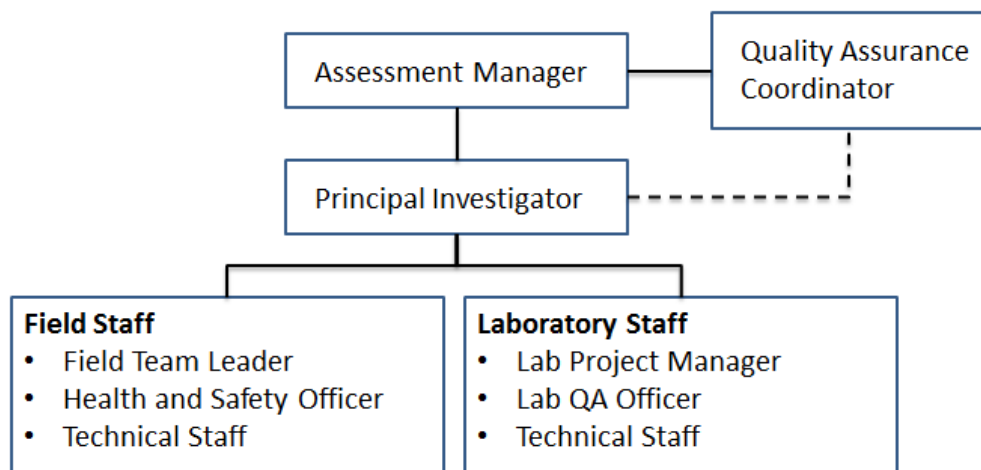
Accordingly, specific study plans developed for this assessment will include the four elements called for by EPA:

- Project Management – documents that the study has a defined goal(s), that the participants understand the goal(s) and the approach to be used, and that the planning outputs have been documented;
- Data Generation and Acquisition – ensures that all aspects of study design and implementation including methods for sampling, measurement and analysis, data collection or generation, data compiling/handling, and QC activities are documented and employed;
- Assessment and Oversight – assesses the effectiveness of the implementation of the study and associated QA and QC activities; and,
- Data Validation and Usability – addresses the QA activities that occur after the data collection or generation phase of the study is completed.

4.5 STUDY MANAGEMENT

Effective implementation of study objectives requires clear study organization, which includes carefully defining the roles and responsibilities of each study participant. Unambiguous personnel structures help ensure that each individual is aware of his or her specific areas of responsibility, as well as clarifying internal lines of communication and authority, which is important for decision-making purposes as studies progress. Individuals' and organizations' roles and responsibilities may vary by study or task, but each person's role and responsibility should be clearly described in the NRDA study plan. Exhibit 4-2 presents a generic personnel plan for a NRDA study.

EXHIBIT 4-2 PERSONNEL PLAN



The Assessment Manager is the designated Trustee Council representative with responsibility for the review and acceptance of the study-specific plan. This individual is also responsible for ensuring that the study's goals and design will meet the broader

requirements of this NRDA. The Assessment Manager coordinates efforts with the Quality Assurance Coordinator and oversees the Study PI.

The QA Coordinator oversees the overall conduct of the quality system. Appointed in consultation with the Trustee Council, this individual's responsibilities include, but are not limited to: reviewing and assisting the PI with the development of study-specific study plans; conducting audits and ensuring implementation of both study-specific and overall plans; archiving samples, data, and all documentation supporting the data in a secure and accessible form; and reporting to the Trustee Council. To ensure independence, the person serving as QA Coordinator will not serve either as the Assessment Manager or as a PI for any NRDA study.

Study-specific PIs oversee the design and implementation of particular NRDA studies. Each PI has the responsibility to ensure that all health, safety, and relevant QA requirements are met. If deviations from the study plan occur, the PI (or his/her designee) will document these deviations and report them to the Assessment Manager and the QA Coordinator.

The Field Team Leader supervises day-to-day field investigations, including sample collection, field observations, and field measurements. The Field Team Leader generally is responsible for ensuring compliance with all field QA procedures defined in the study plan. Similarly, the Laboratory Project Manager is responsible for monitoring and documenting the quality of laboratory work. The Health and Safety Officer (who may also be the Field Team Leader) is responsible for ensuring adherence to specified safety protocols in the field.

4.6 DATA GENERATION AND ACQUISITION

All studies under the direction of the Trustee Council that are specifically undertaken in support of the NRDA will have a prepared study plan that will be completed prior to the initiation of any work. These study plans will be submitted to, and approved by, the QA Coordinator or designee. Each study plan should describe and/or include, at a minimum:

- Study objectives;
- Rationale for generating or acquiring the data;
- Proposed method(s) for generating or acquiring the data, including descriptions of (or references to) standard operating procedures for all sampling or data-generating methods and analytical methods;
- Types and numbers of samples required;
- Analyses to be performed;
- Sampling locations and frequencies;
- Sample handling and storage procedures;
- Chain-of-custody procedures;

- Data quality requirements (for instance, with respect to precision, accuracy, completeness, representativeness, comparability, and sensitivity);
- Description of the procedures to be used in determining if the data meet these requirements; and
- Description of the interpretation techniques to be used, including statistical analyses.
- Split sample protocols and procedures for archiving samples and management of residuals.

In addition, to the extent practicable, laboratories will be required to comply with good laboratory practices. This includes descriptions and documentation of maintenance, inspections of instruments, and acceptance testing of instruments, equipment, and their components, as well as the calibration of such equipment and the maintenance of all records relating to these exercises. Documentation to be included with the final report(s) from each study will include field logs for the collection or generation of the samples, chain of custody records, and other QA/QC documentation as applicable.

4.7 ASSESSMENT AND OVERSIGHT

To ensure that the study plan for each project is implemented effectively, the QA Coordinator will review QAPs for all Trustee Council studies that generate data. The QA Coordinator or designee will also audit all such studies. Audits will include technical system audits (e.g., evaluations of operations) as well as scrutinizing data and reports (e.g., evaluations of data quality and adequacy of documentation).

If, in the professional opinion of the QA Coordinator, the results of an audit indicate a compromise in the quality of the collection, generation, analysis, or interpretation of the data, the QA Coordinator has the authority to stop work by oral direction. Within two working days of this direction, the QA Coordinator will submit to the Trustee Council a written report describing the necessity for this direction. The Assessment Manager will consult with the Trustee Council regarding measures to be taken in response to the QA Coordinator's report.

4.8 DATA VALIDATION AND USABILITY

In addition to the assessment and oversight activities described previously, analytical data will be considered for validation by an independent third party. Prompt validation of analytical data can assist the analyst or analytical facility in developing data that meet the requirements for precision and accuracy. If undertaken, it is expected that data validation will use the study-specific plans and EPA Guidance on Environmental Verification and Validation (EPA 2002).

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