US Army Corps of Engineers

U.S. Army Corps of Engineers
Walla Walla District

Lower Snake River Programmatic Sediment Management Plan

Final Environmental Impact Statement

August 2014

LOWER SNAKE RIVER
PROGRAMMATIC SEDIMENTMANAGEMENT PLAN
FINAL ENVIRONMENTAL IMPACT STATEMENT
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Lead Agency. U.S. Army Corps of Engineers, Walla Walla District

Type of Action. Administrative

Abstract. This Programmatic Sediment Management Plan (PSMP) and Environmental Impact Statement (EIS) presents the U.S. Army Corps of Engineers' (Corps) plan for managing sediment within the lower Snake River system to meet the authorized project purposes that are affected by sediment deposition. The Corps is preparing this EIS to evaluate a long-term plan for management of sediment accumulation that affects authorized purposes of the four lower Snake River lock and dam projects in southeastern Washington and north central Idaho. This EIS also addresses a proposed current immediate need action and regulatory review, consistent with the plan.

The purpose of the proposed action is to establish a programmatic framework to evaluate and implement potential sediment management measures to address problem sediment accumulation. The PSMP provides a long term plan to manage, and prevent if possible, the accumulation of sediment that interferes with authorized project purposes. The immediate need action to reestablish the navigation channel to the Congressionally-authorized dimensions will be consistent with the PSMP.

The Corps formulated a range of alternatives by identifying and evaluating sediment management measures, then assembling the feasible and effective measures into groupings based on how measures could be implemented. The alternatives are programmatic and describe broad categories of actions that could be implemented to meet the purpose and need. The Corps identified Alternative 7 – Comprehensive (Full System and Sediment Management Measures) as the preferred alternative. The alternative includes dredging and dredged material management along with other sediment and system management measures, and provides the Corps with a complete toolbox for addressing sediment that interferes with the authorized purposes of the four projects.

Final EIS. The final report was officially filed with the Director, Office of Federal Activities, U.S. Environmental Protection Agency on August 15, 2014.

Comments. Comments on the final report are due on September 22, 2014, 30 days from August 22, 2014, the expected the date of U.S. Environmental Protection Agency's publication of Notice of Availability in the Federal Register. Comments are to be directed to the following:

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Further Information. Additional information on the Final Environmental Impact Statement and related documents also may be obtained from the above. The documents are also available on the Corps web site at
www.nww.usace.army.mil/Missions/Projects/ProgrammaticSedimentManagementPlan.aspx .

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Introduction

The Walla Walla District of the U.S. Army Corps of Engineers (Corps) has identified and evaluated sediment management strategies for the lower Snake River. Based on the analysis presented in this Environmental Impact Statement (EIS) and stakeholder and public comments, the Corps will adopt and implement a Programmatic Sediment Management Plan (PSMP) (see proposed PSMP in Appendix A) for management of sediment within the lower Snake River system to meet existing authorized project purposes.

As a part of its Congressional authorization, the Corps operates and maintains the navigation system on the lower Snake River, which is part of an inland navigation system from Lewiston, Idaho, to the Pacific Ocean and includes the Columbia River.

The Corps constructed four dams on the Snake River in Washington State (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) between 1961 and 1975. The Corps' sediment management area includes the lower Snake River from the confluence with the Columbia River[1] to the upstream limits of Lower Granite Reservoir, including the lower portion of the Clearwater River. For the purposes of this EIS, the sediment management area, including the four dams and their associated locks and reservoirs, is referred to as the Corps' Lower Snake River Projects (LSRP).

The existing authorized project purposes of the LSRP include commercial navigation, recreation, fish and wildlife conservation, and flow conveyance. Sediment accumulation in the lower Snake River can interfere with these authorized project purposes of the LSRP.

The Corps has historically used dredging as its primary method of removing accumulated sediment that interferes with the authorized project purposes of the LSRP. Dredged sediments were moved to and placed in areas where they would no longer interfere with the authorized project purposes, either in-water within the reservoirs or on upland sites.

Between 1999 and 2002 the Corps prepared a Dredged Material Management Plan (DMMP) EIS, which evaluated alternatives for managing dredged sediments in the LSRP. Following the September 2002 publication of the Record of Decision for the DMMP EIS, a group of environmental and fishing interests (collectively referred to as the "plaintiffs") filed a lawsuit in November 2002, alleging compliance failures by the National Marine Fisheries Service (NMFS) with respect to the Endangered Species Act (ESA) and by the Corps with respect to the National Environmental Policy Act (NEPA). The U.S. District Court, Western District of Washington, granted a preliminary injunction, halting further action by the Corps. The Corps withdrew the

[1] The lower Snake River between the confluence with the Columbia River and Ice Harbor Dam is within the reservoir formed by McNary Dam on the Columbia River.

Record of Decision and in 2005 prepared an EIS for a one-time navigation channel maintenance action (dredging). The litigation was ended in 2005 through a settlement agreement between the plaintiffs and the Corps. In the settlement agreement the Corps was allowed to perform a one-time dredging of the federal navigation channel and related port berthing areas in the winter of 2005/2006. The Corps also agreed to "…initiate and complete a NEPA analysis on a long-term plan for the management of sediment in the lower Snake River, to be designated the Programmatic Sediment Management Plan…." The PSMP is designed to evaluate future actions for sediment management to meet existing authorized project purposes. This Final EIS presents the NEPA analysis of the long-term plan (PSMP) for sediment management directed by the settlement agreement and the current immediate need action (including related regulatory reviews) consistent with the PSMP.

Purpose of and Need for the Proposed Action

The purpose of the proposed action is to maintain the existing projects (the LSRP) by managing sediment that interferes with the existing authorized project purposes by adopting and implementing a PSMP, which includes actions for long-term and immediate needs. The purpose also includes re-establishing the federal navigation channel to the congressionally-authorized dimensions of 14 feet deep by 250 feet wide to address sediment accumulation that is currently interfering with commercial navigation. Coinciding with the current immediate need action is a related need to restore depths necessary to support commercial navigation at non-federal berthing areas of local ports.

The PSMP will provide a programmatic framework to evaluate and implement sediment management measures to address the accumulation of sediment that interferes with existing authorized project purposes. The PSMP is needed to maintain the LSRP by managing, and preventing if possible, sediment accumulation in areas of the lower Snake River reservoirs that interfere with the following existing authorized project purposes:

- *Commercial navigation* by reducing the depth of the federal navigation channel to less than the congressionally-authorized dimensions (14 feet deep by 250 feet wide) when operating at minimum operating pool (MOP), thereby impairing access to port berthing areas, access to navigation locks, and safe movement of tugs and multi-barge tows;
- *Recreation* by limiting water depth at recreation areas to less than original design dimensions and thereby impairing access;
- *Fish and wildlife conservation* by sediment accumulation interfering with irrigation water intakes at Habitat Management Units (HMUs), juvenile ESA-listed fish barge access to loading facilities, and fish barge passage through the reservoirs and locks within the LSRP;

- *Flow conveyance* at Lewiston[2] by reducing the capacity of the river channel between levees to pass high flows. Sediment management at the confluence of the Snake and Clearwater Rivers may be needed in the long-term to manage the risk of flooding consistent with applicable Corps policies.

Historically within the LSRP, the Corps has approached project maintenance by identifying areas where sediment interfered with authorized project purposes and then taking action to remove the sediment, usually by dredging. The PSMP identifies and evaluates a wide range of measures to accomplish the purpose of maintaining the LSRP and provides a decision-making process to manage and, if possible, prevent sediment accumulation that interferes with authorized project purposes, including addressing the current immediate need action to re-establish the federal navigation channel to congressionally-authorized dimensions of 14 feet deep by 250 feet wide at MOP. Future actions under the PSMP may require project-specific environmental reviews tiered off of this programmatic EIS, and may involve additional studies and authorities.

The Corps has identified a current immediate need action to address sediment accumulation that is interfering with commercial navigation. Sediment accumulation has reduced the congressionally-authorized federal navigation channel depth by several feet (at MOP) at two locations across much of its width:

- The downstream navigation lock approach at Ice Harbor Dam
- The confluence of the Snake and Clearwater rivers at the upstream end of Lower Granite Reservoir

A current immediate need action is necessary to reestablish the federal navigation channel to its congressionally-authorized dimensions at these locations.

Coinciding with the current immediate need action for reestablishing the congressionally-authorized dimensions of the federal navigation channel is a related need for a maintenance action at the non-federal berthing areas for the ports of Lewiston and Clarkston to restore depths necessary to support commercial navigation. Both ports are located at the upstream end of Lower Granite Reservoir at the confluence of the Snake and Clearwater rivers and are adjacent to the federal navigation channel. The Port of Lewiston is on the right bank of the Clearwater River while the Port of Clarkston is on the left bank of the Snake River. The Ports are responsible for CWA Section 404 and Rivers and Harbors Act Section 10 compliance for their maintenance actions and must apply to the Corps for the necessary regulatory permits (Sections 404/10) to perform this maintenance. As stated above, the EIS also includes the evaluation of potential environmental effects associated with the permit applications for related berthing area maintenance at the ports of Lewiston and Clarkston. The berthing area maintenance is related to the Corps' purpose of re-establishing the congressionally-authorized dimensions of the federal

[2] Although flood risk management is not an authorized project purpose of the LSRP, ensuring adequate flow conveyance through the Lewiston levee system supports the original Lower Granite Project design and all associated project purposes.

navigation channel and would coincide with federal navigation channel maintenance, pending the outcome of any necessary permit evaluations for the ports' maintenance actions.

The sediment deposition is also currently interfering with the Corps' ability to operate the Lower Granite reservoir within one foot of MOP from April through August for ESA listed threatened and endangered juvenile salmon passage. This operation is called for in the NOAA 2014 Supplemental Biological Opinion for the Federal Columbia River Power System (NOAA FCRPS BiOp[3]) Reasonable and Prudent Alternative (RPA) Action 5.

In addition, the Corps has developed this PSMP EIS to fulfill the relevant portion of the 2005 settlement agreement referenced above.

A Programmatic Approach

A federal agency may enact a programmatic approach versus a project-specific approach for a broad program of management activities under their authority (40 CFR 1502.4(b)). The purpose of programmatic management is to provide consistency in and a roadmap for future project-specific decision-making. The associated programmatic management plan developed by a federal agency requires preparation of a programmatic EIS. This PSMP programmatic EIS includes alternatives that define broad programs for managing sediments through implementation of future actions as they relate to maintaining the authorized project purposes of the LSRP. Actions taken to address the current immediate need action (consistent with the PSMP) to reestablish the navigation channel, including regulatory review by the Corps of related port actions, are covered in this EIS at a site-specific level. Future actions would require project-specific environmental reviews, including preparation of appropriate NEPA documents tiered off of this programmatic EIS.

The Corps and other agencies conducted extensive analysis of sediment loads and transport to support decision making on the management of sediment deposition that interferes with authorized purposes of the LSRP. This research and analysis represents the most comprehensive assessment of sediment sources, loading, transport, and deposition conducted for the Snake River system. It provides information to support decision making about long-term strategies for managing sediment deposition that interferes with authorized purposes of the lower Snake River.

Alternatives

Past sediment management efforts by the Corps have focused largely on site-specific actions within the reservoirs, particularly dredging, to remove sediment deposits that interfere with authorized purposes of the reservoirs. Through the PSMP EIS, the Corps identified dominant sediment sources within the watershed and evaluated the potential for reducing sediment input from upland sources rather than focusing solely on sediment management within the lower Snake River reservoirs. Therefore, in developing and evaluating alternatives, the Corps identified

[3] The supplement to the 2008/2010 FCRPS BiOP.

and evaluated methods of managing sediment through structures or reservoir operations in addition to dredging, as well as methods for reducing sediment entering the reservoirs from tributaries and upland sources. The programmatic alternatives can be thought of as variations on a "toolbox" that contains a group of techniques, or measures, for managing sediments.

The Corps used the following process to develop and evaluate the PSMP alternatives presented in this EIS:

1. Areas were identified where sediment accumulation has adversely affected or is likely to adversely affect navigation, water intakes, recreation, or flow conveyance.
2. A broad range of sediment management measures were developed that could potentially address identified problems in accordance with the purpose and need. Measures did not need to completely solve all sediment-related problems identified by the Corps, but they would have to reasonably contribute to resolving the problems. Measures considered were actions that could be taken by the Corps or by other agencies.
3. Technical, environmental, and economic criteria were developed to determine the feasibility and effectiveness of the measures.
4. Measures were screened during technical workshops for potential inclusion in the PSMP alternatives based on criteria noted above.
5. A range of PSMP alternatives was developed by assembling feasible and effective measures into groups that would meet the purpose and need and provide effective strategies for sediment management.
6. The PSMP alternatives were each evaluated to determine if implementation of the alternative would meet the project purpose and need, if the alternative comprehensively addressed identified problems, and if the alternative provided an effective means of managing sediment over a long term period. Alternatives that did not meet these criteria were eliminated from detailed analysis, and the retained alternatives were evaluated in detail.

Measures

Through a collaborative process that included a series of workshops involving technical experts from the Corps and other agencies, and input from scoping and stakeholders, the Corps developed a broad range of management measures that could address identified sediment accumulation problems. Sediment management measures were grouped as follows:

Dredging and Dredged Material Management – Dredging involves physical removal of sediments from one location, and placement of the dredged material in another location. The dredging process typically consists of excavation, transport, and placement of dredged sediments. Excavation may be by mechanical means (i.e., physically scooping sediments with a clamshell or backhoe) or hydraulic dredging, which removes sediment by suction. Once dredged, sediments are transported to a disposal or placement area. Dredged material may be placed in-water or upland, and may be beneficially used for other purposes, such as habitat creation.

Disposal options available to the Corps for dredged materials are indentified in accordance of Corps regulations (33 CFR 335-338). The "Federal standard" for disposal of dredged material is defined as "[T]he least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process. . . ." (33 CFR 335.7).

Structural Sediment Management Measures – Structural sediment management measures seek to control the location and rate at which sediment is deposited at a specific location, in order to reduce or eliminate the magnitude of the sediment interference with authorized purposes of the LSRP. Examples of structural management measures include weirs to prevent sediment from accumulating in certain areas, and sediment traps provide a place to collect sediment that may otherwise interfere with authorized purposes. Structural sediment management measures could be considered by the Corps subject to authority and funding.

System Management Measures – System management measures modify reservoir operations (such as pool depth) or facilities so that sediment deposition does not adversely affect authorized purposes. Examples of system operations measures include reconfiguring or relocating navigation facilities, managing reservoir water levels for navigation, and modifying flows to flush sediments from problem areas. These measures would occur within the lower Snake River. The Corps and public port authorities would be responsible for implementing system management measures for their respective facilities.

Upland Sediment Reduction Measures – Upland sediment reduction measures are land management actions intended to reduce the amount of sediment that enters into the lower Snake River systems. Upland sediment reduction measures include site-specific projects such as sediment traps or vegetation filter strips designed to reduce erosion of soil from land into area waterways, and programs aimed at encouraging or requiring such projects. Upland sediment reduction measures are currently implemented throughout the watershed of the lower Snake River. For the purposes of this EIS, the expansion or increase of practices beyond current levels of implementation is assumed. Sediment reduction measures would be implemented on public and private lands in contributing drainage areas through programs and actions by agencies other than the Corps. In addition, the Corps also implements upland sediment reduction measures on land it manages adjacent to the LSRP.

Range of Alternatives

The Corps formulated a range of alternatives by assembling the feasible and effective measures into groupings based on how measures could be implemented and what agencies could implement them. In accordance with NEPA, the Corps included a No Action Alternative, defined here as no change in current practices. As noted previously, the alternatives are programmatic and describe broad categories of actions that could be implemented to meet the purpose and need.

Each alternative represents a plan that the Corps (or potentially other agencies) would implement over time, and thus contains both action to address the immediate need to reestablish the authorized navigation channel and a framework for decision-making on future actions. For any alternative, the Corps would monitor sediment accumulation in the LSRP and assess conditions with respect to sediment accumulation that would affect authorized purposes. Those conditions are:

- Immediate needs:
  - Federal navigation channel (including channel, lock approaches, and port berthing areas) is less than authorized dimensions at MOP.
- Future needs:
  - Sediment accumulation that interferes with an authorized purpose recurs at the same location more frequently than every five years.
  - Sediment accumulation that interferes with an authorized purpose is anticipated at a particular location (or locations) in less than five years.

When any of those conditions exist, the Corps (or others) would initiate actions to address them. For the immediate need, the Corps would initiate action to reestablish the authorized dimensions of the navigation channel; for future needs, the Corps (or others) would initiate planning and evaluation of applicable measures, consistent with the framework of the adopted plan. Currently, the immediate need exists at several locations within the LSRP. In addition, several sites within the LSRP have recurring sediment accumulation conditions that represent future needs.

Table ES-1 presents the alternatives considered. Several alternatives were removed from further consideration because they did not meet the criteria noted above. The alternatives considered in detail are described below.

Table ES -1: Range of Alternatives Screening

Alternative	Does the alternative: Provide long-term solution(s) to sediment that interferes with existing authorized project purposes of LSRP?	Does the alternative: Provide immediate need solutions to sediment that interferes with existing authorized project purposes of the LSRP?	Retain for further evaluation in EIS?
1 – No Action	No	No	Yes
2 - Increased Implementation Sediment Reduction Measures	No	No	No
3 - System Management	Partial	No	No
4 - Non-Dredging Sediment Management Measures	Partial	No	No
5 - Dredging-Based Sediment Management	Yes	Yes	Yes
6 - System Management and Non-Dredging Sediment Management	Partial	No	No
7 - Comprehensive (Full System and Sediment Management Measures)	Yes	Yes	Yes

Alternative 1: No Action (Continue Current Practices)

The No Action alternative represents a continuation of the Corps' current operational practices of managing the LSRP. The Corps would not adopt the proposed PSMP or implement any new sediment management actions (e.g., channel maintenance dredging). The Corps would continue its ongoing monitoring of accumulated sediment that affects the existing authorized project purposes of the LSRP.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation

Implementation

Alternative 1 would address all future needs (immediate and forecasted) in the same manner as current practice. The Corps would continue to use the actions described above to address sediment accumulation that interferes with the existing authorized project purposes. Navigation objective reservoir operations would continue to be implemented in the lower Snake River, consistent with the terms and conditions of the NOAA FCRPS BiOp or subsequent ESA consultation and other applicable requirements, to address sediment accumulation that interferes with commercial navigation. For Corps-managed recreation areas (boat basins or ramps) the Corps may post warnings or close affected facilities if either of these actions was needed for safety. The Corps would perform routine maintenance on existing irrigation intakes (e.g. lifting or shifting the intakes, or doing limited excavation), install a temporary intake, or use another available water source to address sediment accumulation at HMU intakes. Reservoir operations would be used during high flow events, in accordance with the Lower Granite Project Water Control Manual (USACE 1987b), if needed to provide flow conveyance at the Snake/Clearwater Rivers confluence.

Alternative 5 – Dredging-Based Sediment Management

The Dredging-Based Sediment Management alternative represents a continuation of the Corps' historical practices of using dredging as the primary tool for managing sediment that interferes with existing authorized project purposes of the LSRP. The Corps would continue its current program of monitoring sediments that affect the existing authorized project purposes of the LSRP. Sediment management would consist of dredging and dredged material management. Sediment management activities would be undertaken in response to or anticipation of sediment accumulation problems.

Agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding. The Corps would continue implementing erosion and sediment control on lands adjacent to the LSRP.

Measures

The following measures would be considered under this alternative:

- Navigation-objective reservoir operation (on a temporary basis until dredging is implemented)
- Navigation channel and other dredging
- Dredging to improve conveyance capacity
- Beneficial use of dredged material
- In-water disposal of dredged material
- Upland disposal of dredged material

Implementation

Based on Corps regulations, the Corps would evaluate disposal options to identify the least-costly, engineeringly feasible, environmentally acceptable option. The disposal method would ultimately be identified through evaluation of disposal alternatives under the substantive provisions of CWA Section 404(b)(1), guidelines established by the EPA (40 CFR 230) and

Corps regulations. Disposal options include consideration of beneficial use of dredged material, in-water disposal, and upland disposal. Beneficial use refers to utilizing dredged sediments as resource materials in productive ways. Potential beneficial use of dredged materials would include creating submerged fish habitat, establishing riparian habitat consistent with the Lower Snake River Fish and Wildlife Compensation Plan or using the material as fill for future development. Dredged material could also be disposed of in upland areas or in-water. Similar to Alternatives 2, 3, and 4, the Corps would perform the actions described in Alternative 1 as interim measures until the dredging actions could be completed. The Corps would continue monitoring sediment in the LSRP, as well as the effectiveness of habitat created by placement of dredged material and other beneficial uses of dredged material that it may undertake.

Alternative 7 – Comprehensive (Full System and Sediment Management Measures)

The Comprehensive (Full System and Sediment Management Measures) alternative is a combination of Alternatives 5 and 6 and provides a suite of all available dredging, system management, and structural sediment management measures for the Corps to use to address sediments that interfere with the existing authorized project purposes of the LSRP. Agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding. The Corps would continue implementing erosion and sediment control on lands adjacent to the LSRP.

Measures

The following measures would be considered under this alternative:

- Navigation-objective reservoir operation (on temporary basis until dredging is implemented)
- Navigation channel and other dredging
- Dredging to improve conveyance capacity
- Beneficial use of dredged material
- In-water disposal of dredged material
- Upland disposal of dredged material
- Reservoir drawdown to flush sediments (drawdown)
- Reconfigure affected facilities
- Relocate affected facilities
- Raise Lewiston levees to manage flood risk
- Bendway weirs
- Dikes and dike fields

- Agitation to resuspend sediments
- Trapping upstream sediment (in reservoir)

Implementation

Implementation of Alternative 7 would be based on which trigger was reached and the authorized project purpose affected. To address an immediate need for navigation, the Corps would perform a dredging action similar to Alternative 5, as this would be the only measure that would effectively re-establish the federal navigation channel to its congressionally authorized dimensions. As an interim measure until dredging could be performed, the Corps may implement the same actions described in Alternative 1. For an immediate need for irrigation intakes, recreation, and flow conveyance the Corps would implement the same routine maintenance actions described in Alternative 1 before considering dredging.

When the trigger for future forecasted needs is reached, the Corps would initiate review of site-specific conditions, screening of alternative measures (including consideration cost, engineering, and environmental factors), and determine which measure (or measures) to implement to address sediment accumulation. While that analysis was being conducted, the Corps may implement the actions described in Alternative 1 to address problem sediment in the interim. The Corps would continue monitoring sediment in the LSRP, as well as the effectiveness of habitat created by placement of dredged material and other beneficial uses of dredged material that it may undertake.

Environmental Effects of Alternatives

Table ES-2 presents a summary of the effects of the plan alternatives on environmental resources.

Table ES-2. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Aquatic Resources	Future Actions: Short-term adverse effects on listed salmonid species during implementation of Navigation Objective Reservoir Operation. Current: Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Short-term adverse effects on aquatic resources during implementation of dredging-based sediment management activities. Long-term beneficial effects from beneficial use of dredged material. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Some short-term and longer-term adverse effects on aquatic resources during implementation of various measures. Long-term beneficial effects through beneficial use of dredged material. Potential adverse effects from weirs and dike fields that may provide habitat for predators on juvenile salmonids. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Terrestrial Resources	Future Actions: Minor adverse effects on plant/wetlands at the margins of reservoirs due to fluctuating reservoir levels of navigation objective reservoir operations. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effects on wildlife during implementation of dredging-based sediment management. Upland beneficial use could have long-term benefits through habitat creation or enhancement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor to moderate short-term adverse effects on wildlife during construction activities associated with implementation of measures. Relocated or reconfigured facilities and upland disposal could have long-term adverse effects from loss of wetlands and habitat; upland disposal could also have long-term benefits to wildlife from habitat creation. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table ES-2. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Recreation	Future Actions: Beneficial effects on recreational boating. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effects on boating/fishing and land-based recreation during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effects on boating/fishing and land-based recreation during measure implementation. Potential short-term adverse effects to recreation on Lewiston levee system during measure implementation. Measures could have long-term beneficial effects on recreation by restoring design dimensions of recreational facilities. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Cultural Resources	Future Actions: Potential adverse effect on shoreline archaeological sites due to potentially prolonged exposure to water. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Potential adverse effects to cultural resources from implementation of dredging-based sediment management measures. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Potential adverse effects to cultural resources from construction activities associated with implementation of sediment and system management measures. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Socioeconomics	Future Actions: Benefit to commercial navigation by providing for safe navigation. Duration of benefit is limited to the point where pool levels can no longer be raised. Potential long-term adverse effects on boating basins and marinas due to sediment accumulation, shifting local economic benefit away from effected facilities. Potential long-term adverse effects behind the Lewiston levee system due to increased flood risk. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Temporary benefits to employment and income during dredging related activities. Long-term economic benefit by providing for safe commercial navigation and recreation opportunities. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Temporary adverse effects on socioeconomics if navigation channels and associate facilities are modified or closed during measure implementation. Temporary benefits to employment and income during construction activities. Long-term economic benefit by providing for safe commercial navigation and recreation opportunities. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table ES-2. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Water Quality and Sediment Quality	Future Actions: Minor localized effects on water quality in the vicinity of boating activity due to prop wash and in the vicinity irrigation intake maintenance. No effect on sediment quality. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Temporary adverse effects on water quality during dredging activities. No long-term effect on water quality or sediment quality. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Temporary adverse effects on water quality during construction activities associated with measure implementation. Drawdown to flush sediments would adversely affect water quality temporarily by increasing turbidity and suspended sediments. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Hydrology and Sediment	Future Action: No effect on sediment loading or transport dynamics of the lower Snake River. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Small, localized change in channel cross section and in location of sediment due to beneficial use activities. No long-term effects on sediment loading or transport dynamics of the lower Snake River. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Long-term or short-term localized change in flow velocity and sediment suspension/transport associated with measure implementation. No effect on sediment loading in the lower Snake River. Beneficial localized effect of creating conditions to avoid or minimize long-term accumulation of sediment in specific problem areas. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Hazardous, Toxic, and Radioactive Waste (HTRW)	Future Actions: No effect from HTRW. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: No HTRW sites in LSRP. Minor short-term adverse effect if hazardous substances are released during dredging and dredged material management. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: No HTRW sites in LSRP. Minor short-term adverse effect if potentially hazardous substances are released during implementation of sediment or system management measures. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table ES-2. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Air Quality	Future Actions: No effect on air quality. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effect from construction equipment operation during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effect from construction equipment operation during sediment and system management measures implementation. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Aesthetics	Future Actions: Localized adverse impact on aesthetics of recreational facility due to potential closure or lack of use. . Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effect on visual quality during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effect to aesthetic resources during sediment and system management measures implementation. Major short-term adverse effects to visual quality in the Lower Granite Reservoir due to river bottom exposure during drawdown. Minor long-term benefits to visual quality of recreation facilities due to relocation and reconfiguration. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

The Corps' Preferred Alternative

In comparing the best available information with regard to each alternative, the Corps determined that Alternative 7 - Comprehensive (system and sediment management measures), best satisfies the project purposes of managing sediments that interfere with the authorized purposes of the LSRP and reestablishing the authorized navigation channel at MOP. Therefore, the Corps identified Alternative 7 as the preferred alternative. In addition to fully addressing immediate needs, the alternative provides for proactive monitoring and planning for addressing potential sediment accumulation rather than reacting to accumulation once it becomes an identified problem. It also provides a broad array of measures the Corps could implement to address sediment accumulation within the LSRP. The proposed future and immediate actions and associated measures comprise the framework of the PSMP.

Any sediment and system management measures associated with Alternative 7 would be implemented by the Corps subject to authority and funding. The Corps assumes sediment reduction measures would continue to be implemented by other land use agencies and authorities at current levels.

Because Alternative 7 provides nondredging options for the Corps to evaluate when planning sediment management actions, and provides measures for the immediate need action that uses dredged material to create fish habitat, the Corps also determined it was the environmentally preferred alternative.

Environmental Operating Principles

The U.S. Army Corps of Engineers (Corps) has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision-making and programs. These principles foster unity of purpose on environmental issues, reflect a new tone and direction for dialogue on environmental matters, and ensure that employees consider conservation, environmental preservation, and restoration in all Corps activities.

Sustainability can only be achieved by the combined efforts of federal agencies, tribal, state, and local governments, and the private sector, each doing its part, backed by the citizens of the world. These principles help the Corps define its role in that endeavor.

By implementing these principles, the Corps will continue its efforts to develop the scientific, economic and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions. The principles are being integrated into all project management process throughout the Corps.

The principles are consistent with the National Environmental Policy Act, the Army Strategy for the Environment with its emphasis on sustainability and the triple bottom line of mission, environment, and community, other environmental statutes, and the Water Resources Development Acts that govern Corps activities.

The Principles

- Foster sustainability as a way of life throughout the Corps organization.
- Proactively consider environmental consequences of all Corps activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

ACRONYMS AND ABBREVIATIONS

AIRFA	American Indian Religious Freedom Act
APA	Administrative Procedures Act
BAER	Burned Area Emergency Response
BEA	business economic area
BiOp	Biological Opinion
BLM	Bureau of Land Management
BMP	best management practice
BNSF	Burlington Northern Santa Fe
BPA	Bonneville Power Administration
CAA	Clean Air Act
CCRH	??? Is a citation ~pg
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGRP	U.S. Global Climate Research Program
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
COC	chemical of concern
the Corps	U.S. Army Corps of Engineers
CRBG	Columbia River Basalt Group
CWA	Clean Water Act
cy/yr	cubic yards per year
dB	decibel
dBA	adjusted decibel
DEQ	Department of Environmental Quality
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Plan
DMMU	dredged material management unit
DO	dissolved oxygen
DPS	distinct population segment
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EM	Corps Engineer Manual
EPA	U.S. Environmental Protection Agency
ER	Engineer Regulation
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
fps	feet per second
ft^2	square feet
FTA	Federal Transit Administration
FWCA	Fish and Wildlife Coordination Act
FY	fiscal year
GCRP	Global Climate Research Program
GHG	greenhouse gas
GRNW	Great Northwest Railroad
HD	House Document
HMU	Habitat Management Unit
HTRW	hazardous, toxic, and radioactive waste
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IPCC	Intergovernmental Panel on Climate Change
L_{dn}	day-night noise level
L_{eq}	hourly equivalent sound pressure levels
LSMG	Local Sediment Management Group
LSRP	Lower Snake River Projects
M^3	cubic meters
mcy	million cubic yards
mcy/yr	million cubic yards per year
Mg/L	milligrams per liter

mi^2	square miles
$MM+CO_{2e}$	million metric tons of carbon dioxide equivalent
MOP	minimum operating pool
msl	mean sea level
N_2O	nitrous oxide
NH_3N	ammonia
NO_3N	Nitrate
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NGO	nongovernment organization
NHPA	National Historic Preservation Act
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_X	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPPC	Northwest Power Planning Council
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Registry of Historic Places
NTU	nephalometric turbidity unit
NWI	National Wetland Inventory
NWPCC	Northwest Power and Conservation Council
ODEQ	Oregon Department of Environmental Quality
ortho-P	orthophosphorus
OSHA	Occupational Health and Safety Act
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCC	Palouse River and Coulee City Railroad
PHS	Priority Habitat and Species (Washington Department of Fish and Wildlife)
PIT	passive integrated transponder
PL	Public Law
PM	particulate matter
PM2.5	particulate matter equal to or less than 2.5 microns in diameter
PM10	particulate matter equal to or less than 10 microns in diameter
the Ports	The ports of Lewiston, Idaho and Clarkston, Washington
ppb	parts per billion
ppm	parts per million
pptr	Parts per trillion
PSMP	Programmatic Sediment Management Plan
RCRA	Resource Conservation and Recovery Act
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RMJOC	River Management Joint Operating Committee
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SEF	Sediment Evaluation Framework
SEIS	Supplemental Environmental Impact Statement
SL1	Dredged Material Management Office (DMMO) Screening Level 1
SO_2	sulfur dioxide
SPCC	spill prevention, control, and countermeasure
SPF	standard project flood
TCP	traditional cultural property
TEQ	toxic equivalent
TMDL	total maximum daily load
TOC	total organic carbon
total-P	total phosphorus
TN	total nitrogen
TSCA	Toxic Substances Control Act
TSS	total suspended solids
UI	University of Idaho
UPRR	Union Pacific Railroad
USC	United States Code

USCA	United States Code Annotated
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USRM	upland sediment reduction measure
UST	underground storage tank
USWCD	Union Soil and Water Conservation District
VOC	volatile organic compounds
Water Center	University Water Resources Center
WCTED	Washington Department of Community, Trade, and Economic Development
WRCC	Western Regional Climate Center
WSU	Washington State University

SECTION 1.0 INTRODUCTION

1.1 Introduction to the PSMP EIS

The Walla Walla District of the U.S. Army Corps of Engineers (Corps) has identified and evaluated sediment management strategies for the lower Snake River. Based on the analysis presented in this Environmental Impact Statement (EIS) and stakeholder and public comments, the Corps will adopt and implement a Programmatic Sediment Management Plan (PSMP) (see proposed PSMP in Appendix A) for the management of sediment within the lower Snake River system to meet existing authorized project purposes.

As a part of its congressional authorization, the Corps operates and maintains the federal navigation system on the lower Snake River, which is part of an inland navigation system from Lewiston, Idaho to the Pacific Ocean and includes the Columbia River.

The Corps constructed four dams on the Snake River in Washington State (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) between 1961 and 1975 (Table 1-1). The Corps' sediment management area includes the lower Snake River from the confluence with the Columbia River[1] to the upstream limits of Lower Granite Reservoir, including the lower portion of the Clearwater River. For the purposes of this EIS, the sediment management area, including the four dams and their associated locks and reservoirs, is referred to as the Corps' Lower Snake River Projects (LSRP) (Figure 1-1).

Table 1-1. Lower Snake River Projects

Dam	Year Completed
Ice Harbor	1961
Lower Monumental	1969
Little Goose	1970
Lower Granite	1975

The existing authorized project purposes of the LSRP include commercial navigation, recreation, fish and wildlife conservation, and flow conveyance. Sediment accumulation in the lower Snake River can interfere with these existing authorized project purposes of the LSRP.

The Corps has historically used dredging as its primary method of removing accumulated sediment that interferes with the existing authorized project purposes of the LSRP. Dredged sediments were moved to and placed in areas where they would no longer interfere with the existing authorized project purposes, either in-water within the reservoirs or on upland sites.

[1] The lower Snake River between the confluence with the Columbia River and Ice Harbor Dam is within the reservoir formed by McNary Dam on the Columbia River.

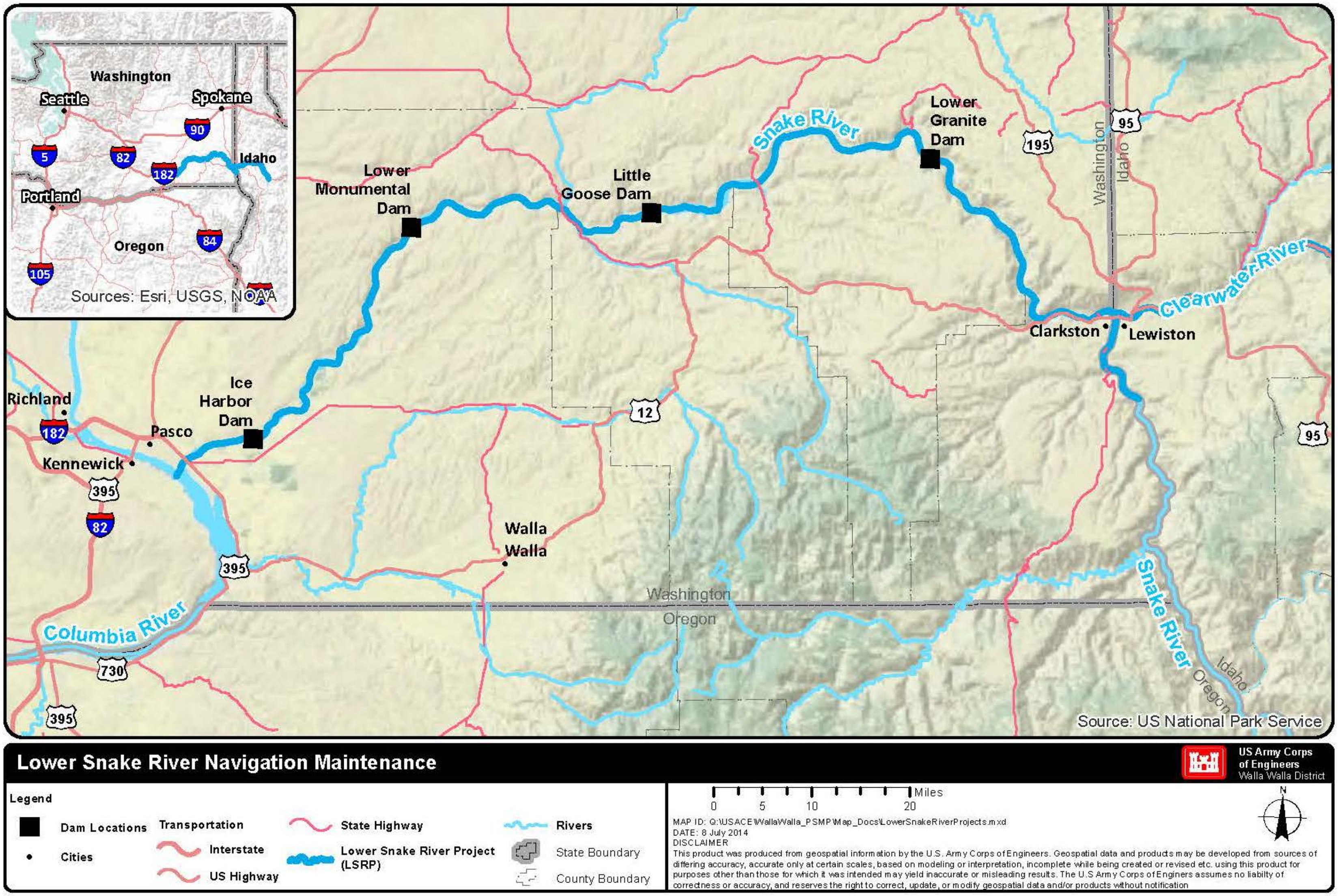

Figure 1-1. Lower Snake River Projects

Between 1999 and 2002 the Corps prepared a Dredged Material Management Plan (DMMP) EIS, which evaluated alternatives for managing dredged sediments in the LSRP. Following the September 2002 publication of the Record of Decision (ROD) for the DMMP EIS, a group of environmental and fishing interests (collectively referred to as the "plaintiffs") filed a lawsuit in November 2002, alleging compliance failures by the National Marine Fisheries Service (NMFS) with respect to the Endangered Species Act (ESA) and by the Corps with respect to the National Environmental Policy Act (NEPA). The U.S. District Court, Western District of Washington, granted a preliminary injunction, halting further action by the Corps. The Corps withdrew the ROD and in 2005 prepared an EIS for a one-time federal navigation channel maintenance action (dredging). The litigation was ended in 2005 through a settlement agreement between the plaintiffs and the Corps. In the settlement agreement the Corps was allowed to perform a one-time dredging of the federal navigation channel and related port berthing areas in the winter of 2005/2006. The Corps also agreed to "…initiate and complete a NEPA analysis on a long-term plan for the management of sediment in the lower Snake River, to be designated the Programmatic Sediment Management Plan…." The PSMP is designed to evaluate future actions for sediment management to meet existing authorized project purposes. This EIS document presents the NEPA analysis of the long-term plan (PSMP) for sediment management directed by the settlement agreement and the current immediate need action (including related regulatory reviews) consistent with the PSMP.

This section presents background information on the LSRP, the purpose and need for the proposed action, Corps authorizations that identify existing project purposes, sediment sources in the lower Snake River watershed, and the historic and ongoing efforts to manage sediments in the lower Snake River watershed to meet the existing authorized project purposes.

1.1.1 Proposed Action

The Corps proposes to adopt and implement a PSMP for managing sediment within the lower Snake River system to meet the existing authorized project purposes that are affected by sediment deposition. These purposes are commercial navigation, recreation, fish and wildlife conservation, and flow conveyance. The Corps is preparing this EIS to evaluate a long-term plan for management of sediment accumulation that affects existing authorized project purposes of the LSRP and a current immediate need maintenance action consistent with the plan to re-establish the federal navigation channel to congressionally authorized dimensions. The Corps would implement the current immediate need action during the first available in-water work period following the approval of the ROD for this PSMP EIS. This PSMP EIS is a comprehensive evaluation of all related federal actions and therefore includes consideration of potential environmental effects of Clean Water Act (CWA) Section 404 and Rivers and Harbors Act Section 10 permit applications for maintenance dredging by the ports of Lewiston and Clarkston (the Ports) at non-federal areas adjacent to the federal navigation channel. The Corps' determination on the permit applications may occur in separate decision documents, in accordance with the Corps' Regulatory Program regulations (33 Code of Federal Regulations (CFR) 320-332), but potential environmental effects are evaluated in this EIS.

1.1.2 Purpose and Need

The purpose of the proposed action is to maintain the existing projects (the LSRP) by managing sediment that interferes with the existing authorized project purposes by adopting and implementing a PSMP, which includes actions for long-term and immediate needs. The purpose also includes a current immediate need action to re-establish the federal navigation channel to the congressionally authorized dimensions of 14 feet deep by 250 feet wide to address sediment accumulation that is interfering with commercial navigation. Coinciding with the current immediate need action is a related need to restore depths necessary to support commercial navigation at non-federal berthing areas of local ports.

The PSMP will provide a programmatic framework to evaluate and implement sediment management measures to address the accumulation of sediment that interferes with existing authorized project purposes. The PSMP is needed to maintain the LSRP by managing, and preventing if possible, sediment accumulation in areas of the lower Snake River reservoirs that interfere with the following existing authorized project purposes:

- *Commercial navigation* by reducing the depth of the federal navigation channel to less than the congressionally authorized dimensions (14 feet deep by 250 feet wide) when operating at minimum operating pool (MOP), thereby impairing access to port berthing areas, access to navigation locks, and safe movement of tugs and multi-barge tows;
- *Recreation* by limiting water depth at recreation areas to less than original design dimensions and thereby impairing access;
- *Fish and wildlife conservation* by sediment accumulation interfering with irrigation water intakes at Habitat Management Units (HMUs), juvenile ESA-listed fish barge access to loading facilities, and fish barge passage through the reservoirs and locks within the LSRP;
- *Flow conveyance* at Lewiston[2] by reducing the capacity of the river channel between levees to pass high flows. Sediment management at the confluence of the Snake and Clearwater Rivers may be needed in the long-term to manage the risk of flooding consistent with applicable Corps policies.

Historically within the LSRP, the Corps has approached project maintenance by identifying areas where sediment interfered with existing authorized project purposes and then taking action to remove the sediment, usually by dredging. The PSMP identifies and evaluates a wide range of measures to accomplish the purpose of maintaining the LSRP and provides a decision-making process to manage and, if possible, prevent sediment accumulation that interferes with existing authorized project purposes, including addressing the current immediate need action to re-establish the federal navigation channel to congressionally authorized dimensions of 14 feet deep

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[2] Although flood risk management is not an authorized project purpose of the LSRP, ensuring adequate flow conveyance through the Lewiston levee system supports the original Lower Granite Project design and all associated project purposes.

by 250 feet wide at MOP. Future actions under the PSMP may require project-specific environmental reviews tiered off of this programmatic EIS, and may involve additional studies and authorities.

The Corps has identified a current immediate need action to address sediment accumulation that is interfering with commercial navigation. Sediment accumulation has reduced the congressionally authorized federal navigation channel depth by several feet (at MOP) at two locations across much of its width (see Figure 1-2):

- The downstream navigation lock approach at Ice Harbor Dam
- The confluence of the Snake and Clearwater rivers at the upstream end of Lower Granite Reservoir

A current immediate need action is necessary to re-establish the federal navigation channel to its congressionally authorized dimensions at these locations.

Coinciding with the current immediate need action for re-establishing the congressionally authorized dimensions of the federal navigation channel is a related need for a maintenance action at the non-federal berthing areas for the Ports to restore depths necessary to support commercial navigation. Both ports are located at the upstream end of Lower Granite Reservoir at the confluence of the Snake and Clearwater rivers and are adjacent to the federal navigation channel (see Figure 1-2). The Port of Lewiston is on the right bank of the Clearwater River while the Port of Clarkston is on the left bank of the Snake River. The Ports are responsible for CWA Section 404 and Rivers and Harbors Act Section 10 compliance for their maintenance actions and must apply to the Corps for the necessary regulatory permits (Sections 404/10) to perform this maintenance. As stated above, the EIS also includes the evaluation of potential environmental effects associated with the permit applications for related berthing-area maintenance at the Ports. The berthing area maintenance is related to the Corps' purpose of re-establishing the congressionally authorized dimensions of the federal navigation channel and would coincide with federal navigation channel maintenance, pending the outcome of any necessary permit evaluations for the Ports' maintenance actions.

The sediment deposition is also currently interfering with the Corps' ability to operate the Lower Granite Reservoir within one foot of MOP from April through August for ESA-listed threatened and endangered juvenile salmon passage. This operation is called for in the National Oceanic and Atmospheric Administration (NOAA) 2014 Supplemental Biological Opinion (BiOp) for the Federal Columbia River Power System (FCRPS) (NOAA 2014), hereinafter referred to as the NOAA FCRPS BiOp[3], Reasonable and Prudent Alternative (RPA) Action 5.

In addition, the Corps has developed this PSMP EIS to fulfill the relevant portion of the 2005 settlement agreement referenced in Section 1.1 above.

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[3] The supplement to the 2008/2010 FCRPS BiOp.

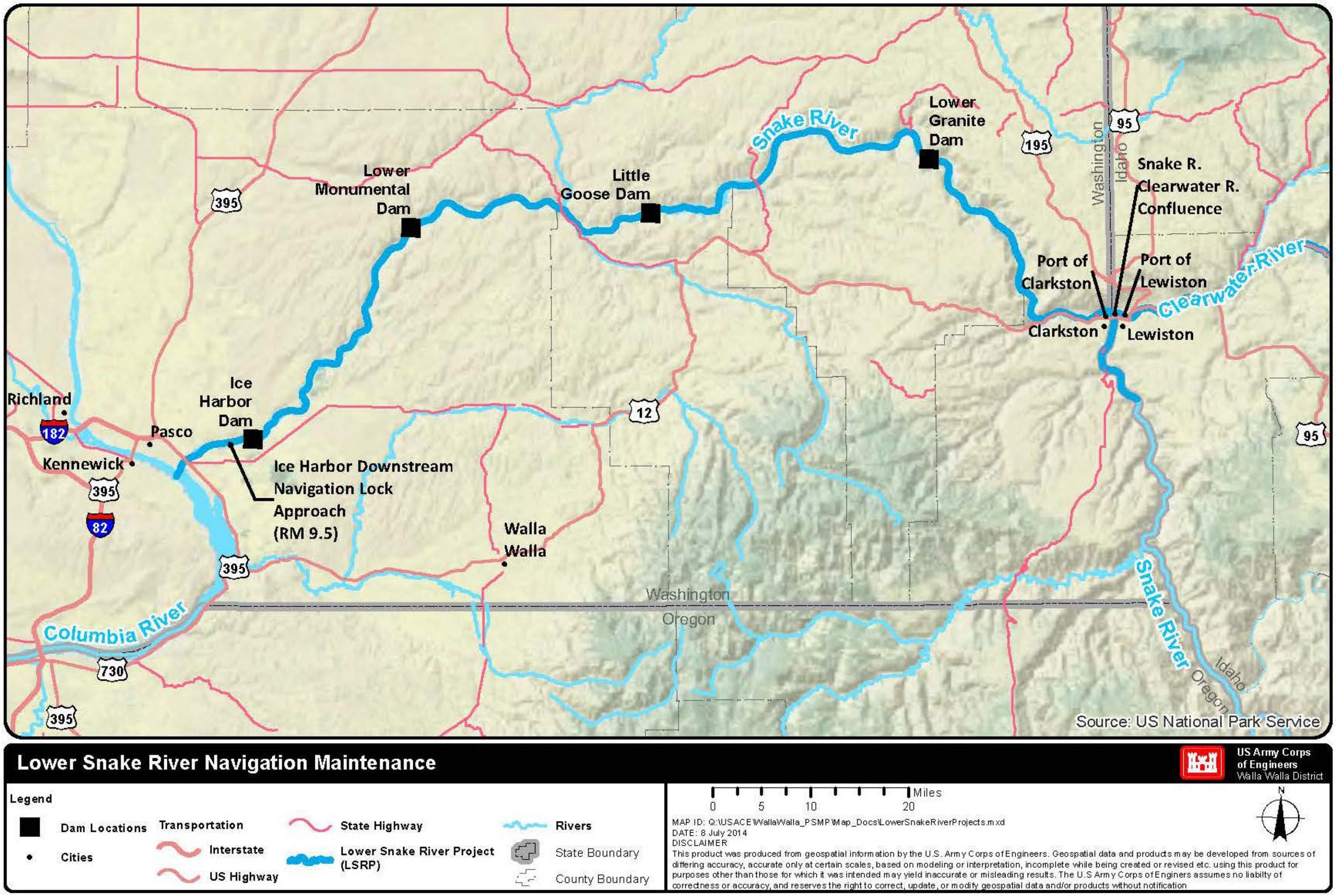

Figure 1-2. Current Immediate Need Action Locations and Port Maintenance Sites

1.1.3 Programmatic EIS

A federal agency may enact a programmatic approach versus a project-specific approach for a broad program of management activities under its authority (40 CFR 1502.4(b)). The purpose of programmatic management is to provide consistency in and a roadmap for future project-specific decision-making. The associated programmatic management plan developed by a federal agency requires preparation of a programmatic EIS. This PSMP programmatic EIS includes alternatives that define broad programs for managing sediments through implementation of future actions as they relate to maintaining the existing authorized project purposes of the LSRP. Actions taken to address the current immediate need action (consistent with the PSMP) to re-establish the congressionally authorized dimensions of the federal navigation channel, including regulatory review by the Corps of related port actions, are covered in this EIS at a site-specific level. Future actions would require project-specific environmental reviews, including preparation of appropriate NEPA documents tiered off of this programmatic EIS.

1.2 Corps Authorities, Directives, and Obligations

As authorized by Congress, the Corps constructed and now operates and maintains the navigation system on the lower Snake and Clearwater rivers. This portion of the inland navigation system stretches from Lewiston, Idaho, to the Columbia River navigation channel. Congress authorized the reservoir system and the navigation channel that runs through the reservoirs with the River and Harbor Act of 1945 (Public Law [PL] 79-14), Section 2. This Act included authorization to construct Ice Harbor, Lower Monumental, Little Goose, and Lower Granite lock and dams for the purposes of inland navigation, power generation, and incidental irrigation water supply. The Flood Control Act of 1944 (PL 78-534) authorized the Chief of Engineers to construct, maintain, and operate recreational facilities in reservoir areas under Corps management. Compliance with the Fish and Wildlife Coordination Act of 1958 (PL 85-624) resulted in certain modifications to the LSRP during and after construction, and added fish and wildlife conservation/mitigation as an authorized project purpose under the Water Resources Development Act of 1976 (PL 94-587).

The Flood Control Act of 1962 (PL 87-874) mandated the establishment of the navigation channel within the LSRP at 14 feet deep by 250 feet wide at the MOP level, and provided the Corps with authority to maintain the channel at those dimensions.
PL 87-874 stated:

> The projects and plans for the Columbia River Basin . . . are hereby modified . . . substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 403, Eighty-seventh Congress: Provided, that the depth and width of the authorized channel in the Columbia-Snake River barge navigation project shall be established as fourteen feet and two hundred and fifty feet, respectively, at minimum regulated flow.

House Document (HD) 403 provided the basis for Congress's designation of a 14-foot by 250-foot navigation channel. HD 403 included a letter from the Secretary of the Army, dated April 25, 1962, making recommendations and transmitting the Report of the Chief of Engineers, dated March 31, 1961, which recommended, "…the depth and width of the authorized channel in the Columbia-Snake River barge navigation project be established as 14 and 250 feet, respectively, at minimum regulated flow." (Para. 31.e, p. 18).

Based on the authorizing legislation and associated congressional documents, Congress intended for the Corps to maintain the lower Snake River navigation channel at the dimensions specifically designated by Congress (i.e., 14 feet deep and 250 feet wide) and for slack water navigation to be possible on the lower Snake River on a year-round basis. The Corps lacks discretion to designate alternative channel dimensions.

In addition, the Corps is authorized to review and approve certain in-water actions, such as dredging, pursuant to the Rivers and Harbors Act of 1899 and the CWA. Under Section 10 of the Rivers and Harbors Act of 1899, Corps approval is required for work or structures in, over, or under navigable waters of the United States. Under CWA Section 404, Corps approval is required for the discharge of dredged or fill material into waters of the United States.

1.3 Sediment and the Authorized Project Purposes of the LSRP

The watershed, or the area that drains and contributes sediment to the lower Snake River, is more than 32,000 square miles and comprises diverse landscapes. The watershed includes the following major tributary rivers: the Salmon, Grande Ronde, Clearwater, and Snake upstream of the Clearwater. Other rivers, such as the Tucannon and Palouse, drain to the lower Snake River downstream of the Clearwater/Snake confluence.

1.3.1 Sediment Interference with Existing Authorized Project Purposes

Dams affect the movement and behavior of sediment within river systems. Upstream of the LSRP, Dworshak Dam on the Clearwater River and the Hells Canyon complex of dams on the Snake River trap substantial amounts of sediment that originate upstream. The lower Snake River dams slow the velocity of the river, allowing the heavier sediments to settle out and deposit within the reservoir while the lighter sediments pass through the dams. The Lower Granite Reservoir, which is the farthest upriver reservoir in the lower Snake River system, receives the majority of the sediment entering the system from the watershed and experiences the greatest accumulation of heavier sediments.

The accumulation of sediment in some locations in the lower Snake River adversely affects the existing authorized project purposes of the Corps' projects, including commercial navigation, recreation, fish and wildlife conservation, and flow conveyance. The Corps manages those sediments pursuant to the authorities described in Section 1.2 above, and has historically managed sediments to maintain:

- The federal navigation channel at the congressionally authorized depth of 14 feet deep and 250 feet wide;
- Access and use of Corps managed recreation facilities;
- Functioning irrigation water intakes for Corps-maintained irrigated (HMUs); and
- Flow conveyance through the Lewiston levee system consistent with Engineer Regulation (ER) 1105-2-101.

1.3.2 Corps Sediment Management Guidance

The following paragraphs provide a brief description of some of the documents the Corps reviewed when preparing this EIS and the proposed PSMP, and when planning the proposed current immediate need action.

The Corps' ER 1105-2-100, *Planning Guidance Notebook* (Corps 2000a) provides policies and guidelines for sediment management planning. ER 1105-2-100 encourages the Corps to perform dredged material management planning for all federal harbor projects. The purpose of the planning is to "ensure that maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, [and] are economically warranted…." Section 3.5.3.1 provides specific information concerning economic information warranting development of the PSMP. The general guidance contained in the ER was applied in the development of the proposed PSMP and this EIS. However, it should be noted that these documents were developed in part to fulfill the requirements of a settlement agreement and the PSMP is intended to address more than just dredged material management. Development of the proposed PSMP, therefore, did not follow the typical Corps DMMP planning process. The ER also includes guidance on the beneficial uses of dredged material. Further, the ER encourages incorporation of a "watershed perspective" in conducting civil works planning, which includes accounting for "…the interconnectedness of water and land resources…."

The Corps' Policy Guidance Letter #61 – *Application of Watershed Perspective to Corps of Engineers Civil Works Programs and Activities* (Corps 1999a) provides policy direction to integrate a watershed perspective, including soliciting participation from the spectrum of agencies, tribes, and stakeholders with interests in the Corps' Civil Works programs and involving diverse technical experts. This policy is embodied in the principles of Regional Sediment Management, which stresses a "system based approach" to solve sediment-related problems (EPA 2011, Corps 2011a).

The Sediment Evaluation Framework (SEF) for the Pacific Northwest (Corps 2009a) provides guidance for assessing and characterizing sediments associated with dredging in Idaho, Oregon, and Washington. It was developed collaboratively by federal and state agencies with responsibility for sediment evaluation and management. The SEF describes the methods available for sediment characterizations related to management activities. While the SEF is geared toward determining the suitability of sediments for open water disposal, it also provides consistency for testing and evaluation procedures for sediment management projects in the LSRP.

The Dredged Material Evaluation and Disposal Procedures User Manual (Corps 2013) is also based on an interagency approach to the management of dredged material in Washington State. The sampling and analysis protocols presented in the User Manual are consistent with those in the SEF. The User Manual does not contain sediment freshwater screening limits or bioassay interpretive guidelines; these parameters need to be obtained from the SEF. However, if freshwater guidelines for certain chemicals of concern are not addressed in the SEF, the DMMP marine values are used.

The Corps' Environmental Operating Principles (included inside the front cover of this document) provide guidance for Corps activities. By following these principles, the Corps aims to develop the scientific, economic, and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions.

1.4 Corps Management of Sediment in LSRP

1.4.1 Sediment Accumulation Areas

The Corps evaluated locations where sediment accumulation could interfere with the LSRP existing authorized project purposes. The Corps identified 43 locations in the LSRP where sediment accumulation historically has affected existing authorized project purposes or where sediment accumulation may potentially be a problem in the future[4]. Table 1-2 lists these areas, their authorized project purpose, and their approximate river mile (RM) location. Of the locations identified, 21 sites are used for recreation, 16 are navigation sites[5], and 5 sites are related to water intakes to irrigate HMUs (i.e., fish and wildlife). Flow conveyance (as it relates to flood risk management through the Lewiston levee system) and navigation are affected existing authorized project purposes at the Snake and Clearwater confluence.

[4] It should be noted that, to date, dredging has occurred at relatively few of the sites identified; however, the Corps has attempted to identify all areas where sediment accumulation could potentially affect authorized project purposes in the future.

[5] Several of these sites are Port facilities. The Ports may apply for permits to conduct maintenance activities not covered in previous permits. The Corps has, at the request of the Ports, dredged accumulated sediments at these permitted locations to coincide with dredging to maintain the federal channel. In these cases, the federal government is reimbursed the additional cost of dredging the Port facilities by charging for that area of activity and disposal plus administrative costs.

Table 1-2. Corps-identified Sediment Problem Areas in the Lower Snake River System

Reservoir	River	Approximate River Mile[1]	Site Name	Purpose
Lower Granite	Clearwater	1.0-2.0	Port of Lewiston*	Navigation
		3.0	Clearwater Boat Ramp*	Recreation
	Snake/ Clearwater	131.5-139.5/ 0.0-2.0	Snake River at Mouth of Clearwater River	Navigation, conveyance
	Snake	128-130	Silcott Island	Navigation
		137.0	Hells Canyon Resort*	Recreation
		139.0	Port of Clarkston*	Navigation
		139.5	Greenbelt Boat Basin	Recreation
		140.5	Southway Boat Ramp*	Recreation
		141.5	Swallows Park Boat Basin and Swim Beach	Recreation
		142.5	Hells Gate State Park*	Recreation
		146.0	Chief Looking Glass Park*	Recreation
Little Goose	Snake	83.0	Port of Garfield Access*	Navigation
		83.5	Port of Central Ferry*	Navigation
		88.0	Willow Landing HMU	Fish and wildlife
		100.0-102.0	Navigation Channel at Schultz Bar	Navigation
		103.5	Port of Almota*	Navigation
		103.5	Illia Landing	Recreation
		105.5	Boyer Park and Marina*	Recreation
		107.0	Lower Granite Lock Approach	Navigation
		48.0	Skookum HMU	Fish and wildlife
Lower Monumental	Snake	51.0	Ayer	Recreation
		55.0	55-Mile HMU	Fish and wildlife
		56.5	Joso HMU	Fish and Wildlife
		59.5	Lyons Ferry Park	Recreation
		66.0	Texas Rapids Boat Basin	Recreation
		70.0	Little Goose Lock Approach	Navigation
		10.0	North Shore Boat Ramp	Recreation
Ice Harbor	Snake	11.5	Charbonneau Park	Recreation
		13.5	Levey Park	Recreation
		15.0	Big Flat Habitat Management Unit (HMU)	Fish and wildlife
		18.0	Fishhook Park	Recreation
		23.0	Lost Island HMU	Fish and wildlife
		24.5	Hollebeke HMU	Fish and wildlife
		29.0–33.3	Walker's Elevator*	Navigation
		39.0	Windust Boat Ramp	Recreation
		41.0	Lower Monumental Lock Approach	Navigation
		0.0	Sacajawea State Park*	Recreation

Table 1-2. Corps-identified Sediment Problem Areas in the Lower Snake River System

Reservoir	River	Approximate River Mile[1]	Site Name	Purpose
McNary	Snake	1.5	Hood Park Boat Ramp	Recreation
		9.2	Ice Harbor Lock Approach/Nav Coffer Cells	Navigation
		0.0–1.5	Snake River Entrance	Navigation
		2.0–10.0	Nav Channel Below Ice Harbor	Navigation
		2.0–10.0	Nav Channel Below Ice Harbor	Navigation

[1] "River Mile" indicates the number of miles upstream of the mouth of the Snake River at its confluence with the Columbia River.

** Designates non-Corps managed facilities*

1.4.2 Corps Sediment Management Activities

The Corps' past project maintenance program has been to monitor sediment accumulation through periodic surveys of the river bottom, coordinate with river users (e.g., navigators, recreation managers) regarding river conditions, and to dredge accumulated sediment that interferes with the existing authorized project purposes of the lower Snake River. Table 1-3 details the Corps' past dredging actions, most of which were conducted to maintain navigation or flow conveyance. The Corps has dredged problem sediment areas every 3 to 5 years on average, scheduling this dredging when river survey data or user reports indicated the sediment deposition was interfering with navigation or other existing authorized project purposes of the reservoirs.

Table 1-3. Partial History of Federal/Port Dredging in the Lower Snake River

Dredging Location	Year	Purpose	Amount Dredged (cubic yards)	Disposal Method
Navigation Channel Ice Harbor, Part I and II, Channel Construction	1961	Navigation	3,309,500	Upland and in-water
Navigation Channel, Ice Harbor Part III, Channel Construction	1962	Navigation	120,000	Upland and in-water
Downstream Navigation Channel, Ice Harbor	1972	Navigation	80,000	Upland and in-water
Downstream Approach, Navigation Channel, Lower Monumental	1972	Navigation	25,000	Upland
Navigation Channel Downstream of Ice Harbor	1973	Navigation	185,000	Upland and in-water
Downstream Approach Channel Const., Lower Monumental Lock	1973	Navigation	10,000	Upland
Downstream Approach Channel Construction, Ice Harbor Lock	1978	Navigation	110,000	Upland and in-water
Downstream Approach Channel Construction, Ice Harbor Lock	1978 1981/82	Navigation	816,814	Upland and in-water
Various Recreation Areas, Swallows Swim Beach, Lower Granite Reservoir (Corps)	1975-1998	Recreation	20,000	Upland sites

Table 1-3. Partial History of Federal/Port Dredging in the Lower Snake River

Dredging Location	Year	Purpose	Amount Dredged (cubic yards)	Disposal Method
Port of Lewiston – Lower Granite Reservoir (Corps)	1982	Navigation/Maintain Flow Conveyance Capacity	256,175	Upland sites
Port of Clarkston – Lower Granite Reservoir (Corps)	1982	Navigation	5,000	Upland sites
Downstream Approach Channel Construction, Ice Harbor Lock	1985	Navigation	98,826	In-water
Confluence of Clearwater and Snake Rivers (Corps)	1985	Maintain Flow Conveyance Capacity	771,002	Upland site
Port of Lewiston – Lower Granite Reservoir (Corps)	1986	Navigation/Maintain Flow Conveyance Capacity	378,000	Upland sites
Confluence of Clearwater and Snake Rivers (Corps)	1988	Maintain Flow Conveyance Capacity	915,970	In-water
Confluence of Clearwater and Snake Rivers (Corps)	1989	Maintain Flow Conveyance Capacity	993,445	In-water
Schultz Bar – Little Goose (Corps)	1991	Navigation	27,335	Upland site
Confluence of Clearwater and Snake Rivers (Corps)	1992	Maintain Flow Conveyance Capacity	520,695	In-water
Barge Approach Lane, Juvenile Fish Facilities, Lower Monumental	1992	Navigation	10,800	Upland site
Ports of Lewiston (Lower Granite Reservoir), Almota and Walla Walla	1991/92	Navigation	90,741	Upland and in-water
Schultz Bar – Little Goose (Corps)	1995	Navigation	14,100	In-water
Confluence of Clearwater and Snake Rivers (Corps)	1996/97	Navigation	68,701	In-water
Confluence of Clearwater and Snake Rivers (Corps)	1997/98	Navigation	215,205	In-water
Greenbelt Boat Basin, Clarkston – Lower Granite Reservoir	1997/98	Recreation	5,601	In-water
Port of Lewiston – Lower Granite Reservoir (Port)	1997/98	Navigation	3,687	In-water
Port of Clarkston – Lower Granite Reservoir (Port)	1997/98	Navigation	12,154	In-water
Lower Granite Lock Approach	1997/98	Navigation	2,805	In-water
Lower Monumental Lock Approach	1998/99	Navigation	5,483	In-water
Lower Monumental Lock Approach (Ice Harbor Reservoir) Lower Granite Lock Approach (Little Goose Reservoir) Clearwater/Snake Confluence and Ports of Clarkston and Lewiston (Lower Granite Reservoir)	2005/2006	Navigation	335,898	In-water

Disposal methods for dredged materials are identified in accordance with Corps regulations (33 CFR 335-338). The Federal Standard for disposal of dredged material is defined as “[T]he least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the CWA 404(b)(1) evaluation process. . . ." (33 CFR 335.7). The Corps considers both upland and in-water disposal alternatives when dredging is proposed. For proposed in-water disposal, the disposal method is ultimately identified after evaluation of disposal alternatives under the substantive provisions of CWA Section 404(b)(1), associated U.S. Environmental Protection Agency (EPA) guidelines (40 CFR 230) and Corps regulations. When in-water disposal is proposed, the Corps is required to identify and utilize the lowest-cost, least environmentally damaging, practical alternative as its disposal method. The alternatives analysis in the CWA Section 404(b)(1) evaluation is incorporated into the NEPA process and ultimately identifies the Corps proposed/preferred disposal alternative.

Historically, the Corps dredged the accumulated sediment from problem areas and disposed of the material either upland or in the reservoirs (called “in-water disposal”). In-water disposal was opposed by regional fishery managers when several Snake River salmonid stocks were proposed for listing as threatened or endangered under the ESA. The concern was that in-water disposal could have an adverse effect on salmonids and provide potential salmonid predator habitat. However, suitable upland disposal sites in Lower Granite Reservoir, where most of the dredging took place, were becoming scarce. In the late 1980s and early 1990s, the Corps funded a series of studies that evaluated the effects of in-water disposal. The results of these studies were addressed in the 1988 *Lower Granite Final Environmental Impact Statement Supplement 1- Interim Navigation and Flood Protection Dredging* (1988 Supplemental Environmental Impact Statement (SEIS)) (Corps 1988). The studies indicated in-water disposal could be beneficial to juvenile salmonids if certain design criteria were used to guide sediment disposal methods. The December 20, 1988, ROD for the 1988 SEIS stated “…dredging with in-water disposal was selected as the preferred interim action to deal with the sedimentation problem in the reservoir until a long-term solution can be identified and implemented.”[6] Since the completion of those studies, the regional fisheries managers have provided qualified support for shallow water disposal as long as the Corps performs the disposal using design criteria from the most recent research. For its most recent disposal actions (1997/98, 1998/99 and 2005/06), the Corps disposed dredged material in-water to create shallow-water habitat for juvenile salmonids and monitored salmonid and other species’ use of the created habitat. In 2013, NMFS stated its review of the monitoring reports indicated the shallow-water habitat was having positive effects and they supported the continued use of that disposal method.

Since 2006, the Corps has primarily addressed sediment accumulation that interferes with navigation through operational changes at Lower Granite Reservoir and Ice Harbor Dam. The Corps has been operating the Lower Granite Reservoir above MOP within its operating range (Elev. 733-738) to provide increased depth for safe navigation. Sediment accumulation in Lower Granite Reservoir has reduced the depth of the federal navigation channel to less than 14 feet at MOP near the confluence of the Snake and Clearwater rivers and at the berthing areas for the

[6] The PSMP is intended to be the long-term solution mentioned in the 1988 SEIS.

Ports. Operation of the Lower Granite Reservoir above MOP, however, is considered an interim/temporary measure until the navigation channel can be re-established at the congressionally authorized 14-foot depth. Operating Lower Granite Reservoir at MOP between April-October is desired, in accordance with RPA Action 5 of the NOAA FCRPS BiOp. The Corps is also adjusting operation of Ice Harbor Dam to temporarily increase water releases to provide adequate depth in the navigation lock approach when a barge is entering or exiting the navigation lock. This is also considered an interim/temporary measure.

The Corps continues to use the same methods it has used since at least 1998 to address sediment accumulation that interferes with the existing authorized project purposes of recreation, fish and wildlife conservation, and flow conveyance. For Corps-managed recreation areas (boat basins or ramps) the Corps considers posting warnings or closing affected facilities if either of these actions is needed for safety. The Corps performs routine maintenance on existing irrigation intakes (e.g., lifting or shifting the intakes, or doing limited excavation), and can install a temporary intake, or use another available water source to address sediment accumulation at HMU intakes. The Corps is prepared to use reservoir operations during high flow events, in accordance with the Lower Granite Project Water Control Manual, if needed to provide flow conveyance at the Snake/Clearwater rivers confluence[7].

1.5 Other Agencies' Management of Erosion and Sediment

As noted in Section 1.3, a 32,000-square-mile watershed drains to the lower Snake River. The watershed includes several major tributary rivers (the Salmon, Grande Ronde, Clearwater, and the Snake River upstream of the Clearwater) and diverse land forms and uses. Erosion from land within the watershed, transport of eroded materials by streams, and sediment deposition are natural processes. The amount and type of eroded sediments varies widely across the watershed based on many factors, including soil types, slopes, and climate conditions. Natural events such as forest fires and landslides can greatly increase the amount of sediments reaching streams and rivers. Additionally, erosion and sediment loading to streams and rivers is often increased by human activities such as logging, agriculture, and urban development.

The Corps owns and manages very little land within the watershed – only about 42 square miles of land adjacent to the LSRP. Other agencies are involved in the management of sediment through land-use management practices that limit erosion and sedimentation. The U.S. Forest Service (USFS) owns and manages approximately 56 percent of the land within the watershed, the Bureau of Land Management (BLM) manages another 6 percent, and the remainder is in other public, tribal, or private ownership. Soil erosion on federal lands results from disturbances, especially from post-wildfire conditions, landslides, and roads in forest areas. Land management agencies implement various structural and conservation measures to limit soil erosion, including road maintenance and removal, post-fire land treatments, streambank stabilization, and protecting and restoring riparian areas.

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[7] Corps (1987a). Water Control Manual for Lower Granite Lock and Dam, Snake River, Oregon, Washington and Idaho, U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

In agricultural areas, which make up approximately 23 percent of the watershed (Tetra Tech 2006), landowners along with conservation districts and other agencies are involved in managing soil resources. Conservation districts work directly with agricultural users to implement soil conservation practices that limit soil erosion caused by agricultural practices.

In addition, the Idaho Department of Environmental Quality (IDEQ), Oregon Department of Environmental Quality (ODEQ), and the Washington State Department of Ecology (Ecology) address water-borne sediments primarily through their total maximum daily load (TMDL) water quality management plans. All three agencies have implemented a TMDL planning process as required by the CWA to develop strategies to reduce pollutants in waterbodies that do not meet water quality standards. Sediment reduction is often targeted as a means to reduce other pollutants from entering streams. Some plans may also directly address sediment.

1.6 A Watershed Approach to Sediment Management Planning

Through the PSMP EIS process, the Corps has undertaken a comprehensive watershed-based approach that investigates and analyzes sources of sediment from within the sediment-contributing area, how sediment moves through the tributaries, and how sediment moves and is deposited within the lower Snake River reservoirs. This approach was based on public and stakeholder input gathered during scoping (in 2006 and 2007) and through extensive coordination and partnerships with the resource agencies and technical experts with the knowledge and tools to aid in the understanding of sediment yield and transport in the lower Snake River watershed. Understanding the sources of sediment and how it is transported allows the Corps to identify where to focus its efforts to manage the sediment. As part of this effort the Corps has conducted or sponsored intensive data collection and analysis of sediment yields and transport throughout the Snake River basin (discussed in detail in Section 1.6.2 below). Public comments on the Draft EIS provided further input on sediment-related issues in the LSRP and the Snake River basin. This Final EIS incorporates the findings of this data collection and analysis along with the stakeholder input to identify the range of alternatives for meeting the stated purpose and need and the process of evaluating those alternatives.

1.6.1 Watershed Sediment Study Area

As noted above, the sediment-contributing watershed for the LSRP encompasses approximately 32,000 square miles. The watershed sediment study area (Figure 1-3) consists of the lower Snake River's sediment-contributing drainage area and includes the four main river systems flowing into Lower Granite Reservoir (the most upstream of the lower Snake River reservoirs): the Hells Canyon Reach of the Snake, and the Clearwater, Salmon, and Grande Ronde watersheds. The watershed also includes the area draining directly to the lower Snake River. Areas above the Hells Canyon dam complex and Dworshak Dam are not included, as these facilities are high structures that effectively prevent most sediment generated upstream of these dams from reaching the lower Snake River system.

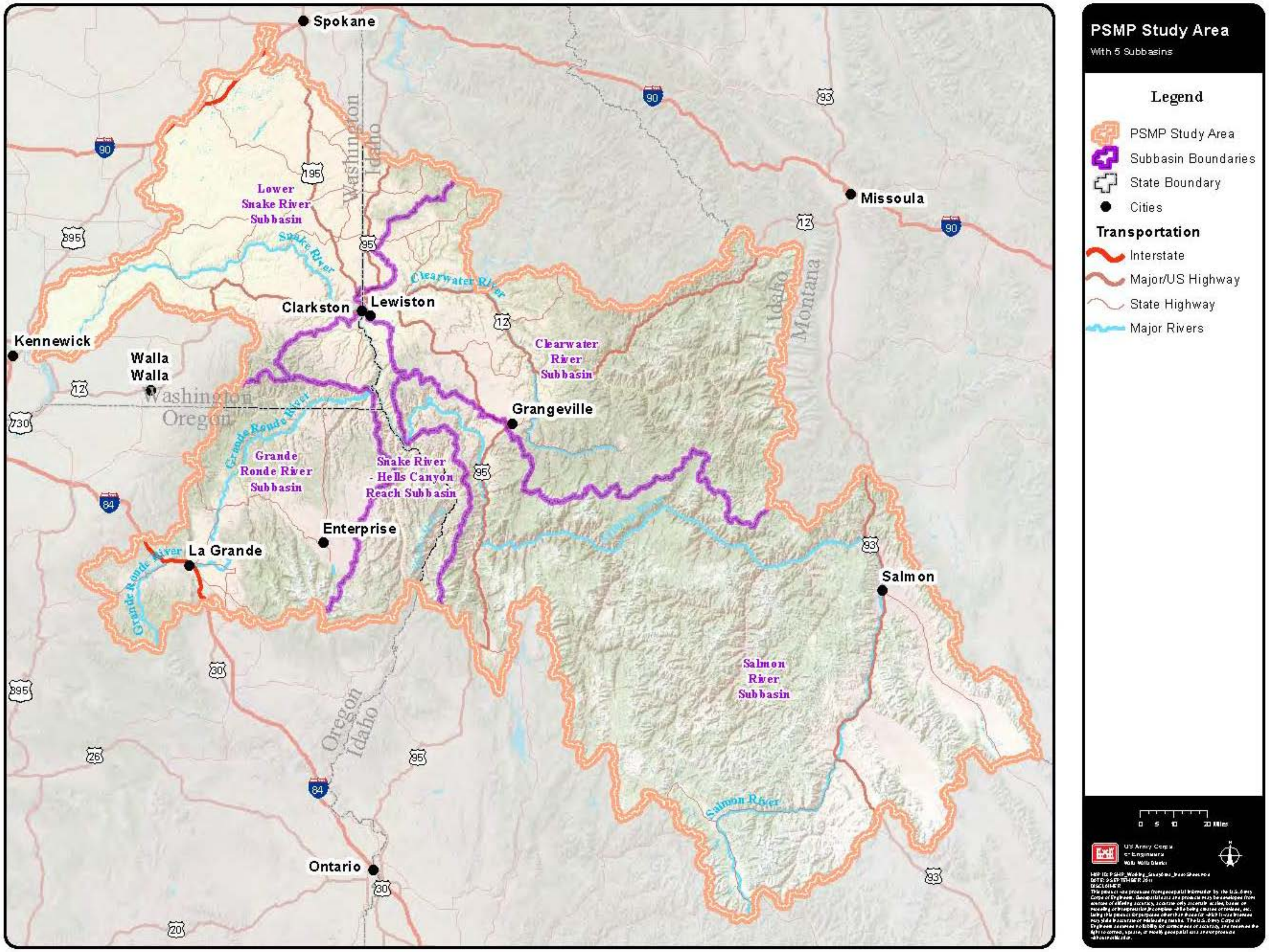


Figure 1-3. PSMP Watershed Study Area

The Corps manages approximately 42 square miles of land around the LSRP, which represents less than 1 percent of the more than 32,000 square miles in the watershed. Other branches of the federal government manage most of the watershed study area, with 27 percent in federal wilderness area and another 35 percent as national forest (non-wilderness). Thirty-five percent of this study area is in private ownership (Figure 1-4).

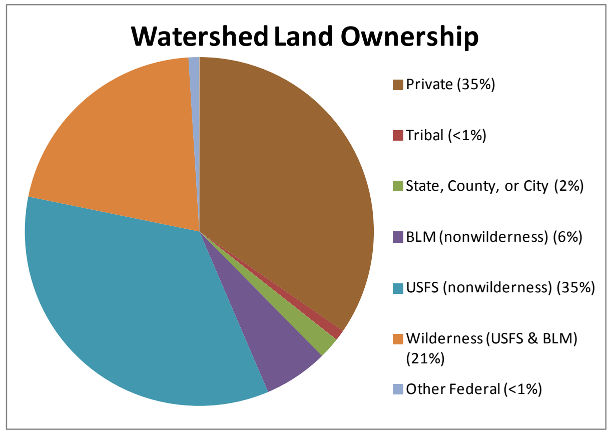


Figure 1-4. Watershed Land Ownership

1.6.2 Sediment and the Lower Snake River Watershed

Sediment is both a resource and a problem in river and reservoir systems. Erosion, sediment loading to and transport by streams, and sediment deposition are natural processes, but erosion and sediment loading can be increased by human activities, sometimes worsening problems associated with sediment. The following sections provide a brief overview of watersheds and sediment, a description of the extensive sediment studies undertaken in support of evaluating sediment management measures to be included in the PSMP, and the key findings of those studies.

1.6.2.1 Watersheds and Sediment – An Overview

The Corps' historical sediment management approach has generally addressee sediment in the locations where it accumulates within the reservoirs and interferes with the existing authorized project purposes of the lower Snake River. In contrast, other agencies' sediment management activities are aimed at reducing sediment delivered to local streams. The PSMP watershed approach involves assessing the large sediment-contributing area to better understand sources of sediment, how sediment moves through the watershed and river systems, and how sediment in the lower Snake River interferes with the Corps' existing authorized project purposes. As part of development of a long-term plan for managing sediment in the LSRP to meet existing authorized project purposes, the Corps and other agencies have conducted extensive literature reviews, data collection, and analysis to assess sediment sources and transport within the sediment-contributing watershed and the lower Snake River. This section describes the general characteristics of sediment, its transport within river systems, and why and where it accumulates in the lower Snake River.

Sediment is a mixture of soil particles and other material carried by a river. Sediment originates from the surrounding lands, as well as from the bed and banks of streams, and is carried into rivers and their tributaries by stormwater runoff and bank erosion, or is blown in by wind. Landslides and unstable slopes can also directly contribute sediment into the river system. Land-disturbing activities and events such as road building, urban development, logging, grazing, and agriculture can increase the sediment load entering the tributary streams and reservoirs. These chronic sources generally contribute sediment to streams over long periods of time. Wildfires alter vegetation and affect physical properties of soil, frequently leading to slope instability (landslides) and large-scale erosion and sediment loading (Goode et al. 2010; Elliot et al. 2014). Research has shown that these large-scale infrequent events are responsible for most sediment delivered to rivers and streams (Goode et al. 2010; Elliot et al. 2014). Complicating the management of sediment is the fact that sediment in large watersheds can be stored for years or even decades within the channel system before it is transported downstream.

Sediment in rivers can be classified into two general types (Figure 1-5):

- ***Suspended sediment*** is typically fine-grained material such as clay, silt, and fine sand, which moves downriver suspended within the water column.
- ***Bed load*** is coarse-grained material such as coarse sand, gravels, and cobbles, which move along the river bottom.

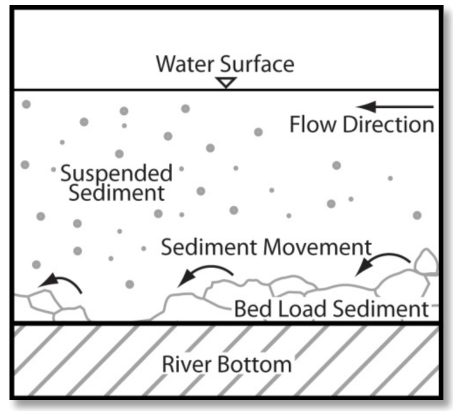


Figure 1-5. Sediment Types

Suspended sediment in relatively steep, swiftly flowing headwater streams often becomes bed load as it moves downstream and into areas where the stream channel deepens and water velocities slow. Figure 1-6 provides a schematic illustrating land surface erosion and conveyance to streams, channel conveyance and deposition, reservoir sediment loading, and reservoir sediment transport and management. Sediment yield and transport through the watershed study area are discussed in detail in Section 3.7.

Sediment is a natural part of the lower Snake River and all other river systems. It can be a valuable resource or a problem, depending on the amount of sediment, whether the sediment contains pollutants, and where, when, and how sediment deposition occurs within the river and reservoir systems and the uses of those river systems. Sediment can carry food and nutrients to nourish downstream plant and animal life and can create new riparian and aquatic habitats. However, too much sediment can smother some aquatic habitats, degrade water quality, and reduce visibility and light in the water column.

Sediment particle size, flow velocity, and other factors affect sediment movement. ***Sedimentation*** is sediment settling, or depositing, along the river bottom and floodplains, which typically occurs when water flow velocity decreases and sediment particles stop moving and settle or stay on the bottom. Sediment primarily enters each of the lower Snake River reservoirs from tributary streams and the upstream Snake and Clearwater rivers.

Sediment deposition can also limit human uses of the reservoirs, such as commercial navigation and recreational boating. Further, large quantities of deposited sediment can reduce the volume of water that can be conveyed within the channel, thereby increasing the risk of flooding during high flows. Sediment deposition can also clog water intakes used for Corps-managed irrigated HMUs.

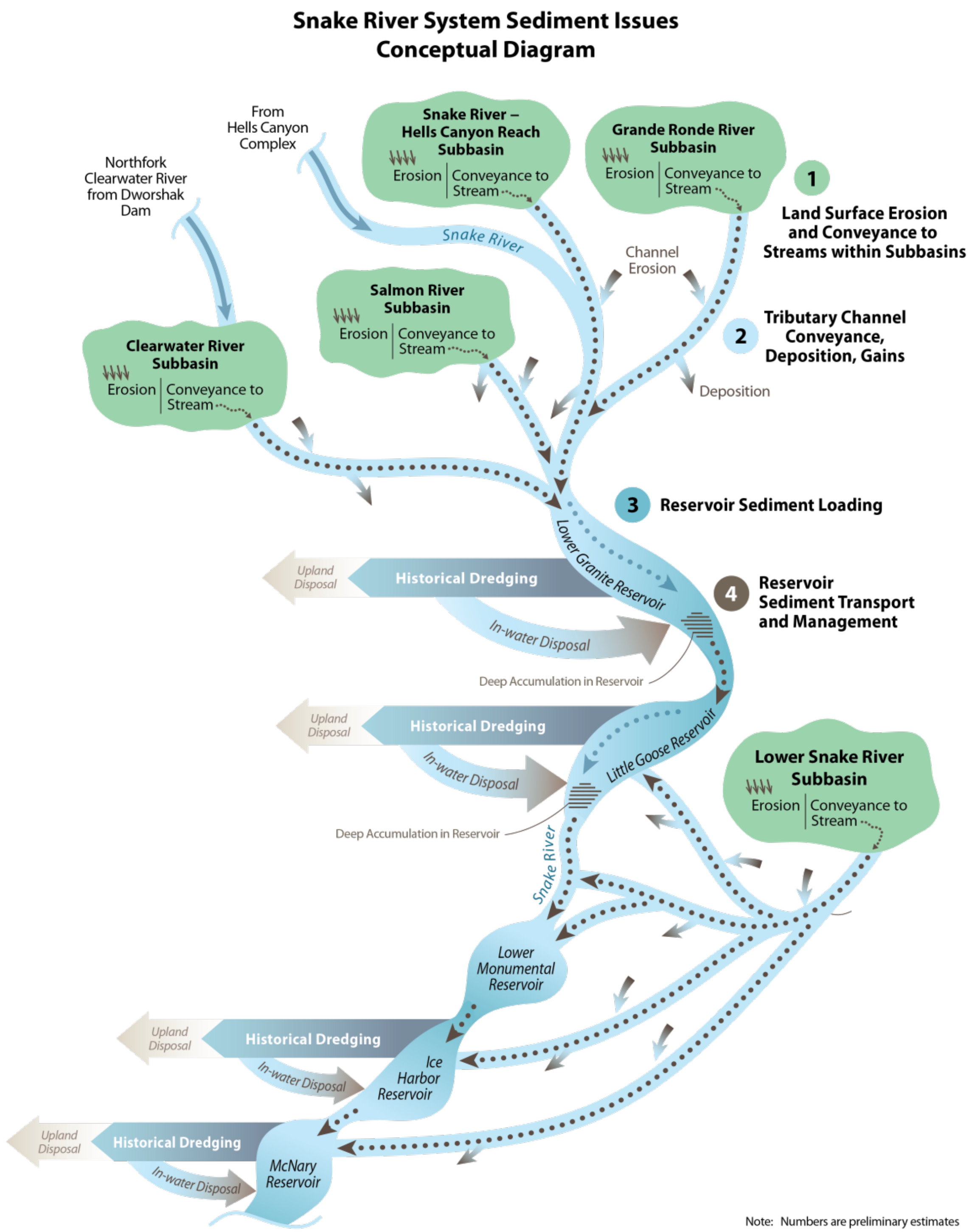


Figure 1-6. Watershed Schematic of Subbasins

1.6.2.2 Summary of Sediment Studies Findings

The findings of the studies described below provided valuable information for the process of evaluating feasible and effective sediment management measures and evaluating alternatives (discussed in Section 2). The findings indicate there is not a clear, quantifiable relationship between reduction of sediment at its source and reduction of sediment deposition that interferes with the existing authorized project purposes of the LSRP. The general findings from these studies are:

- Sand is the predominant sediment that interferes with the existing authorized project purposes in the LSRP.
- Wildfire in the watershed study area has been increasing since the 1970s and fire-affected areas of the Salmon River are the primary contributors of sand to Lower Granite Reservoir.
- Landslides and debris flows from areas affected by wildfire deliver large amounts of sediment (sand) in irregular, episodic events.
- There are no practicable ways in this watershed to prevent fire or control the sediment resulting from fire.
- Fine-grained sediments ("fines") are a minor component of the sediment that interferes with the existing authorized project purposes in the LSRP.
- Agricultural practices and some forest management practices contribute fines to the tributaries.
- Fine sediment has a greater potential to be controlled than sand and best management practices have reduced sediment yield (fines) primarily at a local level in tributaries
- There is no practicable way to measure the effect the reduction of fines in the watershed might have on sediment that interferes with the existing authorized project purposes in the LSRP.
- Not all sediments entering the system become problematic. How sediments settle within the system is highly dependent on conditions such as river flow, channel and river bed profile, sediment grain size and sediment load at the time the sediment enters the system.

The studies enhanced the understanding of the existing conditions and trends of sediment yield and transport (described in detail in Section 3.7), and the Corps' ability to estimate the effects of plan alternatives. The reports documenting the studies, including details on data, methods, and findings are included as appendices to this EIS. A summary of the main points from these studies is provided below.

1.6.2.3 Watershed Sediment Studies

The watershed assessment began with an examination of land cover and conditions that influence sediment yield. The Corps used the 2006 National Land Cover (NLCD) Dataset (NLCD 2006), a land-cover classification scheme that uses the most recent available data and has been applied consistently across the conterminous United States. Assessment of the NLCD 2006 data, and comparison with NLCD 2001 data, demonstrated the following characteristics of the watershed study area:

- Most of the watershed study area draining to Lower Granite Reservoir[8] is forested (55 percent in 2006); shrub communities (21 percent) and grassland (16 percent) categories are the next most-common cover types.
- In contrast, the portion of the watershed study area draining to the lower Snake River below Lower Granite Reservoir is dominated by cultivated agriculture (79 percent).
- The total amount of forested land in the portion of the watershed study area draining to Lower Granite Reservoir decreased between 2001 and 2006.

Data on wildfire from the Geospatial Multi-Agency Coordination Group (GeoMAC 2012) show that the watershed study area has experienced a trend of increasing fire over the last 40 years. Wildfire has affected 22 percent of the Lower Granite Reservoir watershed between 1971 and 2010, including substantial portions of the Salmon, Clearwater, and Snake River-Hells Canyon Reach subbasins. Figure 1-7 illustrates the area affected by wildfire over the past four decades, and Figure 1-8 presents the cumulative increase in the area affected by fire between 1971 and 2010.

To better understand the sources and movement of sediments entering the lower Snake River, the Corps coordinated an extensive program of research and analysis with the following objectives:

- Identify and characterize the sources of sediment in the watershed study area;
- Evaluate sediment transport and deposition in the watershed study area;
- Understand long-term patterns and trends of sediment deposition in Lower Granite Reservoir, particularly at the confluence of the Snake and Clearwater rivers;
- Understand long-term patterns and trends of sediment deposition from major tributaries downstream of Lower Granite Reservoir;
- Evaluate the impact of sediment on the risk of flooding in the Lewiston levee system; and
- Characterize the effectiveness of potential measures to reduce sediment loads to Lower Granite Reservoir.

[8] The sediment yield watershed for Lower Granite Reservoir is composed of the tributary subbasins that drain to the areas upstream of the head, or most upstream part, of Lower Granite Reservoir near the confluence of the Snake and Clearwater rivers. This is an approximately 27,000-square-mile subset of the approximately 32,000-square-mile watershed study area. The remainder of the watershed study area drains to the lower Snake River reservoirs downstream of the confluence of the Snake and Clearwater rivers.

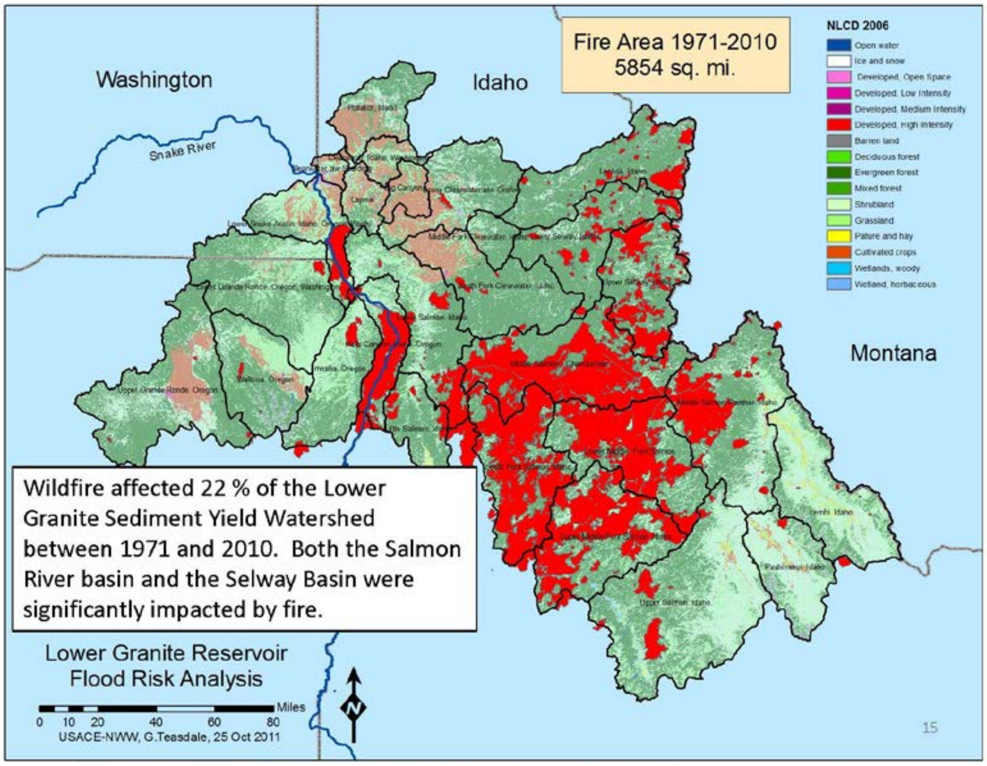


Figure 1-7. Wildfire-affected Areas in Lower Granite Reservoir Watershed

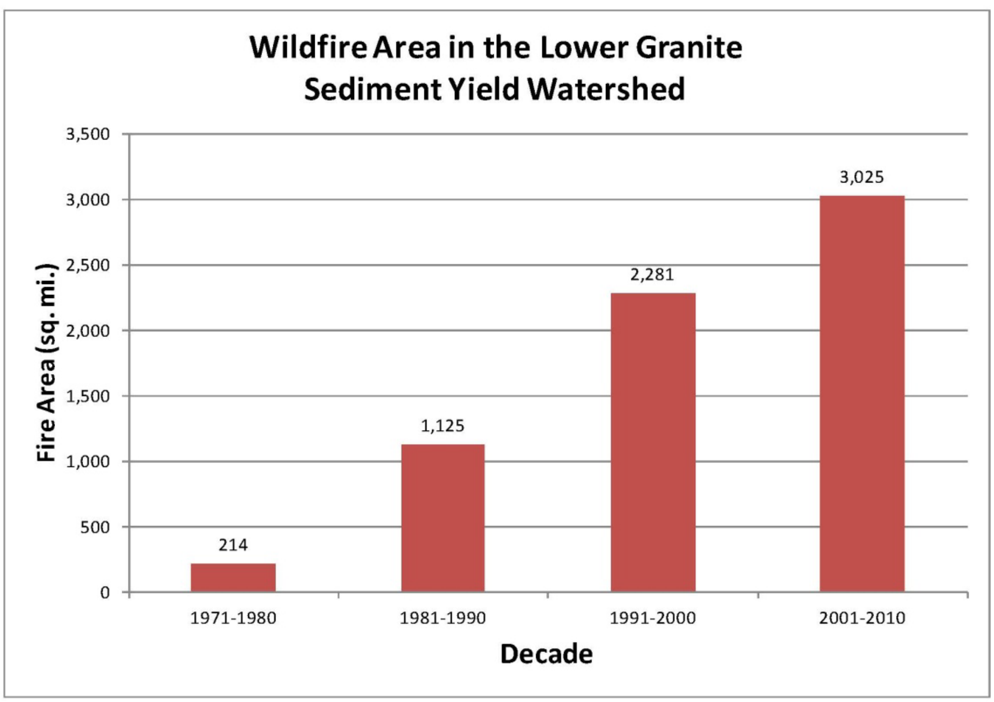


Figure 1-8. Wildfire Area in the Lower Granite Sediment Yield Watershed

The analysis conducted by the Corps and other agencies provides information to support decision making about short- and long-term strategies for managing sediment deposition that interferes with existing authorized project purposes of the LSRP. This research and analysis represents the most comprehensive assessment of sediment sources, loading, transport, and deposition conducted for the Snake River system, and forms the foundation of the Corps' analysis of measures that could potentially address the deposition of sediment in areas that interferes with the existing authorized project purposes of the LSRP.

Studies conducted are summarized in Table 1-4 and reports documenting the studies are included in appendices to this EIS.

Table 1-4. Studies Conducted in the Snake River System

Studies	Agency or Author	Appendix
Sediment sources and yield (basin wide)	Tetra Tech	B
Erosion and sediment yield from forest and rangeland	USFS	C and D
Erosion and sediment yield and reduction potential from agricultural and mixed-use watersheds	University of Idaho/ Washington State University	E
Hydraulics and hydrology investigations of the lower Snake River: Flood frequency analysis Hydraulic modeling and flood risk analysis Lower Granite Reservoir sediment loading analysis Lower Granite Reservoir sedimentation analysis Lower Granite Reservoir bed material characterization Sediment transport analysis Sediment quality analysis Water quality analysis	Corps	F
Sediment load (suspended sediment and bed load) measurements on the Snake and Clearwater rivers and tributaries Sediment coring Bathymetric survey Lower Granite bed sediment video mapping	United States Geological Survey	M
Fingerprinting sediment sources using neutron activation analysis, ICP-MS, and isotope analysis in the lower Snake River basin	University of Idaho/ Washington State University	N

As a starting point, in 2005-2006 the Corps conducted a watershed assessment of land cover, land ownership, and existing sediment management practices (Tetra Tech 2006). This study, along with scoping input (see Section 1.7), helped frame the subsequent and more detailed sediment yield assessment. The objectives of the sediment yield assessment included:

- Assessing and modeling the sediment yield of the study area using scientifically credible methods;
- Forecasting sediment delivery to the lower Snake River reservoirs;
- Identifying the primary sources of and trends in sediment delivery to the lower Snake River reservoirs; and

- Assessing whether sediment reduction measures would be effective in reducing sediment delivery to Lower Granite Reservoir that interferes with the existing authorized project purposes of the LSRP.

The objectives recognized the need to evaluate both the amount and sources of historic, current, and future sediment loads to the lower Snake River reservoirs, and that sediment yield monitoring and estimation should be a continuing and adaptive process that is refined and updated over time.

Methods used to assess and predict sediment yield for large areas like the watershed study area included sediment range surveys, sediment load measurements, and expert opinion (Ayyub 2001). These methods best quantify and characterize ***sediment yield*** and delivery at the scale relevant to management of sediment in the lower Snake River reservoirs. Based on scoping input and coordination with resource agencies with expertise in hydrology and sediment yield, the Corps developed and performed the sediment yield assessment to characterize sediment yield in the study area. The basin-scale assessment is complemented by a tributary assessment that quantified sediment yield from the main tributary watersheds. In combination these allow assessment of relative contributions of sediment to Lower Granite Reservoir from the main tributaries and allow sediment loads to be generally associated with land cover and conditions. Appendices B through F, M, and N are the reports presenting the detailed methods and findings from the major studies conducted by the Corps, USFS, University of Idaho (UI)/Washington State University (WSU), and the U.S. Geological Survey (USGS).

Areas affected by wildfire are associated with the greatest amounts of erosion and sediment yield from forested areas (Elliot et al. 2014). This analysis of fire-affected areas is important to sediment management strategies because it illustrates the areas that are likely contributing relatively large amounts of sediment to the tributaries to Lower Granite Reservoir.

Tributary sediment load measurements provide the basis for estimating sediment yields from the subbasins draining to Lower Granite Reservoir. The USGS measured the suspended sediment loads of each of the main tributaries and developed a set of sediment measurement data for October 2008 through October 2011. The Corps' analysis of these data has shown that:

- Suspended sediment loads generally correspond with discharges – that is, sediment loads are highest when flows are the highest, such as during high flows during spring snowmelt.
- Sediment inflows into Lower Granite Reservoir have not decreased since the 1970s and, based on the recent sediment load measurements, may be increasing in the Snake River.
- At the confluence of the Snake and Clearwater rivers (the head of Lower Granite Reservoir), the Snake River contributes 87.5 percent of incoming suspended sediment, and the

Clearwater River contributes 12.5 percent. More than half of the suspended sediment load to Lower Granite Reservoir (53.5 percent) comes from the Salmon River[9].

- Contributions of sand are of particular interest in sediment management planning since the sediments that typically interfere with the existing authorized project purposes of the LSRP are predominantly sand.
- The Snake River contributes 90.5 percent of the suspended sand load to Lower Granite Reservoir; the Salmon River is responsible for 65.2 percent of the sand load to the reservoir.
- The Grande Ronde River contributes minor amounts of sediment to Lower Granite Reservoir.

Figure 1-9 and Figure 1-10 illustrate the contributions of suspended sediment and suspended sand for the sampling period.

[9] The Salmon River is a tributary of the Snake River upstream of the Lower Granite Reservoir. Thus, the Salmon River sediment loads are a component of the Snake River load entering the reservoir.

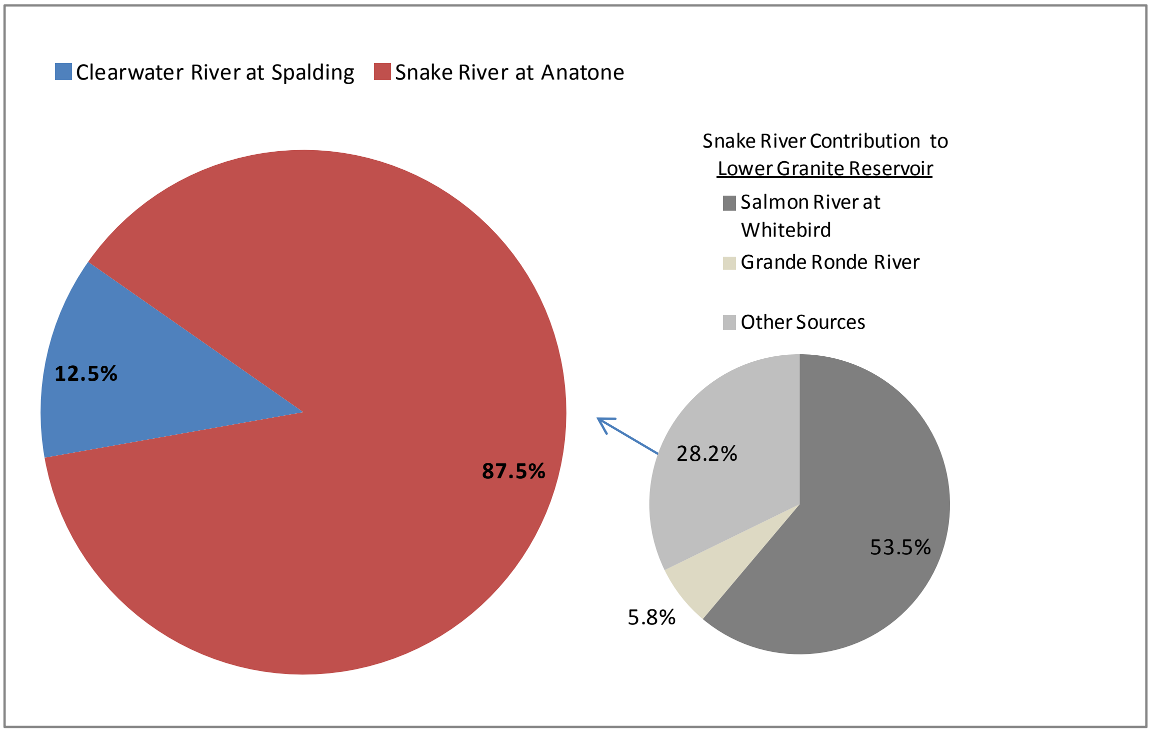


Figure 1-9. Percentage of Total Annual Suspended Sediment Load October 2008-October 2011

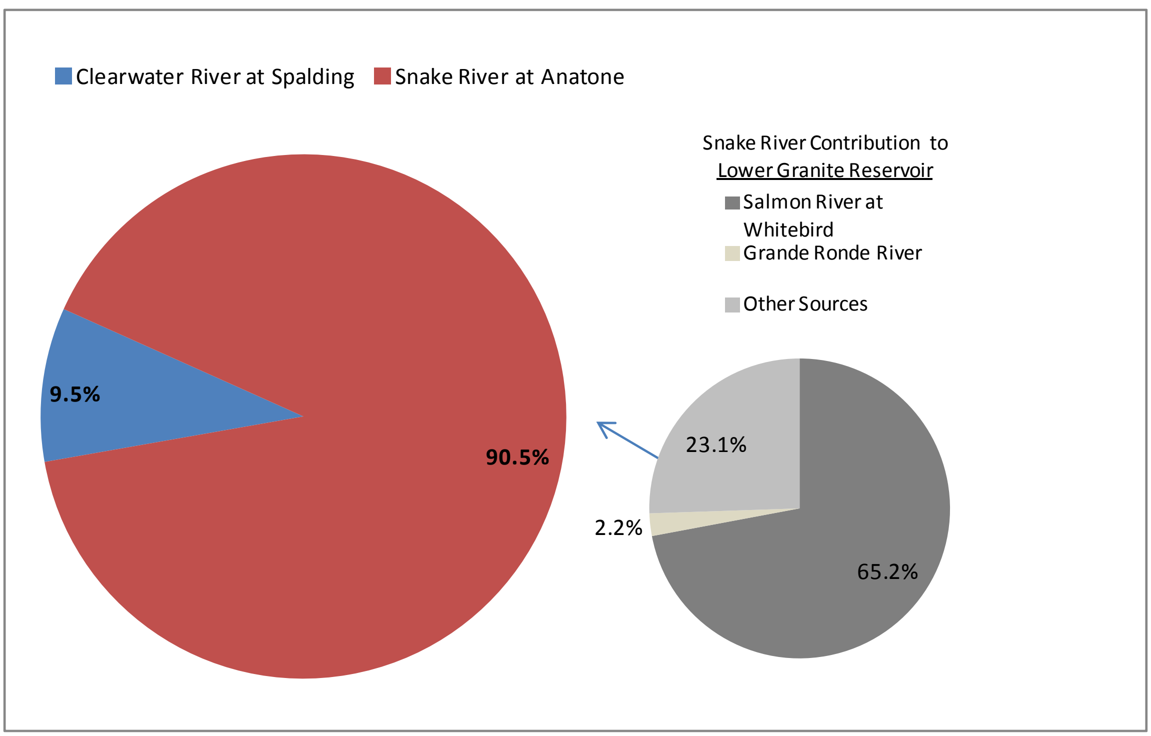


Figure 1-10. Percentage of Total Annual Suspended Sand Load October 2008-October 2011

USGS measurements of sediment and sand loads from tributaries clearly indicate that forested areas, and in particular, fire-affected areas of the Salmon River are the primary contributors of sand to the Lower Granite Reservoir (Corps 2011b). USFS assessments confirmed that landslides and debris flows from areas affected by wildfire deliver large amounts of sediment – primarily sand – in irregular, episodic events. Most of the sediment from these large events is then transported during infrequent periods of high flows (Elliot et al. 2014). Other sources of sediment from forested watersheds, such as roads, contribute smaller quantities of finer sediment than episodic large events, but erosion and sediment from these sources tends to be more chronic (occurring regularly over long periods) and potentially more controllable (Elliot et al. 2014; Goode et al. 2010).

Further, fire over recent decades has been influenced by the climatic trend of hotter, drier summers (Goode et al. 2010). The USFS projects a continuation of this trend, which may lead to increased sediment loading from forested watersheds (Morgan et al. 2008).

The preceding discussion focuses on the sediment contributions in the majority of the watershed study area that is predominantly forest, grassland, and shrub communities. The approximately 5,000 square mile portion of the study area that drains to the lower Snake River reservoirs below the confluence of the Snake and Clearwater rivers differs from the remainder of the study area in that agriculture is the predominant land cover type. WSU and UI studied sediment yield from these agricultural watersheds, and found that:

- Widespread adoption of best management practices (BMPs) has been effective at reducing sediment yields from agricultural areas.
- Despite the reduction of sediment yield from BMPs, agricultural areas continue to contribute relatively large quantities of fine-grained sediments to tributaries, while very little sand from agricultural areas reaches the tributaries (UI/WSU 2010).
- Fine grained sediments represent a small portion of the sediments that interfere with existing authorized project purposes of the LSRP. This is, in part, why historically there have been few locations in reservoirs below Lower Granite where sediment has interfered with existing authorized project purposes.

1.7 Environmental Review Process

Formal adoption and implementation of a PSMP are federal actions requiring compliance with NEPA and other applicable federal environmental laws and regulations. The NEPA process relies on participation of the public, of local, state, and federal agencies, tribal governments, and nongovernment organizations (NGOs) to help identify the scope of issues and concerns associated with a proposed agency action. NEPA then requires study of the proposed action and alternatives to the proposed action and disclosure of their environmental consequences to decision makers and the public through preparation of the appropriate NEPA document (environmental assessment (EA), EIS or categorical exclusion).

1.7.1 Steps in the EIS Process

The following steps are taken by the Corps (as the lead federal agency) in the EIS process:

1. Define project purpose and need.
2. Conduct public scoping to identify issues and concerns the Corps will address in the EIS.
3. Develop alternatives that meet the purpose and need.
4. Describe the potentially affected environment.
5. Evaluate environmental, economic, cultural, and social consequences of the alternatives.
6. Develop measures to avoid, minimize, and mitigate potential adverse environmental impacts.
7. Document the steps listed above in a Draft EIS that is published and distributed for public and agency review and comment.
8. Consider comments and make any required revisions to the alternatives, environmental effects, or other information contained in the Draft EIS.
9. Publish and distribute a Final EIS.
10. Sign a ROD describing the federal actions to be taken.

1.7.2 Scoping

Scoping is a critical component of the NEPA process, and one of the first steps taken in developing an EIS. During the scoping process, the Corps informs the public and agencies about the EIS preparation and allows the public and other agencies to provide input on the EIS. Public involvement allows the Corps to identify and address important issues early in the EIS process. In the case of the PSMP, it also aided the Corps in developing a range of measures and alternatives to consider in the EIS and in developing evaluation methods to assess the measures and alternatives.

The Corps conducted scoping during the fall and winter of 2006/2007 and conducted targeted agency outreach to gather input and encourage participation of federal and state agencies within the watershed study area. The Corps met with federal, state, and local agencies and groups involved in land and water resource management in each of the major subbasins to solicit input on the scope of the study and specific technical expertise on sediment management from those agencies (Corps 2007a).

The Corps also held a series of open houses and meetings during February 2007 in Clarkston, Washington; Boise, Idaho; La Grande, Oregon; and Portland, Oregon. These meetings provided an opportunity for the public to comment on the scope of the study.

The Corps received 21 written scoping comments from federal and state agencies, conservation districts, a county advisory committee, a city, ports, nongovernmental organizations, and citizens. Appendix G presents a complete scoping summary.

The Corps established the Local Sediment Management Group (LSMG) in July 2000 as part of the DMMP process to provide an information exchange forum between the Corps and federal and state regulatory agencies, tribes, local governments, and other stakeholders. The Corps reconvened the group in 2006 to conduct scoping for the PSMP. The group adopted a new charter and has met throughout the EIS preparation process, providing input to the Corps on sediment management on the lower Snake River. The Corps has convened the LSMG four times since 2006 to share information with the member agencies and stakeholders.

1.7.3 Public Comment on the Draft EIS

The Corps made the Draft PSMP EIS available for public review and comment on December 21, 2012, and provided a period for the public to review the document and provide comments to the Corps by March 26, 2013. During that public comment period, the Corps held an open house and information meeting in Clarkston, Washington, on January 24, 2013. The purpose of the open house was to have the Corps present information about the PSMP and allow the public the opportunity to ask questions and submit written comments on the Draft EIS. A summary of the public open house and meeting is included in Appendix G.

The Corps received comments on the Draft EIS from 120 agencies, individuals, and organizations during the comment period. The Corps carefully reviewed each of the comment documents (e.g., letter, email, comment sheet) to identify comments and concerns raised by the public. The Corps considered each specific comment and prepared responses to those comments. Where appropriate, the Corps reviewed and revised the documentation and analysis presented in the EIS. All public comments and Corps responses to those comments were incorporated into a Comment Response Document (Appendix G).

1.7.4 Changes to EIS Content

The Corps made several changes to the EIS in response to comments it received through the public review process. These changes included:

- More clearly defining the current immediate need action to differentiate between the Corps' responsibilities for the federal navigation channel and the Ports' responsibilities for their berthing area maintenance activities. The scope of the current immediate need maintenance action has not changed.
- Revising the measure descriptions in Section 2 to clarify timing of implementation and construction methods.
- Establishing continued implementation of current or increased (as funding/technology allow) upland sediment reduction measures (USRM) as a baseline component of all alternatives evaluated in this EIS, including the "No action" alternative, and not being proposed as a separate/stand-alone measure. Expanded USRM was considered as an alternative.

- Revising the description of the alternatives to clarify how each alternative would satisfy the programmatic and current immediate needs, as well as how each alternative would address sediment that interferes with each project purpose.
- Expanding the analysis of potential environmental effects of the alternatives in Section 4 and re-organizing the discussion to clarify which effects are associated with the PSMP implementation and which are associated with the current immediate need action.
- Revising the disposal method alternatives analysis in the CWA Section 404(b)(1) evaluation (Appendix L) to more fully evaluate alternatives and identify the lowest-cost, least environmentally damaging, practicable alternative.
- Combining the description of the proposed current immediate need action (Appendix H) with the CWA Section 404(b)(1) evaluation (Appendix L) to improve the description and analysis of effects of the proposed action. The combined document is now in Appendix L. Appendix H will not be used.
- Revising the monitoring plan (Appendix J) for the proposed current immediate need action to reflect modifications to the required water quality monitoring parameters.

1.8 Next Steps

Following public release of this Final EIS, the Corps will accept and consider comments on the Final EIS as part of the preparation of its ROD. Upon review of the Draft EIS, Final EIS, public comments on the Final EIS, and other applicable documentation, the Corps intends to issue a ROD documenting its selection of an alternative for the PSMP and the current immediate need action consistent therewith. The Corps determination on the Port's permit applications may occur in separate decision documents in accordance with the Corps regulatory program requirements.

1.9 Organization of this EIS

The remainder of the EIS is as follows:

Section 2, Plan Alternatives, describes the sediment management measures and alternatives considered by the Corps.

Section 3, Affected Environment, describes the existing conditions in the geographical area of the potential affected environment.

Section 4, Environmental Effects of Alternatives, describes the potential impacts of the alternatives on the environmental resources described in Chapter 3.

Section 5, Compliance with Applicable Environmental Laws and Regulations, provides an overview of applicable laws and regulations relevant to the Corps' management of sediment in the lower Snake River.

Section 6, Coordination, Consultation, and Public Involvement, describes how the Corps obtained input from other agencies, tribal governments, and the public.

Section 7, List of Preparers, provides names of those who contributed to the preparation of this EIS.

Section 8, Distribution, provides the Corps' distribution list for this EIS.

Section 9, References.

Section 10, Glossary.

Section 11, Index.

SECTION 2.0 ALTERNATIVES

2.1 Introduction

The Corps considered several alternatives to managing sediment that interferes with existing authorized project purposes of the LSRP. The Corps used a watershed approach to identify sources of sediment and patterns of sediment transport to assess the effectiveness of a range of measures for sediment management. The Council on Environmental Quality (CEQ) regulations implementing NEPA direct agencies to “rigorously explore and objectively evaluate all reasonable alternatives” that would meet the purpose of and need for a sediment management plan as part of an EIS (40 CFR 1502.14(a)). Reasonable alternatives include actions that the Corps can undertake, but also may include alternatives that, although not within the Corps’ jurisdiction as lead agency, would potentially address the identified purpose and need (40 CFR 1502.14(c)). Therefore, as part of the EIS process, the Corps identified and evaluated different measures both inside and outside of their jurisdiction and organized these into potential alternatives for managing sediment. As stated in Section 1.1.2, the Corps’ objective in managing sediment is to maintain the existing authorized project purposes of the LSRP.

The alternatives presented in this section and evaluated in this EIS describe stand-alone and combinations of potentially effective measures (or techniques for managing sediment) that the Corps or others may use to manage sediment that interferes with the existing authorized project purposes of the LSRP. Alternatives developed must satisfy the purpose and need statement in Section 1 by: (1) providing for development of a PSMP based on the preferred alternative; (2) providing for a current immediate need action consistent with the PSMP to re-establish the congressionally authorized navigation channel; and (3) supporting the Corps’ consideration of CWA Section 404 and Rivers and Harbors Act Section 10 permit applications for related berthing-area maintenance by the Ports, as supported by the CWA 404(b)(1) analysis (Appendix L).

This programmatic EIS defines future actions under alternatives considered to the extent possible at this stage of the decision-making process, and provides an evaluation of the proposed action and alternatives and their associated potential environmental effects. This EIS provides a foundation for "tiering" future environmental reviews for site-specific actions. Future actions to manage sediment that involve design and implementation of measures in specific locations would undergo additional review, including a project- and site-specific environmental review tiered off of this document prior to implementation in accordance with applicable federal, state, and local laws and agency requirements. The level of future NEPA analysis would depend on the activity to be undertaken, location-specific conditions, and expected effects.

When considering site-specific dredging actions, the Corps considers both upland and in-water disposal alternatives. For proposed in-water disposal, the disposal method is ultimately identified after evaluation of disposal alternatives under the substantive provisions of CWA Section 404, associated EPA guidelines (40 CFR 230) and Corps regulations. When in-water disposal is proposed, the Corps is required to identify and utilize the lowest-cost, least environmentally damaging, practicable alternative as its disposal method. The alternatives analysis in the CWA Section 404(b)(1) evaluation is incorporated into the NEPA process and ultimately identifies the Corps' proposed/preferred disposal alternative.

2.2 Alternatives Development and Evaluation

As noted in Section 1, past sediment management efforts by the Corps in the LSRP have focused largely on site-specific actions within the reservoirs, particularly dredging, to remove accumulated sediment that interferes with existing authorized project purposes of the LSRP. In preparing the PSMP EIS the Corps conducted a watershed-based study to identify dominant sediment sources within the watershed and evaluate the potential for reducing sediment input from upland sources rather than focusing solely on sediment management within the lower Snake River reservoirs. Therefore, in developing and evaluating alternatives, the Corps identified and evaluated methods of managing sediment through structures or reservoir operations in addition to dredging, as well as methods for reducing sediment entering the reservoirs from tributaries and upland sources.

The Corps used the following process to develop and evaluate the PSMP alternatives presented in this EIS:

1. Areas were identified where sediment accumulation has adversely affected or is likely to adversely affect navigation, water intakes, recreation, or flow conveyance as described in Section 1.3.1 and summarized in Table 1-2 and Section 2.2.1, below.
2. A broad range of management ***measures*** were developed that could potentially address identified problems in accordance with the purpose of and need for the PSMP (Section 1.1.2). Measures need not completely solve all sediment-related problems identified by the Corps, but would have to reasonably contribute to resolving the problems. Measures considered were actions that could be taken by the Corps or by other agencies (Section 2.2.2).
3. Technical, environmental, and economic criteria were developed to determine the feasibility and effectiveness of the measures (Section 2.2.3).
4. All measures were screened for potential inclusion in the PSMP alternatives based on criteria developed and applied as noted in Step 3 above. Those measures that were determined to be feasible and meet the purpose and need were retained for further consideration (2.2.4).
5. A range of PSMP alternatives was developed by assembling feasible and effective measures into groups that would potentially meet the purpose and need and provide effective strategies for sediment management (Section 2.2.5).
6. Each PSMP alternative was screened to determine if implementation of the alternative would meet the project purpose and need (Section 2.2.6). The Corps developed specific evaluation criteria that reflected the purpose and need, and evaluated each of the alternatives using the criteria.

7. Any alternatives that did not meet the criteria noted in Step 6 above were eliminated from further consideration and alternatives that met the criteria were advanced for detailed analysis (Section 2.2.7).

The following sections describe steps 1 through 7 of this process used by the Corps to develop and evaluate the PSMP alternatives presented in this EIS.

2.2.1 Problem Identification

As described in Section 1.1, sediment accumulation in certain areas within the lower Snake River reservoirs interferes with the existing authorized project purposes of the LSRP. Based on historical records, observed conditions, and hydraulic modeling, the Corps has identified the areas where sediment accumulation that interferes with existing authorized project purposes has occurred or may occur in the future. In preparing the PSMP EIS, the Corps conducted extensive data collection and analyses to evaluate sediment sources within the entire contributing basin, identified dominant sediment sources, and identified potential measures for managing sediment both near its origin and at the locations in the lower Snake River reservoirs where its accumulation interferes with existing authorized project purposes. Section 1.6 presents a summary of sediment studies conducted in support of the PSMP.

The Corps also performs and/or evaluates ongoing monitoring efforts regarding sediment accumulation. The Corps conducts routine bathymetric surveys of the federal navigation channel both in the lower Snake River reservoirs and in the confluence of the Snake and Clearwater rivers to determine whether the channel meets congressionally authorized dimensions. If warranted, the Corps arranges to have special surveys of isolated sites where problems develop. The Corps periodically re-surveys fixed sediment range cross sections to monitor long-term sediment accumulation in the reservoirs. The Corps prepares annual reports of sediment conditions within the Lewiston levee system. Port authorities and shipping companies file reports with the Corps on an as-needed basis when navigation channel conditions affect navigation or result in unsafe conditions for navigation. The Coast Guard also reports on areas of concern for navigation, when encountered. Boaters occasionally notify the Corps of obstructions to boating facilities (e.g., recreation areas, marinas).

Through these monitoring efforts, the Corps has identified a current immediate need action to address sediment accumulation that is interfering with commercial navigation in the federal navigation channel. Sediment accumulation has reduced the channel depth by several feet (at MOP) at the downstream navigation lock approach at Ice Harbor Dam and at the confluence of the Snake and Clearwater rivers at the upstream end of Lower Granite Reservoir. A current immediate need action is necessary to re-establish the federal navigation channel to its congressionally authorized dimensions at these locations. Coinciding with the current immediate need action at the federal channel is a related need for maintenance at the non-federal berthing areas for the Ports to restore depths necessary to support commercial navigation

2.2.2 Development of Management Measures

Through a collaborative process that included a series of workshops involving technical experts from the Corps and other agencies along with input from scoping and stakeholders (see Section 2.2.3), the Corps developed a broad range of management measures that could address identified sediment accumulation problems. The Corps' intent was to identify measures that could be combined into alternatives that could, with all component measures, fully address the needs identified in Section 1.1.2. The Corps identified and considered measures that are currently within existing authorizations (i.e., dredging and dredged material disposal), as well as measures that may require new authorizations (e.g., relocating facilities or constructing new in-water structures) or even be implemented by other entities (e.g., increased sediment-reduction measures).

The management measures fall within four general categories: dredging and dredged material management; structural management; system operations management; and upland sediment reduction. These categories and specific measures are summarized in the table below. Section 2.2.4 provides further details on measure retained for incorporation into alternatives.

Table 2-1. Management Measures

Measure	Description
Dredging and Dredged Material Management	
Navigation and Other Dredging	Dredging typically consists of excavation, transport, and placement of dredged sediments. The excavation process for the lower Snake River generally involves the removal by mechanical means (e.g., a barge-mounted “clamshell” dredge scooping sediments from the reservoir bottom) to restore the congressionally authorized dimension or use of the area where sediment has accumulated. Removal of material by hydraulic means (e.g., suction or water-induced vacuum) may also be considered for recreation and HMU irrigation facilities when potential adverse effects to ESA-listed fish are unlikely. This measure would also have ancillary benefit for flow conveyance through the Lewiston levee system.
Dredge to Improve Conveyance Capacity	This measure differs from the “Navigation Channel and Other Dredging” measure in that it involves removal of substantially greater quantities of sediments from areas outside the navigation channel, access channel and port berthing areas, and/or recreation facilities. The excavation process involves sediment removal by mechanical means at the Snake and Clearwater Rivers confluence to improve flow conveyance.
Beneficial Use of Sediment	Beneficial use of dredged material includes a wide variety of options that utilize the dredged material for a productive purpose such as habitat restoration/enhancement, construction and industrial use, etc. and can apply to upland or in-water disposal options. The Corps views dredged material as a valuable and manageable resource and seeks opportunities to use it beneficially whenever possible. The Corps has beneficially used dredged material in the past to create fish habitat. Other potential beneficial uses include: habitat restoration/enhancement, beach nourishment, aquaculture, parks and recreation, agriculture, forestry, horticulture, strip mine reclamation, landfill cover for solid waste management, shoreline stabilization, erosion control, construction fill, and industrial use. Beneficial use of dredged material generally requires a cost-share sponsor (See ER 1105-2-100), unless it is the least-cost environmentally acceptable alternative.
In-water Disposal of Sediment	In-water disposal of dredged material is simply the discharge of dredged material into the waterway. Typically, dredged material is transported to a previously identified in-water location selected to minimize impacts where it is released into the water.

Table 2-1. Management Measures

Measure	Description
Upland Disposal of Sediment	In upland disposal of sediment, dredged material is placed on land, above high water, and out of wetland areas. The dredged material is typically placed in a cell behind levees that contain and isolate it from the surrounding environment. The dredged material is dewatered through evaporation and/or settling with the effluent discharged as clean water.
Structural Sediment Management	
Bendway Weirs	Bendway weirs are rock sills located on the outside of a stream or river bend that are angled upstream into the direction of flow. With the weirs angled upstream, flow is directed away from the outer bank of the bend and toward the point bar or inner part of the bend. This redirection of flow occurs at all stages higher than the weir crest. Where there is sufficient velocity and volume, the redirection of flow generally results in a widening of the channel through scour of the point bar. Bendway weirs are typically used to maintain navigation channels.
Dikes/Dike Fields	Dikes are longitudinal structures used to maintain navigation channels through effects on channel depth and alignment. Dikes constrict low and intermediate flows, causing the channel velocity to increase within the reach, thereby scouring a deeper channel. Dikes are typically built of rock, but can also be constructed using other materials.
Spillway Deflectors	Dam spillway deflectors may be rock or concrete structures located at the base of the dam spillway to dissipate energy and reduce the velocity of the spilling water to minimize the potential for erosion and sediment movement. Spillway deflectors can focus flow from the spillway into the federal navigation channel.
Agitation to Resuspend Sediments	This technique involves the deliberate agitation and resuspension of deposited sediment; the sediment is then carried downriver as part of the suspended load of the river. This technique requires both some form of agitation mechanism, and sufficient river flow (velocity and volume) to carry the additional sediment load away from the targeted area. There are numerous potential means to mechanically agitate and resuspend sediment, including high pressure air and water pumps and using propellers to move sediment.
Agitation to Prevent Settling	In this measure, additional energy from propeller wash or other means is put into the water column in specific areas of concern to prevent or reduce the rate of sediment deposition.
Bubble Curtains	In this measure, additional energy is put into the water column in specific areas to prevent or reduce the rate of sediment deposition. Air curtains are typically composed of a compressor, delivery pipe, and pipe manifolds. Compressed air is delivered into the water column as bubbles. The rising bubbles produce an upward-moving current field; the energy from the current field helps suspended materials remain in the water column. The system can be configured to form a “wall” of bubbles, where the current field acts to block passage of suspended sediments, forms one or more columns of upward current, or forms a wider net of bubbles, where the current field keeps fine-grained sediments from reaching settling velocity.
Trapping Upstream Sediments (in-reservoir)	This measure would involve excavating a pit in a depositional part of the upstream reach of a river or reservoir to trap incoming sediment, thus reducing the sediment available to deposit in other areas where it may interfere with existing authorized project purposes. Sediment would have to be periodically removed from the trap and managed by one of the measures described above (i.e., beneficial use, in-water or upland placement).

Table 2-1. Management Measures

Measure	Description
System Management	
Navigation Objective Reservoir Operation	This measure involves operating LSRP reservoirs at water surface elevations that would provide a congressionally authorized depth of 14 feet within the federal navigation channel. The Corps would manage pool levels within the preset operating range for each reservoir to maintain 14 feet of water depth over areas where sediment deposition has occurred in the channel. Currently the Corps operates the LSRP at MOP, or as close to MOP as possible, during the juvenile salmonid outmigration season (typically from April through August, but as late as October in Lower Granite Reservoir), and at varying levels within each reservoir's 3- or 5-foot operating range through the rest of the year. This measure would provide the Corps the option of operating above MOP and even at the upper end of the operating range year-round as needed to maintain the 14-foot-deep navigation channel.
Maintain Channel at Less than a 14-foot Depth	Maintaining the federal navigation channel at a depth less than 14 feet forces the users to adjust their vessels and/or shipping practices to accommodate the new paradigm, or run the risk of running aground on a shoal. Maintaining the federal navigation channel at a less than 14-foot depth could be accomplished through establishing another depth as a minimum (such as 12 feet, 10 feet, etc.), or maintaining the 14-foot channel on a periodic basis with sediment deposition causing areas with less than a 14-foot depth in the interim. This measure could range from maintenance of the navigation channel at another minimum depth to no maintenance of the navigation channel.
Reconfigure Affected Facilities	Corps facilities affected by sediment deposition may be reconfigured or otherwise modified to avoid the deposited sediment. This measure applies to Corps facilities only and could include a range of facility modifications. Examples include water intake structures, mooring facilities, docks, boat ramps, and loading/unloading facilities that could potentially be extended to reach out beyond nearshore areas where sediment deposition is occurring. In addition to reconfiguring water intake structures, alternative water sources for irrigation could be explored. Reconfiguration of a recreation facility may also include consideration of repurposing; temporarily, partially or fully closing; and/or reducing the scope of the facility.
Relocate Affected Facilities	Corps facilities affected by sediment deposition may be relocated to avoid recurring problems with sediment deposition. Moving or relocating affected facilities is potentially suitable for navigation facilities, recreational boating facilities, and water intake structures. In addition to relocating water intake structures, alternative water sources for irrigation could be explored. The Corps' ability to consider/study the feasibility of reconfiguring or relocating port facilities is limited and generally requires a cost-share sponsor and specific authority. The Corps could consider/study reconfiguration or relocation of port facilities, if requested by the Ports, subject to availability of authority and funding.
Raise Lewiston Levee to Manage Flood Risk	The Lewiston levee system is an upstream extension of Lower Granite Dam and was designed to protect parts of Lewiston, Idaho from inundation during the standard project flood (SPF). The confluence of the Snake and Clearwater Rivers at the upper reach of the Lower Granite Reservoir collects much of the sediment carried into the reservoir. Current analysis indicates that flood risk is within acceptable limits; however, if future sediment accumulation changes the flood risk to Lewiston by raising the water level in the reservoir, raising the levee would be an option for reducing flood risk. The location and height of change would be determined through detailed site- and time-specific studies.
Reservoir Drawdown to Flush Sediment	In this measure, flow would be temporarily modified to increase the capacity of the river system to scour and carry sediment, thereby flushing deposited sediments downstream. The ability of a river system to carry sediment is determined by the river's velocity and volume. Flow modification would be created by a drawdown of a reservoir to increase velocity. Drawdowns of the pool elevation by 10 to 15 feet during a 30- to 45-day period would be conducted in an effort to flush sediments from the navigation channel and selected Port berthing areas. Lower Granite Reservoir is the only LSRP reservoir in which this measure would be effective. Flow modifications would be temporary and could be timed to take advantage of naturally occurring periods of high and low flows.

Table 2-1. Management Measures

Measure	Description
Upland Sediment Reduction (Expanded)	
Vegetation Filter Strips	Vegetated filter strips can provide a buffer between overland flow and waterways; the vegetated filter strips slow the overland flow and remove sediment carried in runoff. The filter strips are generally grass, but can also be forested buffers. The vegetation must be dense enough to slow overland runoff and provide for filtration and settling of sediments and other particulates in the runoff.
Streambank Erosion Control	Streambank erosion can be controlled through structural measures to stabilize the eroding bank and/or influence the characteristics of the stream that are resulting in the bank's erosion. Traditional methods of addressing streambank erosion often involve armoring the streambanks with riprap or concrete, which can have negative implications for habitat, water quality, and aesthetics. Methods that incorporate natural materials and natural channel design principles can provide effective solutions without the negative effects of traditional armoring methods. These methods include: • Bioengineering – using plant materials to structurally stabilize and reinforce eroding banks. • Native revetments – using native materials such as rocks, root wads, and logs to armor banks and deflect flows away from eroding areas of banks. • In-stream structures – using rocks and/or logs to stabilize streambeds and banks by directing force of the stream's flow away from the bank.
Forest Practices – Structural	Structural practices include road construction to maximize self-drainage, road removal, post-fire land treatments, and stabilizing and improving channel stability.
Agriculture – Conservation Measures	Conservation districts administer a number of conservation programs that directly or indirectly seek to reduce erosion and improve water quality. Physical practices to reduce erosion and improve water quality include no-till cultivation, crop rotation, and/or taking highly erosive farmland out of production. In general, these programs are financial- and technical-assistance programs whereby farmers and other landowners voluntarily enter into contracts to implement conservation measures. This measure would involve implementation of additional physical practices (beyond current levels) to reduce erosion and improve water quality. In addition, rangeland conservation practices, such as fencing, moving livestock watering points away from streams, and streambank stabilization in range areas are actions that can reduce erosion and sedimentation in range and grazing areas.
Forest Practices – Conservation Measures	Forest conservation includes measures such as concentrating vegetation treatments in larger blocks, reducing severe fire risk through prescribed fire and thinning, and protecting and restoring riparian areas.
Local Sediment Management Group (LSMG) Coordination Meetings	The LSMG is an information exchange forum comprising the Corps and federal and state regulatory agencies, tribal governments, local governments, and non-governmental organizations (e.g., barge operators, Ports, Pacific Northwest Waterways Association). Also includes participation in other regional coordination concerning sediment management in the lower Snake River basin.

2.2.2.1 Dredging and Dredged Material Management

Dredging involves the physical removal of sediments from one location, and placement of the dredged material in another location. The dredging process typically consists of excavation, transport, and placement of dredged sediments. Excavation would generally be by mechanical means (i.e., physically scooping sediments with a clamshell or backhoe). Removal of material by hydraulic means (e.g., suction or water-induced vacuum) may also be considered for recreation and HMU irrigation facilities when potential adverse effects to ESA-listed fish are unlikely. Once dredged, sediments are transported to a disposal or placement area. Dredged material may be disposed of in-water or upland, or may be beneficially used for other purposes, such as habitat creation. The disposal method is ultimately identified through evaluation of disposal alternatives under the substantive provisions of CWA Section 404(b)(1), guidelines established by the EPA (40 C.F.R. 230), and Corps regulations.

2.2.2.2 Structural Sediment Management Measures

Structural sediment management measures seek to control the location and rate at which sediment is deposited at a specific location to reduce or eliminate the magnitude of the sediment interference with existing authorized project purposes of the LSRP. Examples of structural management measures include weirs to prevent sediment from accumulating in certain areas and sediment traps to collect sediment that may otherwise interfere with existing authorized project purposes.

2.2.2.3 System Management Measures

System management measures modify reservoir operations (such as pool depth) or facilities so that sediment deposition does not adversely affect existing authorized project purposes of the LSRP. Examples of system operations measures include reconfiguring or relocating facilities, managing reservoir water levels for navigation, and modifying flows to flush sediments from problem areas. These measures would occur within the lower Snake River. The Corps, public port authorities, and Corps' property lessees would be responsible for implementing system management measures for their respective facilities.

The Corps' ability to consider the feasibility of reconfiguring or relocating Port facilities is limited and generally requires a cost-share sponsor and specific authority. The Corps could consider reconfiguration or relocation of Port facilities only if requested by the Ports and would be subject to availability of authority and funding.

2.2.2.4 Upland Sediment Reduction Measures (Expanded)

USRM are land-management actions intended to reduce the amount of sediment that enters into the lower Snake River systems. USRM include site-specific projects such as sediment traps or vegetation filter strips designed to reduce erosion of soil from land into area waterways, and programs aimed at encouraging projects or practices to reduce soil erosion (e.g., soil conservation practices in dry-land farming areas). USRM are currently implemented throughout the watershed of the lower Snake River.

For this EIS, the Corps assumes that agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and land owners) would continue to implement existing land management programs and practices related to erosion control at current or increased levels of implementation as funding and technology allow. The Corps would continue implementing erosion and sediment control on its lands adjacent to the LSRP, but such efforts are primarily associated with habitat creation and land management and not specifically sediment control. The ***continued*** implementation of current or increased (as funding/technology allow) USRM is considered a baseline component of all alternatives evaluated in this EIS, including the "No action" alternative, and is not being proposed as a separate/stand-alone measure. ***Expanded*** USRM may be considered as a separate measure for alternatives development, either as a stand-alone alternative or in combination with other measures.

As part of expanded USRM the Corps would continue to coordinate meetings with all applicable land use management agencies and groups through the annual LSMG meeting. The LSMG meeting would serve as an information exchange forum between the Corps and federal and state regulatory agencies, tribes, local governments, and other stakeholders. The primary purposes of the meeting would be to share data and compare trends observed by each agency, identify potential opportunities to improve each agency's independent sediment reduction practices, and analyze trends on a watershed basis. Information gained from LSMG meetings may be used by the Corps to adapt PSMP measures. The Corps participation in any other future USRM efforts will be subject to authority and funding. The Corps intends to explore opportunities for other regional coordination concerning long term planning and sediment management in the lower Snake River basin (e.g., provision of staff expertise under the Regional Sediment Management Program), which are hosted/facilitated by other agencies or stakeholders.

2.2.3 Criteria Development and Measure Screening

The Corps developed criteria to screen measures and determine which measures meet the purpose and need and are technically feasible. Those measures that met the first two of the screening criteria were determined to be reasonable to include in the PSMP alternatives; other criteria provided useful input for further consideration. The criteria applied were:

- Does the measure meet the purpose and need?
- Is the measure technically feasible?
- Is the measure consistent in scale with identified sediment problems (i.e., the solution fits the problem)?
- Is the measure economically feasible?
- Is the measure consistent with existing Corps or other agency authority?
- Can the measure's effectiveness be quantified?
- Can the measure's ability to address identified sediment problems be reasonably predicted?
- If 'no' to the bullet above, would additional research be warranted?
- Does the measure have potentially significant adverse effects on fish and wildlife habitat, water quality, and/or known cultural resources?
- Does the measure have potentially adverse socioeconomic effects?
- Does the measure have potentially adverse effects on hydropower or other existing authorized project purposes?
- Is the measure effective in the short (0 to 10 years) or long term (11 years or beyond), or both?

In 2010 the Corps conducted three interdisciplinary technical workshops to apply the criteria and screen the identified management measures to determine which were feasible and reasonable and therefore would be incorporated into PSMP alternatives. The process and outcomes of the workshops are summarized below.

Technical Workshop 1, held on May 25 and 26, 2010, focused on potential sediment management and system management measures (measures primarily within the Corps' authority to implement). Participants included Corps staff with specific expertise in hydraulics and hydrology, fish and wildlife biology, economics, system operations, navigation, planning, and environmental compliance.

Technical Workshop 2, held on August 11, 2010, focused on screening potential sediment reduction measures. The workshop included presentations and participation by the Corps, USGS, USFS, and UI and WSU staff who had conducted sediment studies. Sediment reduction measures are typically outside of the Corps' authority; therefore, participants in Workshop 2 included technical experts from the organizations noted above and the U.S. Environmental Protection Agency.

During **Technical Workshop 3**, held on September 21, 2010, the Corps considered the recommendations from the first two workshops and determined the feasible and effective measures to incorporate into the alternatives. The Corps removed measures that, based on recommendations made in Technical Workshops 1 and 2, did not meet the purpose and need or were not technically feasible. For measures where the feasibility and effectiveness showed promise at addressing sediment problems but could not be definitively determined based on existing information, the Corps retained these measures subject to further research and evaluation. Table 2-2 presents the measures dismissed and the reasons for their dismissal.

The measures retained for incorporation into plan alternatives as a result of the workshop process are discussed in Section 2.2.4.

Table 2-2: Measures Dismissed

Measure	Reason for Dismissal
Spillway Deflectors	Not technically feasible • Deflectors used at Ice Harbor made it very difficult for barges to move through the navigation channel • Significant safety concerns with this measure due to changes in velocity and direction of flow that could be hazardous to barges and boats
Agitation to Prevent Settling	Not technically feasible • Applicability would be limited and highly localized • No known proven examples of effective application
Bubble Curtain	Not technically feasible • Applicability would be limited and highly localized • Not feasible for types of sediment in LSRP
Maintain Navigation Channel at Less than 14 feet	Does not meet purpose and need • Measure does not meet the purpose and need. The Congressionally authorized channel depth is 14 feet.

2.2.4 Measures Retained for Further Consideration

The following subsections present general information on the measures retained for incorporation into plan alternatives. Table 2-3 identifies the measures retained and their applicability to the LSRP existing authorized project purposes.

Table 2-3. Management Measures Retained

Measure	Applicability to Authorized Purpose			
	Navigation	Recreation	Fish and Wildlife	Flow Conveyance
Dredging and Dredged Material Management				
Navigation and Other Dredging	Yes	Yes	Yes	No (ancillary benefit only)
Dredge to Improve Conveyance Capacity	Yes	No	No	Yes
Beneficial Use of Sediment	Yes	Yes	Yes	Yes
In-Water Disposal of Dredged Material	Yes	Yes	Yes	Yes
Upland Disposal of Dredged Material	Yes	Yes	Yes	Yes
Structural Sediment Management				
Bendway Weirs	Yes	No	No	No
Dikes/Dike Felds	Yes	No	No	No
Agitation to Resuspend Sediments	No	Yes	Yes (partial need flow)	No
Trapping Upstream Sediments (In-reservoir)	Yes	No	No	Yes
System Management				
Navigation Objective Reservoir Operation	Yes	Yes	No	No
Reconfigure Affected Facilities	Yes	Yes	Yes	No
Relocate Affected Facilities	Yes	Yes	Yes	N/A
Raise Lewiston Levee to Manage Flood Risk	No	No	No	Yes
Reservoir Drawdown to Flush Sediment	Yes	No	No	Yes
Upland Sediment Reduction Measures (Expanded)				
Vegetation Filter Strips	No	Maybe	Maybe	No
Streambank Erosion Control	No	Maybe	Maybe	No
Forest Practices – Structural	No	Maybe	Maybe	No
Agriculture – Conservation Measures	No	Maybe	Maybe	No
Forest Practices – Conservation Measures	No	Maybe	Maybe	No
Local Sediment Management Group (LSMG) Coordination Meetings	Yes	Yes	Yes	Yes

2.2.4.1 Dredging and Dredged Material Management

Dredging – Dredging consists of the removal, transport, and placement of dredged sediments. For the purposes of this analysis, the term “dredging” will refer to the excavation process, as placement and use options are discussed separately. The excavation process involves the removal of deposited sediment as part of maintenance activities. After excavation, the sediment is transported from the dredging site to a site where it will be used or permanently placed. This transport operation is typically accomplished by the dredge itself or by using additional equipment such as barges. Use and/or placement can occur in-water or in an upland area.

Backhoes and buckets (such as clamshell, or dragline) are types of mechanical dredges (Figure 2-1). Clamshell buckets are the most commonly used dredges in the lower Snake River. Mechanical dredging has been used primarily due to concerns about potential entrainment of fish associated with hydraulic, or suction, dredging. Sediments excavated with a mechanical dredge are generally placed onto a barge, or a truck for near-shore excavations, for transportation to the use or disposal site.

Removal of material by hydraulic means may also be considered for recreation and HMU irrigation facilities when potential adverse effects to ESA-listed fish are unlikely. The selection of equipment and method to perform a dredging operation is typically dependent on:

Figure 2-1. Dredging Operation on the Snake River

- Physical characteristics of the material to be dredged
- Quantities of material to be dredged
- Dredging depth
- Distance to reuse or placement area
- Physical environment of the dredging and placement areas
- Contamination level of sediments (if any)
- Method of placement or beneficial use
- Production required
- Type of dredges available
- Cost

Dredging has historically been the most common method used to remove sediment and maintain navigation channels, berthing areas, and flow conveyance capacity. Dredging for navigation and recreation re-establishes the authorized dimensions of the navigation channel, berthing area, or boat basin and uses a template that does not extend beyond the original design footprint.

Flow conveyance dredging differs from the “Navigation and Other Dredging” in that it involves removal of substantially greater quantities of sediments from areas outside the Federal navigation channel, access channel and port berthing areas, and/or recreation facilities. Flow conveyance dredging is specific to the Lower Granite reservoir and would extend from the Port of Wilma near Snake RM 134 to the U.S. Highway 12 bridge located upstream of the confluence of the Snake and Clearwater Rivers, near Snake RM 139.5. The flow conveyance dredging upstream limit in the Clearwater River would extend from the Snake River confluence to RM 2.0. The Snake/Clearwater Rivers confluence area dredging template varies in width from 300 feet, near the Port of Wilma, to 1,700 feet in the Clearwater River confluence area. The average dredging width on the Snake River within this area would be 750 feet. Material would be removed to about elevation 708, which is 25 feet below MOP. Material would not be removed from the original riverbed or shoreline.

Because of concerns over potential effects to listed endangered anadromous species and other aquatic resources, dredging is performed within work windows when listed fish species are less likely to be present. Dredging in the lower Snake River is typically limited to a winter in-water work window of December 15 to March 1. Summer dredging may also be considered for other off-channel areas such as recreation areas or irrigation intakes on a case-by-case basis. These shallow-water areas would be expected to have elevated water temperatures during the summer and would not likely have salmonid fish present. The material dredged from these sites would probably be disposed of at an upland location since the in-water disposal areas are located in the main river channel and may have salmonid fish present during the disposal activity.

On a case-by-case basis, hydraulic dredging may be considered for off-channel areas such as recreation areas or irrigation intakes. This would probably be done in the summer when salmonid fish are less likely to be found in these off-channel areas because of elevated water temperatures. The dredged material would exit the dredge as a slurry that is likely to be 65 to 80 percent water and would not be suitable for in-water disposal as described above. Instead, this slurry could be incorporated into the wildlife habitat planting areas or used to restore eroded streambanks near the intakes.

Applicability: Dredging is a measure that is applicable to almost any sediment accumulation issue. Dredging technologies can be scaled to address small or large quantities of sediment and can be applied in almost any environment. A corresponding measure to manage dredged sediments must be available (see *“Dredged Material Management”* below).

Dredged Material Management – Disposal options available to the Corps for dredged materials are identified in accordance of Corps regulations (33 CFR 335-338). The Federal Standard for disposal of dredged material is defined as “[T]he least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process. . . ." (33 CFR 335.7). The Corps considers both upland and in-water disposal alternatives when dredging is proposed. For proposed in-water disposal, the disposal method is ultimately identified after evaluation of disposal alternatives under the substantive provisions of CWA Section 404, associated EPA guidelines (40 CFR 230) and Corps regulations. When in-water disposal is proposed, the Corps is required to identify and utilize the lowest-cost, least environmentally damaging, practicable alternative as its disposal method. The alternatives analysis in the CWA Section 404(b)(1) evaluation is incorporated into the NEPA process and ultimately identifies the Corps' proposed/preferred disposal alternative. Additionally, it is the Corps' policy to always consider beneficial use of dredged material when evaluating disposal options (Corps 1987b).

Beneficial Use of Sediment – Beneficial use of dredged sediment includes a wide variety of options that utilize the dredged material for some productive purpose. Broad categories of beneficial uses, both upland and in-water, based on the functional use of the dredged material include:

- Habitat restoration/enhancement (wetland, upland, island, and aquatic sites including sites used by ESA-listed fish)
- Beach nourishment
- Aquaculture
- Parks and recreation (commercial and noncommercial)
- Agriculture, forestry, and horticulture
- Landfill cover for solid waste management
- Shoreline stabilization and erosion control (fills, artificial reefs, submerged berms, etc.)
- Construction and industrial use (including port development, airports, urban, and residential)
- Fill for other uses (dikes, levees, parking lots, and roads). (Corps 1992; Corps 2007b)

It is the Corps' practice to secure the maximum practicable benefits of dredged material within authority and funding limitations. Detailed guidelines for various beneficial-use applications and cost-share requirements, as applicable, are given in EM 1110-2-5026 (Corps 1987b). Specific applications are dependent on opportunities available at the time the dredging is occurring. Opportunities for beneficial use should be identified and evaluated as part of the planning for any dredging activity.

Applicability: Beneficial use of dredged material is applicable to a wide variety of settings and uses when it is determined to be the preferred disposal method consistent with environmental reviews and the Federal Standard. Often, a local sponsor must be identified as part of the beneficial use.

In-water Disposal of Sediment – In-water disposal of dredged material is simply the discharge of dredged material into the waterway for purposes of disposal (as opposed to in-water habitat creation). Typically, dredged material is transported to a suitable location in a bottom dump barge, and released into the water at the upstream end of the deep water area (Figure 2-2).

All dredged material is a candidate for in-water disposal if it meets the requirements of the Federal Standard. For future actions, the Corps would perform all required sediment sampling and analysis and determine suitability for in-water disposal. If the sediment sampling and analysis results showed the sediments had unacceptable concentrations of chemicals of concern that would preclude using unconfined in-water disposal, the Corps would either not dredge the area or would pursue an acceptable alternate disposal method.

Figure 2-2 . Disposal Site Placement on the Snake River

Applicability: In-water disposal of sediment is applicable to most dredged material management needs in the LSRP. The Corps has identified multiple locations with sufficient capacity to accept the volumes of dredged material that could be generated by potential dredging activities in LSRP.

Upland Disposal of Sediment – Upland disposal of sediment is the placement of dredged material on land, above high water and out of wetland areas, but not as a beneficial use. The dredged material is typically placed in a cell behind berms that contain and isolate it from the surrounding environment and is dewatered through evaporation and/or settling and discharge of clean water. There may be other uses of the land during and after the site is used for dredged material placement.

Upland disposal can be used for any dredged material, coarse or fine-grained. The material would be transported to and placed on the upland site using methods such as scooping it out with a clamshell bucket, using an auger or a conveyor belt, or hydraulic pumping.

Applicability: Upland disposal is an option for disposal when it is determined to be the preferred disposal method consistent with environmental reviews and the Federal Standard. Depending on dredged material quantities, upland disposal could require a fairly large area with proximity and good access to the waterbody being dredged. Site development, including a containment berm and dewatering channels, is typically required.

2.2.4.2 Structural Sediment Management

Structural sediment-management measures described below could be considered by the Corps subject to authority and funding.

Bendway Weirs – Bendway weirs would be placed at strategic locations along the banks of the Lower Snake to redirect water flow in a manner that would prevent problem sediment accumulation and maintain the congressionally authorized dimensions of the federal navigation channel dimensions**.** Bendway weirs are rock structures located on the outside of a stream or river bend, angled upstream into the direction of flow. Water flowing over the bendway weirs is redirected at an angle perpendicular to the middle of the weir. With the weirs angled upstream, flow is directed away from the outer bank of the bend and toward the ***point bar*** or inner part of the bend. Where there is sufficient velocity and volume, the redirection of flow generally results in a widening of the channel through scour of the point bar (Figure 2-3). Other possible effects include:

- Deposition at the toe of the ***revetment*** (river bank stabilization armoring) on the outside of the bend, thus increasing bank stability;
- Scouring on the point bar creating a flow path on the inside of the bend;
- Increased surface water velocities across any cross-section;
- Directing flow patterns in the bends to be generally parallel with the banks (not concentrated on the outer bank of the bend); and
- Causing the ***thalweg*** (the deepest continuous line in the river) of the channel to move from the toe of the outer bank revetment to the stream ends of the weirs.

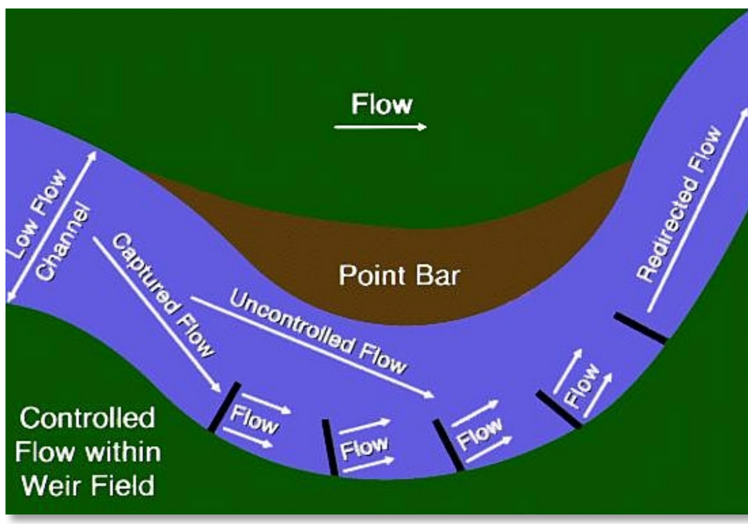


Figure 2-3. Schematic of Bendway Weirs

Weirs are generally built in sets (4 to 14 weirs per bend) and are designed to act as a system to control velocities and current directions through the bend and well into the downstream crossing.

Typically, bendway weirs are applied to unimproved or revetted bends where growth of the point bar is restricting the federal navigation channel width, or where an improved navigation channel alignment is desired. Bendway weirs are commonly used on both navigable rivers and smaller streams.

Applicability: Bendway weirs are applicable in locations where there is sufficient flow and velocity to sustain sediment transport (and possibly mobilize accumulated sediments) through the area of influence of the structures. For the LSRP, bendway weirs could be applicable in locations like the main river channel through Snake-Clearwater confluence where flow velocities are relatively high. Bendway weirs would generally not be effective in off-channel or backwater locations, like some recreation sites or at locations further downstream within the reservoirs where flow depths are larger and flow velocities smaller. Bendway weirs would require sufficient lead time to plan, design, and implement.

Dikes and Dike Fields – Dikes would work in a manner similar to bendway weirs to redirect river flows and velocities and prevent problem sediment accumulation and maintain congressionally authorized navigation channel dimensions. Dikes are linear structures used to maintain navigation channels through effects on channel depth and alignment. Dikes constrict channels at low and intermediate flows, causing the channel velocity to increase within the reach and thereby scour a deeper channel. Dikes are typically built of rock but may be constructed with other suitable materials (Figure 2-4).

Figure 2-4. Dike Construction

Dikes are generally used to contract river channels at low and intermediate flows, forcing all flow through a narrower width (Figure 2-5). The resulting increased velocity erodes, or scours, the bed to a lower elevation. Scour is commonly needed only to provide navigable depths during periods of low flow; therefore, low dikes are more desirable than high dikes which can cause excessive scour at high flows. Scour can also be greater for dikes angled upstream rather than perpendicular to flow or angled downstream.

Figure 2-5. Dike on the Mississippi River

Maintenance of open water areas in dike fields can be encouraged through variations in the design, such as notches or rootless (e.g., not attached to the river bank) dikes. Dikes have traditionally been designed to induce sediment deposition within the dike fields although stone dikes do not necessarily have to fill with sediment to be effective.

Applicability: Applicability of dikes and dike fields is similar to that of bendway weirs.

Agitation to Resuspend Sediments – Agitation to resuspend sediments involves the deliberate agitation and resuspension of deposited sediment. Following agitation, the sediment is then carried downriver as part of the suspended load of the river. This technique requires both some form of agitation mechanism and sufficient river flow (velocity and volume) to carry the additional sediment load away from the targeted area. There are numerous potential means to mechanically agitate and resuspend sediment, including hydraulic dredges, high-pressure air and water pumps, and propellers to move sediment. In this technique, jets of air and/or water are applied to the deposited sediments at sufficient pressure to dislodge them from the bottom, causing the sediments to become resuspended in the water column and carried downriver by the current.

The effectiveness of this measure is dependent on the ability of the agitation mechanism to resuspend the deposited sediment and the ability of the river to carry the resuspended sediment a sufficient distance downriver to avoid problems with resettling. The Corps has used this method in the lower Snake River. It is suited to addressing smaller, localized sediment issues with fine sediments. Assuming conditions are met for this measure to work, agitation and resuspension could be used as a short-term sediment management measure; however, the measure would not prevent sediment from depositing in the same location in the future, nor would it control where resuspended sediment is transported and potentially resettles.

Applicability: Agitation to resuspend sediments is applicable only in those areas where there is sufficient flow, both in terms of volume and velocity, to transport resuspended sediments away from areas where they interfere with existing authorized project purposes of the LSRP, such as locations within the main channel of a reservoir. In addition, hydraulic conditions downstream should be such that the resuspended and transported sediment does not interfere with an existing authorized project purpose in another location.

Trapping Upstream Sediments (In-reservoir) – Trapping upstream sediment involves creating a location within a depositional reach at the upstream end of a reservoir where sediments settle and are captured, thus preventing them from reaching other locations where they may interfere with existing authorized project purposes of the LSRP. A pit in the river bottom would be excavated to create the trap and sediments would be collected, either through periodic dredging or other means. Removed trapped sediments would then be managed through one of the measures described above. This technique has been successfully applied on small river systems (Lipscomb et al. 2005). Trapping upstream sediments (in-reservoir) would require sufficient lead time to plan, design, and implement.

Applicability: This measure is applicable in areas where there is sufficient space and hydraulic conditions allow for the capture of sediment upstream of where sediment interferes with existing authorized project purposes of the LSRP.

2.2.4.3 System Management

Reservoir Drawdown to Flush Sediment – The reservoir drawdown to flush sediment would draw the Lower Granite reservoir down 10 to 15 feet below MOP (measured at the confluence of the Snake and Clearwater Rivers) and would occur on a one-time basis for up to 6 weeks some time during the period of late April through late June. This period takes advantage of naturally high spring freshet flows and corresponds with the juvenile salmonid outmigration season. Drawing down Lower Granite Reservoir would create a high flow and velocity conditions that would scour and transport accumulated sediment from the confluence of the Snake and Clearwater Rivers. Most of the sediment scour would occur within the main channel of both rivers and the scoured sediment would be transported downstream and redeposited. Much of the sediment would likely redeposit within Lower Granite Reservoir or in the upper reaches of Little Goose Reservoir. Sediments could potentially deposit in areas where they would interfere with existing authorized project purposes of the LSRP. There must be adequate high-flow prediction and modeling to allow the Corps to conduct drawdown operations in a timely manner for this measure to function effectively.

Applicability: Drawdown would be most effective during high flow conditions, such as those resulting from spring snowmelt and runoff, when scouring and transport of sediments would be greater. Drawdown affects an entire reservoir and mobilizes sediments from area(s) where they interfere with existing authorized project purposes of the LSRP, as well as other locations in the reservoir. Drawdown would be applicable only to Lower Granite Reservoir where it could address accumulation of sediment in the Snake-Clearwater confluence area. Reservoir drawdown would require sufficient lead time to plan, design, and implement modifications to infrastructure.

Navigation Objective Reservoir Operation – This measure involves operating reservoirs of the LSRP at water surface elevations above MOP as an interim measure to provide a consistent 14-foot-deep channel within the federal navigation channel, consistent with the terms and conditions of the NOAA FCRPS BiOp or subsequent ESA consultation. The McNary Reservoir and lower Snake River reservoirs are typically operated within a three to five-foot range with the lowest end of the range designated as the MOP. Under normal operation the Corps would manage pool levels within the preset operating range for each reservoir to maintain 14 feet of water depth over areas where sediment deposition has occurred in the channel. Raising the operating pool as part of this measure provides a temporary means to provide desired water depths; however, there are physical limits as to how much the pool levels can be raised based on design specification for the dams. For example, the operating range of Lower Granite Reservoir is 733 to 738 feet above mean sea level (msl) and the Corps does not have the authority to raise the pool above 738 msl. Once the pool has been raised to the maximum level, it cannot be raised further and the measure ceases to be effective. Additionally, raising the operating pool in a reservoir has a greater effect near the dam than upriver due to the normal change in elevation moving upstream.

Under this measure, the Corps would operate the reservoirs (primarily Lower Granite Reservoir) at a pool level above MOP to provide temporary relief from sediment accumulated in the navigation channel to provide for safe navigation, consistent with the requirements of the NOAA

FCRPS BiOp or subsequent ESA consultation. The Corps would coordinate with NMFS when proposing to operate above MOP during the juvenile salmonid outmigration season.

The Corps could also adjust operation of the dams to influence water depth at the downstream navigation locks. An example would be adjusting operation of the dam to temporarily increase water releases from the dam to provide sufficient depth for a barge tow to enter or exit the navigation lock.

Applicability: This measure is applicable within the operating range of the reservoirs, and subject to ESA compliance.

Reconfigure/Relocate Affected Facilities – Facilities affected by unwanted sediment deposition may be relocated or otherwise modified to avoid those areas where sediment deposition tends to accumulate and interfere with facility uses. This measure could include a range of facility modifications from extending a dock or mooring facility to relocating an entire port facility. It could also include temporarily or permanently closing Corps-managed recreation facilities. Moving or relocating affected facilities is potentially suitable for commercial navigation facilities, recreational boating facilities, and water intake structures. It is not practicable to move the existing navigation channels, locks, or lock approach channels.

Water intake structures and some docks could potentially be extended to reach out beyond near-shore areas where unwanted sediment deposition is occurring. This technique has been successfully used on several water intake structures in the program area. In lieu of reconfiguring or relocation water intake structures, alternative water sources for irrigation that would alleviate the need for the intake, such as a well, could be explored. Other facilities, such as boat ramps, would likely need to be completely relocated. The effectiveness and applicability of this measure is highly site- and facility-specific and would have to be determined on a case-by-case basis.

Applicability: This measure would be applicable where the use of the affected facility can be replaced, relocated, or potentially closed, and where it would be more economical to do so than manage sediment that affects its use. The Corps' ability to consider the feasibility of reconfiguring or relocating port facilities is limited and generally requires a cost-share sponsor and specific authority. This measure is primarily applicable to Corps-managed facilities. To reconfigure/relocate the affected facilities would require sufficient lead time to plan, design, and implement modifications to infrastructure.

Raise Lewiston Levees to Manage Flood Risk – This measure involves raising critical portions of the Lewiston levee system to limit the risk of being overtopped during a high flow event. The Lewiston levee system is an upstream extension of Lower Granite Dam and was designed to protect parts of Lewiston, Idaho from being flooded by the creation of the reservoir and from inundation during the SPF. As noted in Section 1, the Corps' criteria for managing flood risk at facilities like the Lewiston levee has changed over time. Currently, the Corps uses risk analysis to determine the appropriate approach to managing flood risk. Current analysis indicates that flood risk is within acceptable limits; however, if future sediment accumulation increases the flood risk to Lewiston, raising portions of the levee system would be a viable option for reducing that risk, subject to authority. The location and height of change would be determined through detailed site- and time-specific studies. Based on past analysis of levee modification, any future levee raise would likely involve raising the earthen embankments or building low walls on portions of the existing levees, and modifying surrounding roads and other infrastructure affected by the levee raise (Corps 2002a).

Applicability - Raising levees would be applicable if other means of managing flood risk per the *Risk Analysis for Flood Damage Reduction Studies* (Corps 2006) were determined infeasible or otherwise unacceptable. This measure would be applicable only in the existing area of the Lewiston levee system. To raise the Lewiston levee, sufficient lead time would be required to plan, design, and implement modifications to infrastructure.

2.2.4.4 Upland Sediment Reduction Measures (Expanded)

Continuation of current USRM is not likely to further reduce the amount of sediment that is currently interfering with (or expected to interfere with) existing authorized project purposes of the LSRP. For the purpose of alternative development, this EIS assumes that current or increased (as funding/technology allow) USRM would continue in the future and will be an inherent (baseline) feature of all alternatives considered and is not being proposed as a separate/stand-alone measure.

Data collection and analysis presented in studies of sediment contribution in the Snake River watershed (Appendices B-F) indicate there is no meaningful opportunity to implement additional (expanded) USRM that would appreciably reduce/prevent the predominant coarse sediment (i.e., sand) generated from mass wasting events (e.g., landslides) from entering the rivers and interfering with existing authorized project purposes of the LSRP. The studies indicate there may be opportunities for increased USRM (e.g., road and vegetation management) that may help reduce the amount of fine sediment (i.e., silt) entering tributaries, but fine sediments are a minor problem in the LSRP as compared to sand. Additionally, the Corps has not identified a practical way to quantify or confirm the relationship/nexus between increased USRM and the reduction of fine sediment that interferes with existing authorized project purposes of the LSRP (primarily recreation areas and HMU irrigation intakes). However, given the uncertainty regarding fine sediments, expanded USRM have been retained as a measure for initial alternatives development in this EIS. Expanded USRM would be carried out (except on Corps-managed federal lands) by other federal, state and private land managers, as funding/technology allow; Corps participation would generally be limited to coordination of the LSMG meetings. The Corps intends to explore opportunities for other regional coordination concerning long term planning and sediment management in the lower Snake River basin (e.g., provision of staff expertise under the Regional Sediment Management Program), which are hosted/facilitated by other agencies or stakeholders.

Vegetation Filter Strips – This measure involves either planting a strip of vegetation along a waterbody or preserving a strip of existing vegetation along a waterbody to provide a buffer between overland flow and receiving waterbodies. The vegetated filter strips slow the overland flow and remove sediment, organic material, nutrients, and chemicals carried in runoff. Strips have been designed to treat runoff from agricultural fields, roadways, parking lots, and construction sites. Filter strips are generally grass, but can also be forested buffers (Figure 2-6).

Figure 2-6. Vegetation Filter Strip Surrounding Agricultural Area

Soil particles (sediment) settle from runoff water when flow is slowed by passing through a vegetative filter strip. The larger particles (e.g., sand) settle within the shortest distance. Finer particles (silt and clay) are carried the farthest before settling from runoff water, and may remain suspended when runoff velocity is high. Land-use practices above vegetative filter strips affect the ability of strips to filter sediment. Fields with steep slopes and/or exposed soils would deliver more sediment to filter strips than more gently sloping fields and those with good vegetative cover. Large amounts of sediment entering vegetative filter strips can overload their filtering capacity. For the vegetation strip to be effective, runoff must pass through the strip as overland flow. If the runoff is concentrated in ***rills*** (narrow and shallow incision in topsoil) or gullies, the filter strip would not be effective.

Applicability: Vegetative filter strips are applicable on and adjacent to farmland that is actively cultivated and from which soil is eroding into surrounding streams.

Streambank Erosion Control – This measure uses structural features to control streambank erosion by stabilizing the eroding bank and/or influencing the characteristics of the stream that are resulting in the bank's erosion. Techniques of streambank erosion control include:

- Bank armoring with riprap or ***gabions*** (caged riprap) (Figure 2-7)
- Bioengineering
- Native material revetments
- In-stream structures, such as cross vanes and bendway weirs.

Streambank erosion control measures are commonly applied where accelerated streambank erosion is occurring. Bank erosion can be a normal process; however, erosion can be accelerated by removing or damaging riparian vegetation, changing stream hydrology, and changing watershed land uses. Traditional methods of addressing streambank erosion often involve armoring the streambanks, which has negative implications for habitat, water quality, and aesthetics.

Methods that incorporate natural materials and natural-channel design principles can provide effective solutions without the negative effects of traditional armoring methods. These methods often benefit habitat, water quality, and aesthetics, in addition to reducing streambank erosion. These methods include:

Figure 2-7. Gabion Baskets Installed for Slope Stabilization Along a Stream

- Bioengineering – using plant materials to structurally stabilize and reinforce eroding banks;
- Native revetments – using native materials such as rocks, root wads, and logs to armor banks and deflect flows away from eroding areas of banks; and
- In-stream structures – using rocks and/or logs to stabilize streambeds and banks by directing force of the stream's flow away from the bank.

Streambank erosion control measures are generally effective at stopping site-specific erosion problems. Where erosion control practices involve bioengineering, the protection needs to allow for establishment of vegetation to provide for long-term stability. Streamside vegetation also improves riparian and in-stream habitat by providing shade, cover, and food.

Applicability: Streambank erosion control is applicable to streambanks that are relatively accessible for implementation of control measures to stabilize streambanks, and where control measures would not have other, off-setting environmental effects. As noted above, streambank erosion control can be a component of environmental restoration of a stream system.

Forest Practice, Structural – This measure involves a variety of techniques to reduce erosion from forest land or to stop eroded sediments from entering waterways. Erosion and sediment control structures are designed to control a variety of surface drainage, erosion, and sediment migration conditions through methods such as:

- Decommissioning and restoring unused forest roads and/or structural changes to reduce erosion from and around existing roads;
- Preventing the formation or advancement of rills and gullies;
- Reducing the flow velocity in watercourses or providing structures capable of withstanding high flow velocity;
- Stabilizing the grade and controlling head cutting in natural or artificial channels;

- Conveying water from one elevation to another;
- Diverting water away from unstable slopes; and
- Filtering and retaining sediment.

Erosion and sediment control structures utilized in forest practices include road construction that maximizes self-drainage, road removal, post-fire land treatments, and stabilizing and improving channel stability.

Applicability: Structural forest practices are applicable in wide variety of situations and locations. Decommissioning and restoring roads is applicable in forest areas with active or abandoned road networks. Other structural measures are applicable in areas that are readily accessible for measure implementation and where measures would not have other, off-setting environmental effects. Implementing management measures for large-scale erosion problems, such as from landslides, is often not feasible due to lack of accessibility, poor site conditions, and prohibitive land use policies.

***Forest Practice, Conservation* –** Forest conservation includes vegetation management measures to manage forest lands by reducing severe fire risk through prescribed fire and thinning, and by protecting and restoring riparian areas.

Forest fires are a natural part of a forest's life cycle. They can be detrimental or desirable, depending on when and where they occur. Prescribed fires are controlled burns used to change the character of a vegetation community (e.g., adding strata or "layers" to the vegetation structure), improve watershed conditions, and provide protection from uncontrolled fires by removing fuel sources and creating vegetative fire breaks. Thinning and vegetation management are also used to maintain a healthy forest community by encouraging desirable plants and strata variation while removing invasive species and vegetation that serve as fuel sources for fire.

Riparian protection and restoration can be accomplished through:

- Limiting harvest within riparian zones;
- Harvesting just one side of a stream channel, if feasible;
- Retaining trees within riparian zones; and
- Retaining a vegetated buffer strip within riparian zones.

Protecting riparian zones provides a vegetated barrier that prevents eroded soils, nutrients, and pesticides from entering stream systems, stabilizes stream banks, and provides food and cover for wildlife.

Applicability: Forest conservation measures are applicable in most areas that are actively managed for timber, rangeland, or other uses, and have notable erosion issues.

Agricultural Conservation – This measure involves the use of conservation measures available to the agricultural community to reduce soil erosion on land used for agricultural purposes. Conservation measures focus on engineering and vegetative, crop, and livestock management to control erosion, preserve water quality, and support healthy ecosystems while providing a sustainable food supply. Cultivation and range management conservation measures that can be implemented include:

- Implementing soil conservation practices (e.g., no-till cultivation, crop rotation, and/or taking highly erosive farmland out of production);
- Avoiding disturbing any areas with landslides, gullies and slips;
- Avoiding intact riparian areas; if altered, they should be revegetated and restored;
- Fencing around streams to prevent cattle from entering; and
- Adding streambank stabilization in range areas.

Applicability: Agricultural conservation measures are applicable to farm fields and pastures that have potential for highly erosive conditions, such as steep slopes, highly erosive soils, use by livestock, etc., and where implementation of the measures would not have other environmental effects that would offset the environmental benefits of the measures.

Local Sediment Management Group (LSMG) Coordination Meetings – The LSMG is an information exchange forum comprising the Corps and federal and state regulatory agencies, tribal governments, local governments, and non-governmental organizations (e.g., barge operators, ports, Pacific Northwest Waterways Association). The Corps established the LSMG in July 2000 as part of the DMMP process. The Corps reconvened the group in 2006 to assist in defining the scope for the PSMP. The group met throughout the EIS preparation process, providing input to the Corps on sediment management within the LSRP and sharing information with member agencies and stakeholders. The LSMG is expected to meet regularly in the future. The LSMG will:

- Update the LSMG Charter to reflect its ongoing role as an information exchange for long term sediment management planning and implementation of the PSMP;
- Meet at least once each year to review progress and exchange information on sediment management;
- Facilitate interagency communication and coordination regarding sediment management in the lower Snake River Basin;
- Provide a forum to address regional sediment issues regarding the lower Snake River drainage area.

As part of this measure, the Corps also intends to explore opportunities for other regional coordination concerning sediment management in the lower Snake River basin (e.g., provision of staff expertise under the Regional Sediment Management Program), which are hosted/facilitated by other agencies or stakeholders.

Applicability: The LSMG would be applicable to all potential USRM and other sediment management measures.

2.2.5 Range of PSMP Alternatives

The Corps formulated a range of alternatives by assembling the feasible and effective measures into groupings based on how measures could be implemented and what agencies could implement them. In accordance with NEPA, the Corps included a No Action Alternative, defined here as no change in current practices. As noted previously, the alternatives are programmatic and describe broad categories of actions that could be implemented to meet the purpose and need. For any alternative, the Corps would continue to monitor sediment accumulation in the LSRP and assess conditions with respect to sediment accumulation that would affect existing authorized project purposes as described in Section 2.2.1 above.

Additionally, for the purpose of alternatives development, this EIS assumes that current USRM, as described in Section 2.2.4.4, would continue in the future (or increase as funding/technology allow) as a baseline feature of *all* alternatives considered below and is not being proposed as a separate measure. The Corps assumes agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding, or may increase implementation should funding and technology allow. The USFS would continue to implement ongoing activities including road decommissioning, road maintenance, the post-fire Burned Area Emergency Response (BAER) program which initiates erosion control and road stabilization following significant wildfires, and riparian area improvement projects. The Corps would continue implementing erosion and sediment control on its lands adjacent to the LSRP.

Each alternative represents a plan that the Corps (or potentially other agencies) would implement over time. Each alternative provides a programmatic decision-making framework for future actions based on the following two triggers:

- Future forecasted need actions:

  A future forecasted need action is warranted when sediment accumulation that impairs an existing authorized project purpose has occurred at a particular location(s) more frequently than once in the past 5 years[1] or is anticipated to reoccur more than once in the next 5 years (i.e. a chronic problem). When either of those triggers is met, the Corps (or others) would initiate planning and evaluation of applicable measures, consistent with the framework of the proposed PSMP, to determine which measure or combination of measures to implement. The intent would be to implement a long-lasting solution for that particular location. It may take several years for the measures to be implemented and to have an effect. The PSMP does not restrict the Corps' ability to initiate other future forecasted need studies when warranted.

- Future immediate need actions:

  A future immediate need action is warranted at the time sediment accumulation is impairing an existing authorized project purpose of the LSRP at a particular location(s). Immediate needs arise when sediment accumulation that is not predicted through monitoring or forecasts occurs and interferes with existing authorized project purposes. Measures to address an immediate need would be implemented as soon as funding and environmental compliance would allow. They may or may not have a long-lasting effect at that location.

Table 2-4 presents the alternatives developed by the Corps and the measures associated with each of the alternatives.

[1] Five years was selected as the appropriate time period for establishing forecast needs based on historical dredging actions (see Table 1-3).

Table 2-4. Alternatives and Associated Measures

Measures	Alternative 1 No Action Alternative: Continue Current Practice	Alternative 2 Increased Implementation Sediment Reduction Measures	Alternative 3 System Management	Alternative 4 Structural Sediment Management Measures	Alternative 5 Dredging-Based Sediment Management	Alternative 6 System Management and Non-Dredging Sediment Management	Alternative 7 Comprehensive (Full System and Sediment Management Measures)
Dredging and Dredged Material Management							
Navigation and Other Dredging					●		●
Dredging to Improve Flow Conveyance Capacity					●		●
Beneficial Use of Sediment					●		●
In-water Disposal of Sediment					●		●
Upland Disposal of Sediment					●		●
Structural Sediment Management							
Trapping Upstream Sediments (in reservoir)				●		●	●
Agitation to Resuspend Sediments				●		●	●
Bendway Weirs				●		●	●
Dikes and Dike Fields				●		●	●
System Management Measures							
Reservoir Drawdown to Flush Sediment			●			●	●
Navigation Objective Reservoir Operation	●	●	●	●	●	●	●
Reconfigure Affected Facilities			●			●	●
Relocate Affected Facilities			●			●	●
Raise Lewiston Levee to Manage Flood Risk			●			●	●

Table 2-4. Alternatives and Associated Measures

Measures	Alternative 1 No Action Alternative: Continue Current Practice	Alternative 2 Increased Implementation Sediment Reduction Measures	Alternative 3 System Management	Alternative 4 Structural Sediment Management Measures	Alternative 5 Dredging-Based Sediment Management	Alternative 6 System Management and Non-Dredging Sediment Management	Alternative 7 Comprehensive (Full System and Sediment Management Measures)
Upland Sediment Reduction Measures (Expanded)							
Vegetation Filter Strips		●					
Streambank Erosion Control		●					
Forest Practices – Structural		●					
Agriculture – Conservation Measures		●					
Forest Practices – Conservation Measures		●					
Vegetation Filter Strips		●					
Local Sediment Management Group (LSMG) Coordination Meetings		●					

[1]*The alternatives the Corps developed are described in the following sections. Each description includes a summary which measures are included and how the alterative would be implemented to address both the future forecast and future immediate needs*.

2.2.5.1 Alternative 1 - No Action (Continue Current Practices)

The No Action alternative represents a continuation of the Corps' current operational practices of managing the LSRP. The Corps would not adopt the proposed PSMP or implement any new sediment management actions (e.g., channel maintenance dredging). The Corps would continue its ongoing monitoring of accumulated sediment that affects the existing authorized project purposes of the LSRP as described in Section 2.2.1.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation

Implementation

Alternative 1 would address all future needs (immediate and forecasted) in the same manner as current practice. The Corps would continue to use the actions described above to address sediment accumulation that interferes with the existing authorized project purposes. Navigation objective reservoir operations would continue to be implemented in the lower Snake River, consistent with the terms and conditions of the NOAA FCRPS BiOp or subsequent ESA consultation and other applicable requirements, to address sediment accumulation that interferes with commercial navigation. For Corps-managed recreation areas (boat basins or ramps) the Corps may post warnings or close affected facilities if either of these actions was needed for safety. The Corps would perform routine maintenance on existing irrigation intakes (e.g. lifting or shifting the intakes, or doing limited excavation), install a temporary intake, or use another available water source to address sediment accumulation at HMU intakes. Reservoir operations would be used during high flow events, in accordance with the Lower Granite Project Water Control Manual (Corps 1987a), if needed to provide flow conveyance at the Snake/Clearwater Rivers confluence.

2.2.5.2 Alternative 2 – Expanded Implementation of Upland Sediment Reduction Measures

Under the Expanded Implementation of Sediment Reduction Measures alternative, the Corps would rely solely on expanded implementation of USRM implemented by other agencies and land owners[2] to address sediment accumulation that interferes with all of the existing authorized project purposes of the LSRP. The watershed approach of this PSMP EIS considered methods that could reduce sediment loads to the lower Snake River as a means of addressing sediment accumulation that interferes with existing authorized project purposes of the LSRP. The Corps identified land management techniques and soil conservation practices (sediment reduction

[2] For this alternative, USRMs were assumed to increase from the current levels of implementation, as described in Section 2.2.4.4 above.

measures) that might reduce erosion from upland sources within the Snake River watershed. The Corps coordinated with land management agencies and sponsored research and analysis by the USFS, USGS, UI and WSU to assess the effectiveness of USRM. Data collection and analysis presented in studies of sediment contribution in the Snake River watershed (Appendices B-F) indicate there may be opportunities for limited expanded USRM (e.g., road and vegetation management) for further reducing the amount of fine sediment (i.e., silt) entering tributaries/LSRP, but fine sediments are a minor problem in the LSRP as compared to sand. The Corps, however, has been unable to identify a practical way to quantify or confirm the relationship/nexus between increased USRM and reduction of fine sediment that interfere with existing authorized project purposes of the LSRP (primarily recreation areas and HMU irrigation intakes). Under this alternative, the Corps would also continue to coordinate with other land managers and stakeholders (through the LSMG and other regional coordination meetings) on potential long-term planning and sediment management options/efforts and use adaptive management in future modifications and updates to the PSMP.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation
- Expanded implementation of USRM by other land managers/owners:
    - Vegetation filter strips
    - Streambank erosion control
    - Structural forest practices
    - Forest conservation measures
    - Agriculture conservation measures
    - LSMG coordination meetings

Implementation

Implementation of Alternative 2 would be the same for all future actions under the PSMP. For this alternative, the Corps assumes land managers – federal, state, and local agencies and tribes – and land owners would expand their implementation of sediment reduction measures (beyond current levels) throughout the sediment-contributing watershed. Once a trigger is reached, the Corps would implement the same actions for each of the existing authorized project purposes as described in Alternative 1 as an interim measure until the USRM take effect. The Corps would also continue performing erosion control on Corps lands adjacent to the LSRP. The Corps would also continue to coordinate with other land managers and stakeholders through the LSMG coordination meetings and other regional coordination meetings on potential sediment management options/efforts and use adaptive management in future modifications and updates to the PSMP.

2.2.5.3 Alternative 3 – System Management

Under the System Management alternative, the Corps would evaluate and implement only system management measures to manage sediment accumulation that interferes with existing authorized project purposes of the LSRP. The Corps would consider only measures that modify reservoir operations (such as pool depth) or modify Corps-owned/managed facilities. The navigation objective reservoir operation measure would address all future needs (immediate and forecasted) as described in Alternative 1. To reconfigure/relocate facilities, raise the Lewiston levee, or draw down the reservoir, sufficient lead time would be required to plan modifications to infrastructure; therefore, those measures would not be appropriate to address current or future immediate need actions. Closing affected recreation facilities could address all future needs (immediate and forecasted) as required by Corps safety regulations. The Corps assumes agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding, or may increase implementation should funding and technology allow.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation
- Reservoir drawdown to flush sediments (drawdown)
- Reconfigure affected facilities
- Relocate affected facilities
- Raise Lewiston levees to manage flood risk

Implementation

Implementation of Alternative 3 would be based on which trigger, immediate need or forecast need, was reached. To address an immediate need, the Corps would identify and evaluate only measures that would have an immediate effect and that the Corps could implement quickly. The Corps would also continue performing erosion control on Corps lands adjacent to the LSRP. When the trigger for future forecasted needs was reached, the Corps would evaluate and implement system management measures based on a management framework presented in the PSMP. The Corps may implement the actions described in Alternative 1 in the interim until the system management measures could have an effect. The Corps would continue to monitor sediments in the lower Snake River and assess the effectiveness of management actions. Based on this monitoring and assessment, the Corps would adapt the system management measures as needed to optimize management of sediment accumulation that interferes with the existing authorized project purposes of the LSRP. Agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to USRM, consistent with their current authorizations and funding.

2.2.5.4 Alternative 4 – Structural Sediment-Management Measures

The Structural Sediment-Management Measures alternative involves using measures that control the location and rate at which sediment is deposited at a specific location to reduce or eliminate the magnitude of the sediment interference with existing authorized project purposes of the LSRP. Under this alternative, the Corps would monitor sediment in the lower Snake River and, as applicable, plan, design, and implement structural sediment management measures based on the framework presented in the proposed PSMP and subject to authority and funding. Installing bendway weirs and dikes/dike fields, and trapping upstream sediments would require sufficient lead time to plan and design, and therefore would not be appropriate to address current or future immediate need actions. Agitation to resuspend sediments (for the authorized purposes of Recreation and Fish and Wildlife) could address all future needs (immediate and future forecasted).

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation
- Bendway weirs
- Dikes and dike fields
- Agitation to resuspend sediments
- Trapping upstream sediment (in-reservoir)

Implementation

Implementation of Alternative 4 would be the same as Alternative 3 except the Corps would consider only structural measures instead of system management measures to address future forecasted needs.

2.2.5.5 Alternative 5 – Dredging-Based Sediment Management

The Dredging-Based Sediment Management alternative represents a continuation of the Corps' historical practices of using dredging as the primary tool for managing sediment that interferes with existing authorized project purposes of the LSRP. The Corps would continue its current program of monitoring sediments that affect the existing authorized project purposes of the LSRP. Sediment management would consist of dredging and dredged material management. Sediment management activities would be undertaken in response to or anticipation of sediment accumulation problems.

Agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding. The Corps would continue implementing erosion and sediment control on lands adjacent to the LSRP.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation (on a temporary basis until dredging is implemented)
- Navigation channel and other dredging
- Dredging to improve conveyance capacity
- Beneficial use of dredged material
- In-water disposal of dredged material
- Upland disposal of dredged material

Implementation

Based on Corps regulations, the Corps would evaluate disposal options to identify the least-costly, engineeringly feasible, environmentally acceptable option (Federal Standard). As stated above in Section 2.2.2.1, the disposal method would ultimately be identified through evaluation of disposal alternatives under the substantive provisions of CWA Section 404(b)(1), guidelines established by the EPA (40 CFR 230) and Corps regulations. Disposal options include consideration of beneficial use of dredged material, in-water disposal, and upland disposal. Beneficial use refers to utilizing dredged sediments as resource materials in productive ways (Corps 2011a). Potential beneficial use of dredged materials would include creating submerged fish habitat or establishing woody riparian habitat consistent with the Lower Snake River Fish and Wildlife Compensation Plan (Corps 1975, 2004) or using the material as fill for future development. Dredged material could also be disposed of in upland areas or in-water. Similar to Alternatives 2, 3, and 4, the Corps would perform the actions described in Alternative 1 as interim measures until the dredging actions could be completed. The Corps would continue monitoring sediment in the LSRP, as well as the effectiveness of habitat created by placement of dredged material and other beneficial uses of dredged material that it may undertake.

2.2.5.6 Alternative 6 – System Management and Non-Dredging Sediment Management

The System Management and Non-Dredging Sediment Management alternative combines system management and structural sediment-management measures to represent the nondredging measures potentially available for managing sediments in the LSRP. This alternative is a combination of Alternatives 3 and 4. Under this alternative the Corps would use only non-dredging measures to address sediment accumulation that interferes with existing authorized project purposes. Under this alternative, the Corps would monitor sediment in the lower Snake River and, as applicable, plan, design, and implement structural sediment-management measures based on the framework presented in the proposed PSMP and subject to authority and funding.

The following measures would be considered under this alternative:

- Navigation objective reservoir operation
- Reservoir drawdown to flush sediments (drawdown)
- Reconfigure affected facilities
- Relocate affected facilities
- Raise Lewiston levees to manage flood risk
- Bendway weirs
- Dikes and dike fields
- Agitation to resuspend sediments
- Trapping upstream sediment (in-reservoir)

Similar to other alternatives with the exception of Alternative 2, this alternative would include agencies and landowners implementing sediment reduction measures at current levels.

Implementation

Implementation of Alternative 6 would be the same as Alternatives 3 and 4 except the Corps would consider both system management measures and structural measures to address future forecasted needed.

2.2.5.7 Alternative 7 – Comprehensive (Full System and Sediment Management Measures)

The Comprehensive (Full System and Sediment Management Measures) alternative is a combination of Alternatives 5 and 6 and provides a suite of all available dredging, system management, and structural sediment management measures for the Corps to use to address sediments that interfere with the existing authorized project purposes of the LSRP. Agencies and land owners responsible for land management in the basins that drain into the LSRP (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices related to erosion control, consistent with their current authorizations and funding. The Corps would continue implementing erosion and sediment control on lands adjacent to the LSRP.

Measures

The following measures would be considered under this alternative:

- Navigation objective reservoir operation (on temporary basis until dredging is implemented)

- Navigation channel and other dredging
- Dredging to improve conveyance capacity
- Beneficial use of dredged material
- In-water disposal of dredged material
- Upland disposal of dredged material
- Reservoir drawdown to flush sediments (drawdown)
- Reconfigure affected facilities
- Relocate affected facilities
- Raise Lewiston levees to manage flood risk
- Bendway weirs
- Dikes and dike fields
- Agitation to resuspend sediments
- Trapping upstream sediment (in reservoir)

Implementation

Implementation of Alternative 7 would be based on which trigger was reached and the existing authorized project purpose affected. To address an immediate need for navigation, the Corps would perform a dredging action similar to Alternative 5, as this would be the only measure that would effectively reestablish the congressionally authorized dimensions of the federal navigation channel to its congressionally authorized dimensions. As an interim measure until dredging could be performed, the Corps may implement the same actions described in Alternative 1. For an immediate need for irrigation intake, recreation, and flow conveyance capacity, the Corps would implement the same routine maintenance actions described in Alternative 1 before considering dredging.

When the trigger for future forecasted needs is reached, the Corps would initiate review of site-specific conditions, screening of alternative measures (including consideration cost, engineering, and environmental factors), and determine which measure (or measures) to implement to address sediment accumulation. While that analysis was being conducted, the Corps may implement the actions described in Alternative 1 to address problem sediment in the interim. The Corps would continue monitoring sediment in the LSRP, as well as the effectiveness of habitat created by placement of dredged material and other beneficial uses of dredged material that it may undertake.

2.2.6 Alternatives Screening

The Corps developed screening criteria to evaluate alternatives. The screening criteria were applied to the range of alternatives described above to determine which alternatives would satisfy the identified purpose and need (see Section 1). The criteria applied were:

- Alternative must provide sufficient measures to address future forecasted needs in areas of reoccurring sediment deposition that is expected to interfere with existing authorized project purposes of the LSRP.
- Alternative must provide sufficient measures to address immediate needs for restoring existing authorized project purposes of the LSRP (e.g., reestablishing the congressionally authorized dimensions of the federal navigation channel).

The criteria helped eliminate those alternatives that could not reasonably or practically meet the project purpose and need. Only those alternatives that met both of the screening criteria were moved forward for further evaluation. The exception was the No Action Alternative. As a standard NEPA practice this alternative was carried forward to serve as the baseline for comparison.

2.2.7 Alternatives Removed from Further Consideration

By applying the screening criteria listed in Section 2.2.6, the Corps determined which alternatives did not meet the purpose and need and were therefore removed from further consideration in this EIS. Alternatives 1 and 2 did not meet either of the criteria. Alternative 1 was retained because NEPA requires evaluation of the No Action alternative. Alternatives 3, 4, and 6 partially met some of the needs described in the criteria, but did not provide sufficient measures to comprehensively address future and immediate sediment management needs in the LSRP. Each of these alternatives was therefore excluded from further analysis in the EIS. Alternatives 5 and 7 met both of the screening criteria and each provide a complete set of measures to comprehensively address LSRP sediment management needs. Therefore, both were retained for detailed analysis in this EIS. Table 2-5 summarizes the screening of the range of alternatives, and the following sections further discuss the reasons for removing some alternatives from further consideration.

Table 2-5: Range of Alternatives Screening

Alternative	Does the alternative: Provide long-term solution(s) to sediment that interferes with existing authorized project purposes of LSRP?	Does the alternative: Provide immediate need solutions to sediment that interferes with existing authorized project purposes of the LSRP?	Retain for further evaluation in EIS?
1 – No Action	No	No	Yes
2 - Increased Implementation Sediment Reduction Measures	No	No	No
3 - System Management	Partial	No	No
4 - Non-Dredging Sediment Management Measures	Partial	No	No
5 - Dredging-Based Sediment Management	Yes	Yes	Yes
6 - System Management and Non-Dredging Sediment Management	Partial	No	No
7 - Comprehensive (Full System and Sediment Management Measures)	Yes	Yes	Yes

2.2.7.1 Alternative 2 – Increased Implementation of Sediment Reduction Measures

The Corps coordinated with land management agencies and sponsored research and analysis by the USFS, USGS, UI and WSU to assess the effectiveness of USRM. The analysis by the above-mentioned agencies demonstrated that sediment reduction from upland sources would not, by itself, be effective at reducing sediment accumulation that interferes with existing authorized project purposes of the LSRP, either for future forecasted needs or future immediate needs, particularly given the possibility of sediment loads increasing in the future.

Watershed studies performed for this EIS indicate there is no meaningful opportunity to implement additional USRM that would appreciably reduce/prevent the predominant coarse sediment (i.e., sand) generated from mass wasting events (e.g., landslides) from entering the tributaries/LSRP and interfering with existing authorized project purposes of the LSRP. The studies indicate there may be opportunities for increased USRM (e.g., road and vegetation management) that may help reduce the amount of fine sediment (i.e., silt) entering tributaries/LSRP, but such reduction is likely to be localized only and fine sediments are a minor problem in the LSRP as compared to sand. Additionally, the Corps has not identified a practical way to quantify or confirm the relationship/nexus between increased USRM and reduction of fine sediment that interferes with existing authorized project purposes of the LSRP (primarily recreation areas and HMU irrigation intakes). The effectiveness of such USRM cannot be quantified or predicted and further feasibility research is not warranted. Expanded USRM, as a stand-alone alternative or combined with other measures, is unlikely to assist the Corps in addressing sediment deposition that interferes with existing authorized project purposes of the LSRP, for future actions or for the current immediate need action under the PSMP.

Alternative 2 would have no effect in addressing future immediate needs as these measures address future sediment deposition but have no effect on accumulated sediment that is already interfering with existing authorized project purposes and was therefore excluded from further consideration in the PSMP EIS.

Expanded USRM would not meet the stated purpose and need. However, the Corps determined that continued coordination of the LSMG meetings, and participation in other regional coordination meetings for long term planning and sediment management, may be a useful tool for exploring potential USRM in the future and is retained as a measure to be incorporated into all alternatives carried forward in this EIS for further analysis.

2.2.7.2 Alternative 3 - System Management

Similar to increased sediment reduction, expanded system management measures implemented by the Corps (as a stand-alone alternative) were considered as measures to address sediment accumulation that interferes with existing authorized project purposes. While several system-management measures potentially could address sediment accumulation at some areas or provide a partial solution to some sediment accumulation problems, system management measures alone would not address sediment accumulation that interferes with the existing authorized project purposes of the LSRP. Further, system management measures would not fully address accumulated sediment that is already interfering with existing authorized project purposes. Therefore Alternative 3 was excluded from further consideration.

2.2.7.3 Alternative 4 – Non-Dredging Sediment Management Measures

Non-dredging sediment management measures, like system management measures, provide partial solutions to some sediment accumulation needs. Alternative 4 would have the same limited effectiveness as Alternatives 2 and 3 in addressing an immediate need. Alternative 4 would provide a variety of structural measures for potentially addressing future needs and would provide opportunities to potentially reduce sediment accumulation in some areas. Alternative 4 would provide partial solution to future sedimentation that interferes with existing authorized project purposes of the LSRP, but would not fully address accumulated sediment that is already interfering with existing authorized project purposes. Therefore Alternative 4 was excluded from further consideration.

2.2.7.4 Alternative 6 – System Management and Non-Dredging Sediment Management

Alternative 6 combines the elements of Alternatives 3 and 4 providing a broader array of measures available to the Corps to potentially address sediment that interferes with the existing authorized project purposes of the LSRP. While Alternative 6 provides more measures, the combination it presents does not fully address the purpose and need. Like Alternatives 3 and 4, Alternative 6 provides partial solutions to future needs and would not address accumulated sediment that is already interfering with existing authorized project purposes. Therefore, Alternative 6 was also excluded from further consideration.

2.2.8 PSMP Alternatives Evaluated in Detail

The Corps determined that Alternatives 5 and 7 met the purpose and need and should be evaluated in detail. Both alternatives provide solutions for future forecast sediment accumulation that interferes with existing authorized project purposes of the LSRP as well as address accumulated sediment that is already interfering with existing authorized project purposes. The Corps also determined that continued participation in the LSMG coordination meetings, and other regional coordination meetings for long term planning and sediment management, may be a useful tool for exploring potential USRM in the future and is retained as a measure to be incorporated into all alternatives carried forward in this EIS for further analysis. Alternative 1, No Action, is evaluated in detail in accordance with NEPA (40 CFR 1502.14(d)).

2.3 Current Immediate Need Action

Following the identification of the PSMP alternatives to be evaluated in detail (Alternatives 1, 5, and 7), the Corps considered the effectiveness of those alternatives to address the current immediate need that exists at Ice Harbor Dam and the Snake/Clearwater Rivers confluence to re-establish the federal navigation channel to the congressionally authorized dimensions (see Section 1.1.2). Alternative 5 and the dredging and dredged material management measures under Alternative 7 would accomplish this project purpose. Other structural and management measures under Alternative 7 would not effectively address sediment that has already accumulated in the navigation channel.

The description of the alternatives includes a description of how the Corps' Regulatory offices would respond to the request from the Ports of Lewiston and Clarkston for permits to restore the Ports' berthing-area dimensions and would also describe the restorative actions available to the Ports.

2.3.1 Alternative 1

This alternative would address the current immediate need action only to the extent that raising pool levels to higher or maximum operating pool or adjusting operational procedures at the dam would re-establish the congressionally authorized channel dimensions. This alternative would not, by itself, reestablish the navigation channel to its congressionally authorized dimensions because some areas would not be 14 feet deep even at maximum pool.

Corps Regulatory Review of Port Action – Regarding the related current maintenance action for the Ports, the Corps' Regulatory offices would not issue CWA Section 404 or Rivers and Harbors Act Section 10 permits to the Ports under this alternative. The Ports would take no action to address the sediment that has accumulated in the berthing areas.

2.3.2 Alternative 5

To address the current immediate need, the Corps would dredge areas of accumulated sediment that interfere with commercial navigation. Three of these areas are located in the Lower Granite reservoir and a fourth is located just downstream of the Ice Harbor Dam. The Corps would perform the dredging during the first available in-water work period following the approval of the Record of Decision for this PSMP EIS. Appendix L presents detailed information on the proposed current immediate need action. Until the dredging could be performed, the Corps would perform navigation objective reservoir operations and operational changes at Ice Harbor, as described in Alternative 1. The Corps would consider both upland and in-water disposal alternatives in the CWA Section 404(b)(1) evaluation, as described in Section 2.2.2.1 above. The draft CWA Section 404(b)(1) evaluation would be released for public/agency comment with the PSMP final EIS and/or separate public notice. The CWA 404(b)(1) evaluation would also be released for public comment on the proposed disposal method when the Ports' CWA Section 404/Rivers and Harbors Act Section 10 permit applications public notice is issued. The lowest-cost, least environmentally damaging, practicable alternative would be identified as the proposed/preferred disposal method. The final CWA Section 404(b)(1) evaluation, and all associated public/agency comments and responses, would be appended to the final PSMP EIS, which would be released for an additional 30-day public comment period before a Record of Decision can be signed. Based on the CWA Section 404(b)(1) evaluation in Appendix L the Corps proposes to use beneficial in-water placement of the dredged material to create additional shallow-water habitat for juvenile salmonids at a location in the Lower Granite reservoir, Snake River RM 116 just upstream of Knoxway Canyon (Figure 2-8).

Corps Regulatory Review of Port Action - Under this alternative, the Ports' proposed berthing-area maintenance action would be considered to be a related/ancillary action to the Corps' current immediate need action, subject to approval/conditions of the associated CWA Section 404/Rivers and Harbors Act Section 10 permits of the adjacent federal channel. The CWA Section 404(b)(1) evaluation in Section 2.3 of Appendix L considers disposal alternatives potentially available only to the Ports, as well as those potentially available to both the Corps and Ports. The Corps' Regulatory offices would issue CWA Section 404/Rivers and Harbors Act Section 10 permits to the Ports for the dredging of the Port berthing areas and the in-water placement of the sediment at Knoxway Canyon. In accordance with an agreement between the Corps and the Ports, the contractor would dredge the berthing areas concurrently with the federal navigation channel dredging and using funds provided by the Ports. The proposed disposal method would be the same as for the Corps' current immediate need action (Knoxway Canyon). Appendix L presents detailed information on the proposed maintenance action at the Ports.

2.3.3 Alternative 7

To address the current immediate need action, the Corps would dredge areas of accumulated sediment to reestablish the federal navigation channel to the congressionally authorized dimensions, and dispose of dredged material at Knoxway Canyon (near Snake River RM 116), as described in Alternative 5. Other structural and management measures under Alternative 7 would not effectively address sediment that has already accumulated in the navigation channel.

Corps Regulatory Review of Port Action – As described for Alternative 5, the Corps' Regulatory offices would issue CWA Section 404/Rivers and Harbors Act Section 10 permits to the Ports for the dredging of the Ports' berthing areas and the disposal of the sediment at Knoxway Canyon. The Corps would then dredge the berthing areas for the Ports concurrently with dredging the federal channel.

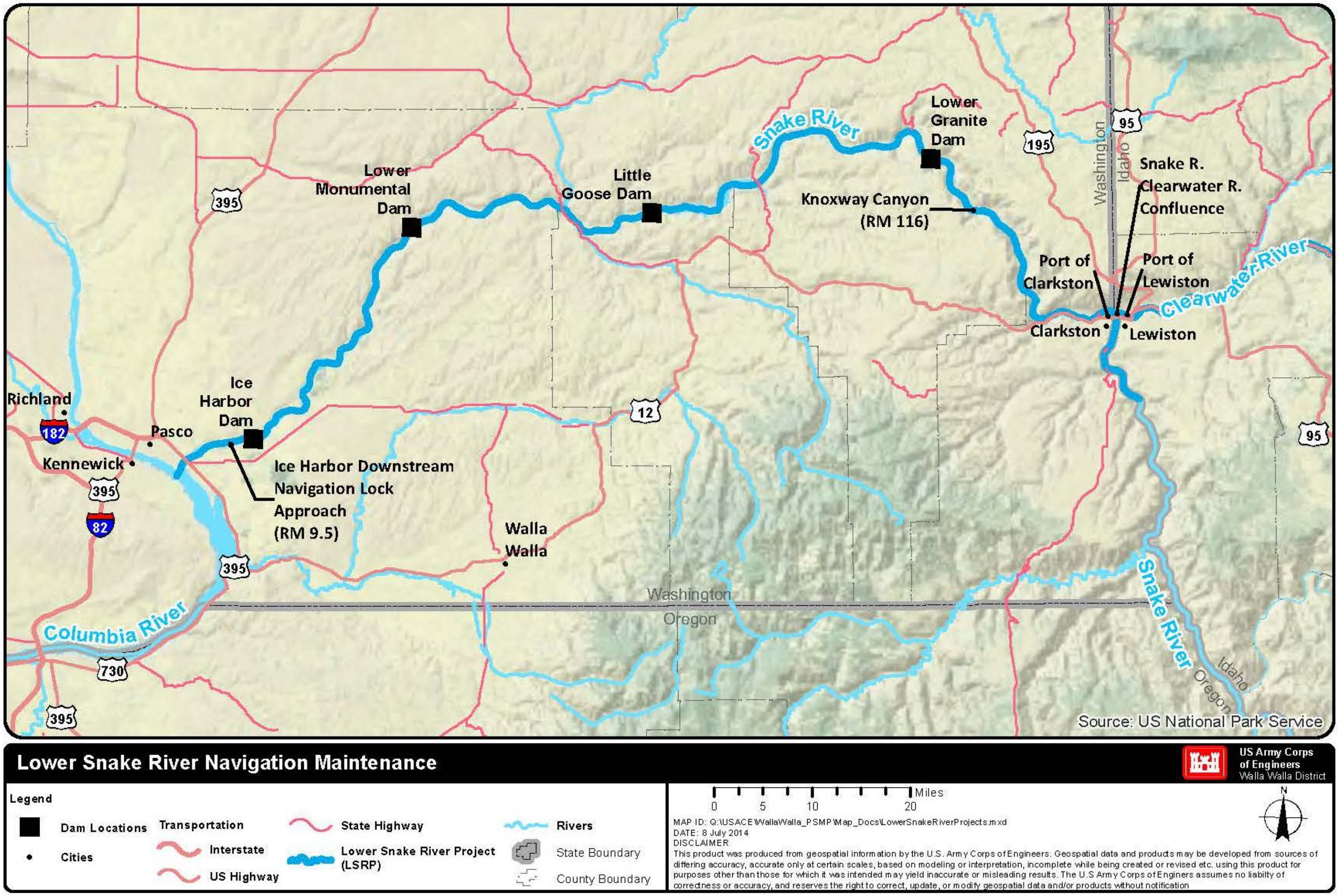


Figure 2-8. Knoxway Canyon In-water Placement Site

2.4 Corps' Preferred Alternative

In comparing the best available information with regard to each alternative (see Table 2-5 and Section 4), the Corps determined that Alternative 7 - Comprehensive (Full System and Sediment Management Measures), best satisfies the purposes of managing sediments that interfere with the existing authorized project purposes of the LSRP and re-establishing the federal navigation channel at its congressionally authorized dimensions. Therefore, the Corps identified Alternative 7 as the preferred alternative for the proposed PSMP.

Consistent with Alternative 7, the Corps proposes to address the current immediate need action to re-establish the congressionally authorized dimensions of the federal navigation channel by performing a dredging and disposal action during the first winter in-water work window following the signing of the ROD. The in-water disposal method at Knoxway Canyon as identified in the CWA 404 (b)(1) evaluation (Appendix L) is the preferred method of disposal as it would have no unacceptable environmental effects and would provide environmental benefits to the aquatic environment.

Alternative 7 provides a broad array of measures the Corps could implement to address sediment accumulation within the LSRP. It also provides for proactive monitoring and planning for addressing potential sediment accumulation rather than reacting to accumulation once it becomes an identified problem. In addition, the Corps determined that continued coordination of the LSMG meetings, as well as participation in other regional sediment planning and coordination meetings, may be a useful tool for exploring potential USRM in the future and is retained as a measure to be incorporated into the preferred alternative. Any sediment and system management measures associated with Alternative 7 would be implemented by the Corps subject to authority and funding. The Corps assumes sediment reduction measures would continue to be implemented by other land use agencies and authorities at current levels.

2.5 Environmentally Preferred Alternative

The Corps identified Alternative 7 as the environmentally preferred alternative as it provides the widest range of measures for the Corps to evaluate when planning sediment management actions and does not rely solely on dredging. Alternative 1 would only use navigation objective reservoir operation to address sediment accumulation and would not provide the desired fish passage conditions consistent with NOAA FCRPS BiOp. Alternative 5 relies only on dredging to address sediment accumulation that interferes with existing authorized project purposes.

2.6 Environmental Effects of Alternatives

Table 2-6 provides a summary of the environmental effects for each alternative. Detailed discussion of environmental effects is presented in Section 4.0.

Table 2-6. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Aquatic Resources	Future Actions: Short-term adverse effects on listed salmonid species during implementation of Navigation Objective Reservoir Operation. Current: Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Short-term adverse effects on aquatic resources during implementation of dredging-based sediment management activities. Long-term beneficial effects from beneficial use of dredged material. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Some short-term and longer-term adverse effects on aquatic resources during implementation of various measures. Long-term beneficial effects through beneficial use of dredged material. Potential adverse effects from weirs and dike fields that may provide habitat for predators on juvenile salmonids. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Terrestrial Resources	Future Actions: Minor adverse effects on plant/wetlands at the margins of reservoirs due to fluctuating reservoir levels of navigation objective reservoir operations. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effects on wildlife during implementation of dredging-based sediment management. Upland beneficial use could have long-term benefits through habitat creation or enhancement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor to moderate short-term adverse effects on wildlife during construction activities associated with implementation of measures. Relocated or reconfigured facilities and upland disposal could have long-term adverse effects from loss of wetlands and habitat; upland disposal could also have long-term benefits to wildlife from habitat creation. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table 2-6. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Recreation	Future Actions: Beneficial effects on recreational boating. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effects on boating/fishing and land-based recreation during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effects on boating/fishing and land-based recreation during measure implementation. Potential short-term adverse effects to recreation on Lewiston levee system during measure implementation. Measures could have long-term beneficial effects on recreation by restoring design dimensions of recreational facilities. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Cultural Resources	Future Actions: Potential adverse effect on shoreline archaeological sites due to potentially prolonged exposure to water. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Potential adverse effects to cultural resources from implementation of dredging-based sediment management measures. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Potential adverse effects to cultural resources from construction activities associated with implementation of sediment and system management measures. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Socioeconomics	Future Actions: Benefit to commercial navigation by providing for safe navigation. Duration of benefit is limited to the point where pool levels can no longer be raised. Potential long-term adverse effects on boating basins and marinas due to sediment accumulation, shifting local economic benefit away from effected facilities. Potential long-term adverse effects behind the Lewiston levee system due to increased flood risk. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Temporary benefits to employment and income during dredging related activities. Long-term economic benefit by providing for safe commercial navigation and recreation opportunities. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Temporary adverse effects on socioeconomics if navigation channels and associate facilities are modified or closed during measure implementation. Temporary benefits to employment and income during construction activities. Long-term economic benefit by providing for safe commercial navigation and recreation opportunities. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table 2-6. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Water Quality and Sediment Quality	Future Actions: Minor localized effects on water quality in the vicinity of boating activity due to prop wash and in the vicinity irrigation intake maintenance. No effect on sediment quality. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Temporary adverse effects on water quality during dredging activities. No long-term effect on water quality or sediment quality. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Temporary adverse effects on water quality during construction activities associated with measure implementation. Drawdown to flush sediments would adversely affect water quality temporarily by increasing turbidity and suspended sediments. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Hydrology and Sediment	Future Action: No effect on sediment loading or transport dynamics of the lower Snake River. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Small, localized change in channel cross section and in location of sediment due to beneficial use activities. No long-term effects on sediment loading or transport dynamics of the lower Snake River. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Long-term or short-term localized change in flow velocity and sediment suspension/transport associated with measure implementation. No effect on sediment loading in the lower Snake River. Beneficial localized effect of creating conditions to avoid or minimize long-term accumulation of sediment in specific problem areas. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Hazardous, Toxic, and Radioactive Waste (HTRW)	Future Actions: No effect from HTRW. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: No HTRW sites in LSRP. Minor short-term adverse effect if hazardous substances are released during dredging and dredged material management. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: No HTRW sites in LSRP. Minor short-term adverse effect if potentially hazardous substances are released during implementation of sediment or system management measures. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

Table 2-6. Environmental Effects Summary Table

Discipline	Alternative 1: No Action (Continue Current Practices)	Alternative 5: Dredging-Based Sediment Management[1]	Alternative 7: Comprehensive (Full System and Sediment Management Measures)[1]
Air Quality	Future Actions: No effect on air quality. Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effect from construction equipment operation during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effect from construction equipment operation during sediment and system management measures implementation. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.
Aesthetics	Future Actions: Localized adverse impact on aesthetics of recreational facility due to potential closure or lack of use. . Current Immediate Need Action: Same effects as those described for Future Actions.	Future Actions: Minor short-term adverse effect on visual quality during dredging and dredged material placement. Current Immediate Need Action: Same effects as those described for Future Actions from dredging and in-water beneficial use of dredged material.	Future Actions: Minor short-term adverse effect to aesthetic resources during sediment and system management measures implementation. Major short-term adverse effects to visual quality in the Lower Granite Reservoir due to river bottom exposure during drawdown. Minor long-term benefits to visual quality of recreation facilities due to relocation and reconfiguration. Current Immediate Need Action: Same effects as those described under Current Immediate Need Action for Alternative 5.

[1] Alternatives 5 and 7 both include the navigation objective reservoir operation as a measure for future actions. As such, both alternatives would have environmental effects associated with that measure as documented for Alternative 1

SECTION 3.0 AFFECTED ENVIRONMENT

This section describes the existing environmental resources that could be affected by the alternatives considered in this EIS. The descriptions of the physical, biological, cultural, recreational, and socioeconomic resource areas serve as a basis for evaluation and comparison of the anticipated effects of the alternatives described in Section 4, Environmental Effects of Alternatives. The initial watershed study area for this EIS was the entire lower Snake River basin (approximately 32,000 square miles). The Corps coordinated with land management agencies and sponsored research and analysis by the USFS, USGS, UI and WSU to assess the effectiveness of USRM (Appendices B-F). The analysis by the prior-mentioned agencies demonstrated that sediment reduction from upland sources would not be effective at reducing sediment accumulation that interferes with existing authorized project purposes of the LSRP, either for future actions or the current immediate need. Data collection and analysis presented in studies of sediment contribution in the Snake River watershed indicate there may be opportunities for limited additional USRM (e.g., road and vegetation management) for further reducing the amount of fine sediment (i.e., silt) entering tributaries, but fine sediments are a minor problem in the LSRP as compared to sand. Additionally, the Corps has been unable to identify a practical way to quantify or confirm the relationship/nexus between increased USRM and reduction of fine sediment that interfere with existing authorized project purposes of the LSRP.

The geographical area of the potential affected environment is, therefore, generally focused on the lower Snake River in proximity to the LSRP and Clearwater River (from the upstream extent of Lower Granite Reservoir near Asotin to its confluence with the Columbia River below Ice Harbor Dam). The area includes four multipurpose dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) and their associated reservoirs.

3.1 Aquatic Resources

Each reservoir in the area of potential affect, as noted above, has three general zones that are characterized by different habitats (Hjort et al. 1981). The first zone is the forebay area just upstream from the dam, which is typically ***lacustrine*** (lake-like) in nature. At the upper end of the reservoir is a second zone that tends to be shallower and have significantly faster water velocities. In between these two zones is a transition area that changes in the upstream end from riverine to more lake-like in the downstream direction. Each zone can include several habitat types; however, most can be characterized as either backwater (including ***sloughs*** and ***embayments***) or open-water habitats (Hjort et al. 1981; Bennett et al. 1983). Backwaters in the lower Snake River reservoirs generally have low water velocity, slightly warmer water, finer substrate, and submerged and emergent vegetation.

This section provides an overview of the aquatic resources present in the LSRP. Aquatic resources include ***planktonic*** and ***benthic*** species, aquatic plants, and fish. The following discussions present general descriptions of the key aquatic species that may be affected by the proposed action. Although the majority of research on aquatic resources has focused on Lower Granite Reservoir, this information is also applicable to the other reservoirs within the LSRP.

A summary of available data on fish spawning requirements, life histories, and predation on juvenile ***salmonids*** by resident fish is also presented in this section.

3.1.1 Plankton

Zooplankton and ***phytoplankton*** occur throughout the LSRP and form an important part of the aquatic food chain. Both phytoplankton and zooplankton are food sources for larger aquatic organisms, and high concentrations of zooplankton in backwater areas can attract smaller prey species that feed on these organisms. In turn, high concentrations of prey fish can attract larger predatory fish species (Corps 1999b, 2002b).

Zooplankton can compose an important component to the diet of rearing ***anadromous*** and resident fish species (Bennett et al. 1983). The times of year when zooplankton and phytoplankton are most active can be measured by assessing the ***Primary productivity*** within the LSRP. This measure is used to describe the rate that plants and other photosynthetic organisms produce organic compounds in the ecosystem. Primary productivity in the lower Snake River reservoirs has been measured at its lowest during December and highest from March through May (Seybold and Bennett 2010).

3.1.2 Benthic Invertebrates

Benthic organisms contribute significantly to the diets of many riverine and reservoir fish species. The benthic ***invertebrate*** community consists of organisms such as aquatic worms, insects, crayfish, and mussels that live on the river bottom. These benthic organisms, also referred to as ***macroinvertebrates***, significantly contribute to the food chain by providing a food source for fish and other aquatic species. Where reservoirs are established, the invertebrate species composition and abundance convert from flowing riverine species typically found in the shallower and higher velocity environments of the predam river to still water or open water reservoir invertebrate species found in deeper and slower velocity environments of the post-dam reservoir. Species diversity of macroinvertebrate communities at shallow sites can increase with downstream movement or colonization of drifting organisms scoured from upriver habitats (Bennett et al. 1983). Some of these organisms “drift” in the upstream portion of the reservoirs primarily in the seasons of higher flow, which increases their availability to rearing and downstream-migrating juvenile salmonids and resident fishes.

Studies from the 1980s indicate that shoreline areas less than 15.5 feet deep generally had the highest invertebrate abundance, species diversity, and species evenness (similar number of individuals for each species) in the Lower Granite Reservoir (Bennett and Shrier 1986, Bennett et al. 1988). These studies also found that annual and seasonal population abundance was more variant for species exhibiting seasonal emergence as they pupated into adults and left the aquatic environment (e.g., ***chironomids***) than species that are aquatic through all life stages (e.g., aquatic ***oligochaetes* –** worms).

Chironomids, a type of fly that resembles mosquitoes, can make up a substantial portion of the diets of juvenile salmonids and other local fish species. Chironomids are most likely located in sandy silt sediments and decrease in both finer and coarser sediment-type environments. The chironomid communities within the LSRP are composed of several different species, thus resulting in chironomids being readily susceptible to predation by rearing salmonid ***smolts*** across the duration of the smolt migration season.

Crayfish are an important component to the diet of smallmouth bass, northern pike minnow, channel catfish and white sturgeon, and predominantly inhabit shallow water riprap areas from which they forage riverward for oligochaetes and other soft-substrate inhabitants (Bennett et al. 1983; Zimmerman 1999). Crayfish were found in the Lower Granite Reservoir during the physical drawdown test in 1992 (Bennett et al. 1995a; Curet 1994), and in the unimpounded Snake River between Lower Granite Reservoir and Hells Canyon Dam (Nelle 1999). The important role of crayfish in resident and predatory fish diets is extensively documented in both Lower Granite Reservoir (Bennett et al. 1988; Zimmerman 1999) and in the unimpounded Snake River upriver of Lower Granite Reservoir (Nelle 1999; Petersen et al. 1999; Zimmerman 1999).

Surveys for and experiments on mollusks in the early 2000s, focusing on listed, rare, or sensitive species in reservoirs, tributaries and mainstem the Snake River in Hells Canyon Idaho and Oregon. The most important result of this study was documentation of the undescribed *Taylorconcha sp.* throughout the Snake River in Hells Canyon, although *Taylorconcha sp.* was not found within 12 miles downstream of Hells Canyon Dam, most likely due to river armoring. Additional results included: 1) the mollusk community was similar throughout the Snake River, except where the Salmon River entered the Snake River; 2) *Taylorconcha sp*. abundance was directly related to the abundance of *Potamopyrgus antipodarum*, a highly invasive snail, and with moderate abundance of detritus; 3) hand-picking cobbles was more efficient than suction dredging for snails and limpets but not for bivalves, 4) the most abundant mollusks were two invasive species, *P. antipodarum* and *Corbicula fluminea;* and 5) only one live small colony of native *Gonidea angulata* (*Unionidae*) and no live *Anodonta californiensis* (*Unionidae*) were found in the survey. (Lester et al. 2005). High numbers of nonnative *Corbicula* were also found.

Mollusc diversity in the lower Snake River has been greatly reduced by the impoundment of the Snake River. Prior to impoundment, the lower Snake River likely supported 34 species of molluscs, 33 of which were native to the river (Appendix M). Limited sampling done during the test drawdown produced only seven mollusc species. The current mollusc fauna is dominated by the Asian clam (*Corbicula fluminea*), which became established in the Columbia River in the 1940s. The California floater (*Anodonta californiensis*), a Washington State species of concern, was also found in the sampling. The shortface lanx (*Fisherola nuttallii*) as well as three other snails (western floater *A. kennerlyi*, knobby rams horn *Vorticifex effusa*, and creeping ancylid

Ferrissia rivularis), and the bivalve, western ridged mussel (*Gonidea angulata*) were also found in small numbers. All other native species have likely been extirpated.

3.1.3 Aquatic Plants

Aquatic plants, also called ***macrophytes,*** typically grow in shallow water along the shorelines of lakes or in the slow-moving reaches of rivers. They can be entirely submerged or emergent (partially above the water surface). In both cases, they fill many important roles in the aquatic environment, including cover for fish, oxygen production, substrate for invertebrates, and food sources for fish and wildlife. Additionally macrophytes supply surfaces for fish eggs to incubate, provide protection for fish species during various life stages, and function as a direct food source for many aquatic organisms. They are also especially important for young fish that hide among plant stems and leaves to escape predators.

Macrophytes help stabilize shorelines by reducing erosion and recycling nutrients. Both submerged and emergent macrophytes are far more extensive in the lower reservoirs (Lower Monumental and Ice Harbor) than in the upper reservoirs (Lower Granite and Little Goose) and upstream Snake River stations (Seybold and Bennett 2010).

3.1.4 Fish

The lower Snake River supports diverse populations of fish, including resident and anadromous species (Table 3-1). Within the LSRP, anadromous salmonids and trout are seasonally present, with juveniles of some stocks present year-round in rearing tributaries and the LSRP. Such species include Chinook salmon, coho salmon, sockeye salmon, and steelhead trout. Anadromous Pacific lamprey is also present in the LSRP. In addition to the species noted above, other native and introduced resident fish are also abundant in the LSRP (Bennett et al. 1983). Table 3-1 lists the anadromous and resident species that have been collected during various studies within the LSRP.

Table 3-1. Anadromous and Resident Fish Collected in the Lower Snake River [1]

Common Name[2]	Scientific Name	Native (N) or Nonnative (E)
Anadromous Species		
Pacific lamprey	*Lampetra tridentata*	N
Chinook salmon • Snake River spring/summer • Snake River fall	*Oncorhynchus tshawytscha*	N
Snake River Sockeye salmon	*Oncorhynchus nerka*	N
Coho salmon	*Oncorhynchus kisutch*	N (Reintroduced)
Snake River steelhead	*Oncorhynchus mykiss*	N
American shad	*Alosa sapidissima*	E
Resident Species		
White sturgeon	*Acipenser transmontanus*	N
Mountain whitefish	*Prosopium williamsoni*	N
Rainbow/redband trout	*Oncorhynchus mykiss/O.m. gibbsi*	N
Brown trout	*Salmo trutta*	E
Bull trout	*Salvelinus confluentus*	N
Chiselmouth	*Acrocheilus alutaceus*	N
Carp	*Cyprinus carpio*	E
Peamouth	*Mylocheilus caurinus*	N
Northern pike minnow	*Ptychocheilus oregonensis*	N
Speckled dace	*Rhinichthys osculus*	N
Leopard dace	*Rhinichthys falcatus*	N
Longnose dace	*Rhinichthys cataracae*	N
Redside shiner	*Richardsonius balteatus*	N
Bridgelip sucker	*Catostomus columbianus*	N
Largescale sucker	*Catostomus machrocheilus*	N
Mountain sucker	*Catostomus platyrhynchus*	N
Yellow bullhead	*Ictalurus natalis*	E
Brown bullhead	*Ictalurus nebulosus*	E
Black bullhead	*Ictalurus melas*	E
Channel catfish	*Ictalurus punctatus*	E
Flathead catfish	*Pylodictis olivaris*	E
Tadpole madtom	*Noturus gyrinus*	E
Sand roller	*Percopsis transmontana*	N
Pumpkinseed	*Lepomis gibbosus*	E
Warmouth	*Lepomis gulosus*	E
Bluegill	*Lepomis macrochirus*	E
Smallmouth bass	*Micropterus dolomieu*	E
Largemouth bass	*Micropterus salmoides*	E
White crappie	*Pomoxis annularis*	E

Table 3-1. Anadromous and Resident Fish Collected in the Lower Snake River [1]

Common Name[2]	Scientific Name	Native (N) or Nonnative (E)
Black crappie	*Pomoxis nigromaculatus*	E
Yellow perch	*Perca flavescens*	E
Walleye	*Stizostedion vitrium*	E
Prickly sculpin	*Cottus asper*	N
Paiute sculpin	*Cottus beldingi*	N
Mottled sculpin	*Cottus bairdi*	N
Banded Killifish	*Fundulus diaphanus*	E

Sources: Bennett et al. 1991, Bennett et al. 1983, Mundy and Witty 1998; Ashe et al. 2000; NWPCC 2004a. Arntzen et al. 2012
[1] [2]Federally listed species are ***bolded.***

The lower Snake River system contains the reservoirs of the dams from the mouth of the Snake River upstream to the city of Asotin. The types of habitats found within each individual reservoir highly influence a reservoir's use by anadromous salmonids as well as resident fish species. Although there is a difference in numbers, there is little difference in the species composition of resident fish within the reservoirs. Species found in high abundance in all reservoirs include suckers, northern pike minnow, bass, chiselmouth, and redside shiners (Bennett et al. 1983; Bennett and Shrier 1986; Bennett et al. 1988). Species such as crappies, sunfish, and largemouth bass are highly abundant in backwaters of all reservoirs. Minor variations in species composition are related to variations in the availability of backwater habitats and flowing waters in the various reservoirs.

3.1.4.1 Shallow Water Habitat

An important element of fish use of the lower Snake River reservoirs is the availability and use of shallow water habitat (less than 20 feet deep). Currently, less than 10 percent of Lower Granite Reservoir consists of shallow water habitat (Seybold and Bennett 2010). Because shallow water habitat is considered the most productive habitat in aquatic ecosystems in terms of supporting the largest populations and most diverse array of species (Wetzel 2001), the aquatic productivity of the reservoirs could potentially be enhanced by increasing the amount of shallow water habitat. In light of this, the Corps has created several dredged material placement sites in the Lower Granite Reservoir and one site in Ice Harbor Reservoir, and has supported numerous research and monitoring efforts in the Lower Granite Reservoir to assess the biological impacts and potential benefits of in-water placement of dredged material to enhance fish habitat (Tiffan and Connor 2012; Arntzen et al 2012; Gottfried et al. 2011; Bennett and Seybold 2004; Bennett and Shrier 1986; Seybold et al. 2007). Although some researchers have associated deposited sediments in reservoirs with unproductive habitat (Summerfelt 1993; Waters 1995), outmigrating subyearling Chinook salmon have exhibited preference for sand substrates in the lower Snake River (Bennett et al. 1988, 1998; Curet 1994, Gottfried et al. 2011, Tiffan and Connor 2012; Tiffan and Hatten 2012). Results of these studies have indicated that in-water placement of dredged material has improved habitat conditions for listed juvenile salmonids by providing feeding and rearing habitat, while maintaining the overall fish community composition and structure (Chipps et al. 1997;

Gottfried et al. 2011, Tiffan and Connor 2012; Tiffan and Hatten 2012). Based on recent biological monitoring and modeling, the creation of new shallow water habitat in the lower portion of Lower Granite Reservoir in shallow depths along the shoreline is likely to be most beneficial for outmigrating juvenile fall Chinook (Arntzen et al. 2012, Tiffan and Connor 2012, Tiffan and Hatten 2012).

3.1.4.2 Focal Anadromous Fish Species

The following sections present a brief life history of the focal fish species found within the LSRP, including federally listed threatened or endangered stocks. (Additional information on threatened and endangered fish species is noted in Section 3.1.5) A generalized summary of the middle ninety percentile of juvenile and adult migration timing over the past 10 years (2004-2013) of various anadromous salmonid stocks originating in the Snake River is presented in Figure 3-1. Migration timing data source was smolt monitoring mid-March through October and adult ladder counts March through December. Some stocks are likely present in small numbers outside of the timing shown. While juvenile salmonid rearing, and adult holding and spawning occurs throughout the Snake River watershed, the amount of spawning and rearing in the lower Snake River reservoir system is relatively low.

Source: Corps 2002b; Fish Passage Center 1999

Figure 3-1. Middle Ninety Percentile Migration Timing of Anadromous Salmonid Stocks at McNary and Lower Granite Dams. Timing based on the minimum and maximum dates for the annual 5th and 95th percentile passage during the previous 10 years (2004-2013).

Spring/Summer Chinook Salmon

The Snake River spring/summer Chinook salmon ***evolutionarily significant unit*** (ESU) includes naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as fifteen artificial propagation programs. This ESU was listed as threatened in 1992.

Upon returning to fresh water after spending two to three years in the ocean (Howell et al., 1985), adult spring Chinook salmon typically pass through the LSRP from mid-April to mid-June with 90 percent passing in the month of May (Stuehrenberg et al. 1995). Adult summer Chinook salmon typically pass the mainstem dams by September, with the majority passing between mid-June and mid-August. All populations are believed to spawn from August through October, primarily in tributaries upstream of the LSRP (Corps 1999b). Elevation appears to be the key factor influencing run/spawn timing. In tributary systems with both spring and summer runs, spring Chinook salmon tend to spawn farther upstream and earlier than summer run salmon (Matthews and Waples 1991); however, spawning area and timing may overlap in some areas.

After rearing in their natal tributaries for a year, the juvenile Snake River spring and summer Chinook salmon typically migrate through the LSRP from April through June. Little, if any rearing of spring and summer Chinook salmon occurs in the lower mainstem Snake River Reservoirs (Chapman et al. 1995). When the outmigrants reach the lower Snake River they tend to move steadily out of the system as indicated by relatively short reservoir residence times (Giorgi and Stevenson 1994). However, a few individuals of spring Chinook salmon from undetermined origin have been documented as using backwater areas within the Columbia River Basin for rearing, feeding, or overwintering (Easterbrooks 1995, 1996, 1997, 1998). This is consistent with finding of Keefer and Perry (2008), who noted that some subyearling spring/summer Chinook move long distances downstream and overwinter in large tributary or mainstem Snake River habitats.

The Tucannon River supports spring Chinook spawning in the mainstem Tucannon from the mouth of Sheep Creek (RM 52) downstream to King Grade (RM 21) (WDFW 2004). Spawning has not been observed in Tucannon tributaries (NWPCC 2004a). Spawners enter the Tucannon from late April to early July, and spawning typically occurs from late August through September (WDFW 2004). Juvenile spring Chinook rear in the Tucannon system for 12 to 15 months prior to migrating to the ocean, and outmigration takes place from October to July, peaking from April to late May.

Spring/Summer Chinook Critical Habitat **–** The essential components of critical habitat for Chinook salmon are the same as those listed for sockeye salmon. Essential features of spawning and juvenile rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, cover/shelter, food, ***riparian*** vegetation, and space. The migratory corridor for Snake River spring/summer Chinook includes the Snake River and the Columbia River to the Pacific Ocean, in addition to all spawning and juvenile rearing areas (NMFS 1993). In the lower

Snake River reservoirs, critical habitat elements are predominately related to migration and overwintering.

Fall Chinook Salmon

There is only one recognized run of ESA-listed fall Chinook that occurs in the watershed study area. The Snake River fall Chinook ESU was listed as federally threatened in 1992, and the status was reconfirmed in 2005. The ESU includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam (to the confluence with the Columbia), and in the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater Rivers, as well as four artificial propagation programs, including the Lyons Ferry Hatchery (70FR37175). The Lyons Ferry Hatchery is located in Lower Monumental Pool downstream from the mouth of the Palouse River on the north shore of the Snake River.

After emergence in the early spring and initial dispersal, juvenile fall Chinook salmon exhibit a high fidelity for lower-velocity backwater areas for rearing. Fall Chinook salmon can exhibit either an ocean-type life history (migrating to the ocean during the first year of life) or stream-type life history (rearing in fresh water for a year and migrating to the ocean during the second year of life) (Connor et al. 2005). The majority of Snake River fall Chinook juveniles migrate through the lower Snake River during the summer (June through September) exhibiting an ocean-type life history (Connor et al. 2005). Passive integrated transponder (PIT) tag detections of fall Chinook migrating from the Clearwater River (Corps 2002b) suggest that some fall Chinook migrate as yearlings and exhibit a stream-type life history. This is supported by recent studies that illustrate that some subyearling fall Chinook overwinter in the lower Snake River reservoirs (Connor et al. 2005; Tiffan and Connor 2012). Individuals expressing such behavior, also referred to as “reservoir-type” Chinook salmon, likely emerge later in spring and then overwinter in reservoirs as subyearlings and migrate seaward as yearlings the following spring (Connor et al. 2005). According to Connor et al. (2005), the expression of this reservoir-type life history appears to be inversely proportional to rearing temperature. Higher overwintering rates have been observed following years with cooler spring water temperatures (Connor et al. 2002).

Recent radio-telemetry and PIT tag studies (Tiffan et al. 2006, Kock et al. 2007) have indicated that while fall Chinook salmon are distributed throughout the lower Snake River, a relatively large percentage overwintered in the Little Goose Reservoir ***forebays*** for extended periods (e.g., weeks to months). Behaviors overall were quite variable, with some salmon showing directed downstream movements and some showing increased movement during runoff events from winter rainfall (Keefer and Perry 2008).

After two to three years in the ocean, adult Snake River fall Chinook return to the Snake River between late summer and early winter. Spawning begins around mid-October (Connor et al. 1993) and continues through December (Groves and Chandler 1999). Major spawning areas for Snake River fall Chinook include an approximately 40-mile reach of the lower Clearwater River downstream of Dworshak Dam and the 103 miles of the Snake River basin below Hells Canyon Dam (Garcia et al. 2010; Corps 2002b). The majority of all ***redds*** counted within the watersheds upstream of Lower Granite Dam were located within this section of the Snake River itself with fewer redds located in the tributaries (Garcia et al. 2010). Snake River fall Chinook spawning has also been documented in the ***tailwater*** areas directly downstream of Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams, typically in areas where water velocity is high and substrate is relatively large (Bennett et al. 1983, 1992; Kenney 1992; Dauble et al. 1994, 1995, 1996; Mueller 2005; Mueller and Coleman 2007; Mueller and Coleman 2008; Mueller 2009; Normandeau 2014).

During studies conducted from 1993 to 1997 to identify potential spawning habitat or redds for fall Chinook downstream of the four Snake River dams, Dauble et al. (1999) found fall Chinook salmon redds in the tailrace downstream of Lower Granite, Little Goose, and Ice Harbor Dams. Redds were in water from 13.1 to 26.6 feet deep, on cobble substrate, and adjacent to the outfall flow from juvenile fish bypass systems. The total area used for spawning was approximately 27,555 square feet (ft^2) for the Lower Granite site and 6,243 ft^2 for the Little Goose site.

In 1998, Dauble et al. characterized habitat suitability in the tailraces of the Lower Granite and Lower Monumental Dams. They found that four percent of the lock approach area at Lower Granite Dam and less than 1 percent of the lock approach area at Lower Monumental Dam provided conditions suitable for Snake River fall Chinook spawning. They also observed that the portions of the tailraces near the discharges from the powerhouses contained substantially more suitable Snake River fall Chinook spawning than the lock approaches. Mueller (2003) concluded that water depth and substrate size at the two lock approaches were suitable for Snake River fall Chinook spawning, but riverbed slope and water velocity were not.

Starting in 2006, the Corps conducted a three-year study to determine if fall Chinook salmon spawn within the immediate tailrace regions of Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams as part of developing a PSMP for the lower Snake River. As part of this comprehensive evaluation downstream of all four lower Snake River dams in which habitat criteria met the requirements for fall Chinook salmon, spawning areas were surveyed for redds (Mueller and Coleman 2007, 2008; Mueller 2009). In 2006, Mueller and Coleman (2007) confirmed one redd in the tailwaters below Lower Granite Dam and two redds in the tailwaters below Little Goose Dam in suitable habitat during comprehensive deepwater video surveys. In 2007, six redds were found in the tailrace regions of two of the four dams—four at Lower Granite Dam and two at Ice Harbor Dam (Mueller and Coleman 2008). In 2008, surveys showed a total of 15 redds in the tailrace regions of 2 of the 4 dams – 8 redds downstream of Lower Granite Dam and 7 redds in the tailrace region of Lower Monumental Dam (Mueller 2009). As presented by the Corps and EPA (2003a) and subsequent evaluations, due to the presence of suitable substrate, adult fall Chinook salmon have the potential to spawn in the lower Snake River navigation channel. However, typical low water velocities in the navigation channel appear to severely limit suitable spawning conditions except in the immediate tailraces (Corps 2003a), where water velocities, can contribute to precluding spawning in the vicinity of the navigation channel.

Seybold and Bennett (2010) and Tiffan and Connor (2012) report that both subyearling spring and fall Chinook salmon were caught more frequently than other salmonids at selected dredged-sediment placement sites in the lower Snake River reservoirs. The created shallow water sites had abundant primary production with a wide variety of benthic invertebrates that serve as prey items for subyearling Chinook (Seybold and Bennett 2010). Within the reservoirs, Seybold and Bennett (2010) found that higher mean catch per unit effort values for subyearling Chinook salmon occurred at sampling stations located in the two upper reservoirs, Lower Granite and Little Goose, and the lowest catch per unit effort occurred at the Tucannon River in the Lower Monumental Reservoir. .

Tiffan and Connor (2012) found wild juvenile fall Chinook salmon were frequently found in water less than 6.5 feet (2m) deep from early spring through early summer, whereas hatchery fall Chinook salmon subyearlings and spring, summer and fall Chinook salmon yearlings more frequently used water from 6.5 to 20 feet (2 to 6 meters) deep. Overall mean spring-summer density of wild subyearlings was 15.5 times higher in the less than 6.5 feet (2 meter) depths than in the 6.5-to-20 feet (2-to-6 meter) meter depths. While a sizeable portion of juvenile fall Chinook salmon remained in the lower Snake River after the spring and summer migrations, the use of shallow water habitat during the fall and winter is limited. Radio-tagged fish located during mobile tracking were generally found over deep water or away from shore during the fall.

Fall Chinook Critical Habitat – The LSRP is designated critical habitat for Snake River fall Chinook which includes all river reaches presently or historically accessible to the species (NMFS 1993). Essential features of spawning and juvenile rearing areas are the same as for Snake River spring/summer Chinook. The migratory corridor for Snake River fall Chinook includes the Snake and Columbia rivers to the Pacific Ocean, in addition to all spawning and juvenile rearing areas (NMFS 1993). Limited spawning habitat for wild Snake River fall Chinook salmon is present in the LSRP, immediately downstream of each of the lower Snake River mainstem dams (Corps 2005).

Coho Salmon

Historically, coho salmon were abundant in the lower Snake River basin but were officially declared extinct in 1986 (Cichosz et al. 2001; HSRG 2009). In 1995, in cooperation with the USFWS, the Nez Perce Tribe initiated a coho salmon reintroduction program in the Clearwater subbasin.

Reintroduction efforts from this program have been met with marginal success in portions of the watershed study area. Coho salmon reintroduced in the Clearwater subbasin are considered out-of-ESU, and are not listed as threatened or endangered (HSRG 2009). Coho salmon from the program first returned in 1997 with 85 fish over Lower Granite Dam, and increased to 884 and 1,035 fish in 2000 and 2001, respectively (Corps 2002b). From 2003 to 2007, adult coho counts at Lower Granite Dam have averaged over 2,100 fish (HSRG 2009). These adult coho return to the Clearwater subbasin to spawn typically pass the Lower Granite dam between September and November (Corps 2002b).

After rearing in their natal tributaries for a year, juvenile coho migrate downstream through the LSRP to the ocean from April and May (Figure 3-1) (Seybold and Bennett 2010; Arntzen et al 2012).

Sockeye Salmon

One run of ESA-listed sockeye salmon is known to occur in the LSRP. Snake River sockeye salmon were listed as endangered in November 1991, and their listing was reaffirmed in June 2005. Critical habitat was designated for Snake River sockeye salmon in December 1993. No spawning or rearing elements of critical habitat for Snake River sockeye salmon have been designated in the lower Snake River; however, this portion of the mainstem Snake River is used as a migratory corridor by both juveniles and adults as they travel to higher-elevation tributary lakes for spawning and rearing (Gustafson et al. 1997). In the LSRP, adult Snake River sockeye salmon upstream passage typically occurs from May through early August (Corps 2002b; Fish Passage Center 2012). Juveniles rear in lakes for one to two years and typically actively migrate to the ocean (with minimal rearing in the reservoirs) from April to July; however, limited migration can occur through November (Corps 2002b).

Sockeye salmon are unique in that they are the only species of Pacific salmon that depend entirely on higher-elevation tributary lakes for spawning and rearing (Gustafson et al. 1997). Snake River sockeye are native to Idaho’s high mountain lakes, but currently Redfish Lake in the Stanley Basin supports the only remaining substantial run of Snake River sockeye. In 1991 the Snake River sockeye captive broodstock program was initiated by the IDFG and NMFS to prevent species extinction. In 1999, the first hatchery-produced anadromous sockeye salmon returned to the program. In 2000, 257 adult sockeye returned up the Snake River to collection facilities on Redfish Lake Creek and the upper Salmon River at the IDFG Sawtooth Fish Hatchery. In 2010, the number of adult sockeye passing over Lower Granite Dam (presumed to be of Redfish Lake origin) was over 2,200. NMFS (2010) reported that adult sockeye returns to Lower Granite Dam in 2009 (1,219), almost entirely produced by the captive broodstock program, were nearly 9.7 times the 10-year average.

Wild Snake River juvenile sockeye salmon generally migrate downriver during April, May, and June. During sampling in May and June 2002, Bennett (2003) found 21 and 14, respectively, juvenile sockeye salmon rearing along shallow water shorelines in Lower Granite and Little Goose Reservoirs (Corps 2005). During recent sampling of the LSRP, Seybold and Bennett (2010) and Arntzen et al. (2012) found that juvenile sockeye salmon were infrequently caught in Lower Granite and Little Goose Reservoirs; however, some individuals were caught in the Ice Harbor Reservoir.

***Sockeye Critical Habitat* –** Essential Snake River salmon habitat consists of spawning and juvenile rearing areas, juvenile migration corridors, areas for growth and development, and adult migration corridors (58 FR68543). Critical habitat components for Snake River sockeye spawning, rearing, or overwintering are not designated in the LSRP.

The mainstem Snake River is designated as critical habitat for both juvenile and adult migration corridors for Snake River sockeye salmon. The essential components of the juvenile migration corridors include adequate substrate, water quality and quantity, water temperature, cover and shelter, food, space, and safe passage conditions (58 FR68543). For adult migration, the essential components are the same, with the exclusion of food. These components of designated critical habitat are needed during the juvenile and adult migrations, which occur between April and August (Figure 3-1).

Steelhead

The Snake River steelhead ***distinct population segment*** (DPS) includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho, and six artificial propagation programs (Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and Little Sheep Creek/Imnaha River). This DPS was listed as threatened in 1997.

Adult steelhead enter fresh water after spending one to four years in the ocean from May through October and spawn the following spring from March to June (Thurow 1987). Snake River steelhead are also known as summer-run steelhead because of the timing when they leave the ocean. The Snake River basin steelhead adults migrate upstream through the lower Snake River from late March through December with peak passage from September through to November (Corps 2002b). Steelhead migration timing is highly variable and these fish can be present at some life stage year round. Inland summer steelhead found in the Columbia River and Snake River basins can be subdivided into either A-run or B-run based on their upstream migration timing at Bonneville Dam. A-run summer steelhead pass upstream of Bonneville Dam from June to August, while B-run steelhead pass from late August to October (Wydoski and Whitney 2003). A-run steelhead passing Lower Granite Dam are predominantly one year of ocean age, while the B-run fish are predominantly two years of ocean age and typically three to four inches longer (Wydoski and Whitney 2003). A-run summer steelhead spawn throughout the Snake River system; B-run summer steelhead are produced only in the Clearwater and the Middle and South Fork Salmon Rivers (Wydoski and Whitney 2003). Some adult steelhead overwinter in the lower Snake River and resume their migration to spawning grounds the following spring as water temperatures begin to increase. Snake River steelhead are unlikely to spawn in the reservoir portion of the lower Snake River because they typically spawn in upstream tributaries the following spring from March to June (Thurow 1987). Unlike Pacific salmon, some steelhead do not die after spawning and may return to their natal streams multiple times to spawn (Wydoski and Whitney 2003).

NMFS (2008a) reported that population-specific adult abundance is generally not available for Snake River steelhead due to difficulties conducting surveys over much of their range. However, based on adult counts at Lower Granite Dam through 2004, abundance has been stable or increasing for both A-run and B-run populations (NMFS 2008a). However, with respect to natural production, it appears that A-run Snake River steelhead have generally replaced themselves, while B-run steelhead have not.

Steelhead fry typically emerge from April through mid-June, and rear in areas close to where spawning occurred in natal tributaries for 2 to 3 years before beginning their seaward migration (Corps 2002b). Out-migrants actively migrate through the lower Snake River and reservoirs from late April through June and typically rear very little during their out-migration. During recent sampling of the lower Snake River reservoirs, steelhead smolts were collected more frequently at the sampling stations in the lower reservoirs than at stations in the upper reservoirs (Seybold and Bennett 2010).

Iteroparity, the ability for anadromous fish to repeat-spawn, is a natural life history strategy that is expressed by some steelhead. These individuals may spawn more than once during their lifetime, returning to the ocean following each spawning episode. Current rates of observed steelhead iteroparity in the Columbia River Basin are severely depressed due to anthropogenic effects including the hydropower system and other habitat degradations.

Kelt, steelhead that have spawned and that are migrating downstream on their return to the ocean, must pass up to eight dams during their seaward migration. Kelt passage in the lower Snake River occurs in March through June (Corps 2005).

***Steelhead Critical Habitat* –** Within the LSRP and tributaries, the lower Snake River mainstem and reservoirs, the Tucannon, Deadman Creek, Almota Creek, and Alpowa Creek are designated as critical habitat for the Snake River steelhead DPS. Critical habitat attributes suitable for migration corridors as well as potential rearing or overwintering for Snake River steelhead are present in the LSRP.

In the lower Snake River reservoirs and contributing tributaries that support the DPS, components of designated critical habitat for juvenile migration are most suitable from mid-March to August. Although habitat components related to spawning are not present in the lower Snake River reservoirs, upstream tributaries support the majority of spawning in the Snake River basin from March through June. Some rearing, feeding, or overwintering may occur in the confluence area of the lower Snake River and Clearwater River (Corps 2005).

Pacific Lamprey

Pacific lamprey are primitive anadromous fish with cartilage instead of bones. Pacific lamprey pass upstream through the LSRP as adults when returning to spawn in tributaries and downstream as juveniles when migrating to the ocean. Although they are currently not listed under the ESA, they are considered a culturally significant resource to local tribes.

After spending 20 to 40 months in the Pacific Ocean, adult Pacific lamprey enter freshwater to spawn (Kan 1975) between April and June, and migrate to spawning areas by September (Close et al. 1995). Peak upstream dam passage typically occurs from July through September (Corps

1980-2000). Adult Pacific lamprey spawn in low-gradient stream reaches with gravel substrate, often at the tailouts of pools and riffles at depths of 1.0 to 13.1 feet and water velocities of 1.6 to 3.3 feet per second (fps) between April and July (Pletcher 1963, Luzier et al. 2011). There is no evidence that Pacific lamprey have used or currently use the mainstem Snake River for spawning or rearing (Corps 2005; Corps 2010a). However, spawning Pacific lamprey have been observed in small tributaries entering the lower Snake River reservoirs (Wydoski and Whitney 2003). After hatching, ammocoetes (larval juvenile lamprey) drift downstream to burrow into the substrate sand or mud. Ammocoetes rear in the substrate for 5 to 6 years until they metamorphose into migratory juvenile lamprey. During metamorphosis, they move from low-velocity areas with fine substrates to gravel in moderate current, then finally to gravel and boulder substrates where the currents are stronger (Luzier et al. 2011). Migratory juvenile lamprey migrate downstream after completing metamorphosis in late fall through spring, becoming parasitic on soft-scaled fish.

Juvenile lamprey habitat use in the lower Snake River is largely unknown. In response to concerns regarding potential impacts to juvenile Pacific lamprey as part of potential sediment management actions, a minimally obtrusive electroschocking sled with an optical camera was developed in 2011 to survey for the presence or absence of juvenile Pacific lamprey. Arntzen et al. (2012) conducted surveys at 24 sample sites within the LSRP to determine the presence of juvenile Pacific lamprey, including locations where sediment accumulation is interfering with commercial navigation, past dredge disposal sites, and reference sites. No lamprey were observed at any of the 24 sample sites during either of the two sample periods in late July and September 2011. It is plausible that juvenile lamprey were present but not observed with this electroshocking sled as it was recently developed for this specific objective and had a limited testing period prior to deployment. However, while juvenile lamprey are often found in silt/sand substrate (Arntzen et al. 2012), it is unlikely that juveniles are present in moderate or high numbers within the reservoirs of the lower Snake River due to a paucity of available rearing habitat. Juvenile lamprey typically have a patchy distribution related to other environmental variables such as water depth and velocity, light level, organic content, chlorophyll concentration, proximity to spawning area and riparian canopy (Moser et al. 2007).

3.1.4.3 Resident Fish

Resident fish species in the LSRP (see Table 3-1) include native and introduced riverine species as well as introduced species that are associated with ***lacustrine*** (lake-like) habitats (Bennett et al. 1983; Bennett and Shrier 1986; Hjort et al. 1981; Mullan et al. 1986). Coldwater resident species (such as trout and whitefish) that were once common in the Snake River basin have declined since the construction of the dams and their predominance has been replaced by cool- and warm-water species. This change in species composition has been due to the blockage of spawning migrations in some areas and modification of habitats (Mullan et al. 1986). Resident fish in the lower Snake River reservoirs occupy numerous habitats and often use different habitats for different life history stages (Bennett et al. 1983; Bennett and Shrier 1986; Hjort et al. 1981; Bennett et al. 1991).

Bass, crappie, bluegill, yellow perch, and carp use backwater areas for spawning and rearing (Bennett et al. 1983; Bennett and Shrier 1986; Hjort et al. 1981; Bennett et al. 1991; Zimmerman and Rasmussen 1981). The centrarchids (sunfishes, including bass and crappie) normally spawn in shallow water less than 6.5 feet deep (Bennett et al. 1983) while yellow perch generally utilize waters less than 10 feet deep (Stober et al. 1979). Spawning and incubation times vary between species; however, most of these backwater species spawn from May through mid-July (Corps 1999b).

Juvenile fish are found in abundance in backwater and open-water areas where flowing water is found. Adult distribution is generally similar to spawning and juvenile distribution, but often varies depending on feeding strategies of the particular species. Adults may occur throughout different habitats and move seasonally or daily to different areas (Bennett et al. 1983; Bennett and Shrier 1986; Hjort et al. 1981). Although adults use a variety of habitat types, lake-dwelling species are generally more abundant in shallow, slower-velocity backwater areas, and native riverine species occur abundantly in areas with flowing water found in the tailrace zone (Hjort et al. 1981; Bennett et al. 1983; Bennett and Shrier 1986; Mullan et al. 1986).

Bull Trout

Bull trout, listed as threatened under the ESA in 1998, are found primarily in colder streams, although individual fish are found in larger river systems throughout the Columbia River Basin (Fraley and Shepard 1989; Rieman and McIntyre 1993; Buchanan and Gregory 1997). The only subpopulation of bull trout associated with the watershed study area is found in the Tucannon River basin (Corps 2002b). Bull trout are also located in Asotin Creek, but it is unknown if they migrate downstream into the Snake River.

Bull trout typically spawn from August to September during periods of decreasing water temperatures. Migratory bull trout frequently begin spawning migrations as early as April and have been known to move upstream as far as 155 miles to spawning grounds. Temperature during spawning generally ranges from 39 to 51°F with redds often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989). Water temperatures exceeding 59°F are believed to limit bull trout distribution. Bull trout require spawning substrate consisting of loose, clean gravel relatively free of fine sediments.

Adult bull trout that migrate between the lower Snake River reservoirs and tributaries (***adfluvial***) generally spend about half of every year in the lower Snake River reservoirs from November to May. These fish most likely forage in shallow areas where the majority of prey exists. Depending on water conditions, bull trout will occupy deeper areas of the reservoir where water temperatures are cooler (45 to 54°F/7.2 to 12.2°C) and move to the surface when water temperatures drop to or below 54°F (12.2°C).

There have been several observations of adult bull trout passing Lower Monumental and Little Goose dams. From 1994 to 1996, 27 bull trout passed upstream in the fishladder (mainly in April and May) at Little Goose. At least six bull trout passed upstream in the fish ladder at Lower

Monumental and Little Goose in 1990 and 1992 (Kleist 1993). Kleist also observed one bull trout in 1993 in the fish ladder just downstream of the count window at Lower Monumental. One bull trout was captured in the Palouse River below Palouse Falls in 1998. These were likely migratory fish from the Tucannon River; however, one bull trout was observed at Lower Granite in 1998 that may indicate fluvial fish are migrating to other upstream populations (Corps 2002b). Bull trout have been observed passing downstream in the juvenile bypass system at lower Snake River dams, primarily at Little Goose, during the spring from April to June (Bretz 2011).

During recent sampling of shallow-water habitats in the lower Snake River reservoirs, single bull trout have been collected some years at a sampling site in the Lower Tucannon River (Seybold and Bennett 2010, Arntzen et al. 2012). Researchers speculated that this sampling was probably not indicative of widespread bull trout use of the lower Snake River reservoirs; instead, it is potentially indicative of an adfluvial life history strategy (Seybold and Bennett 2010). During sampling and tracking of bull trout in the lower Tucannon River, bull trout have been found to enter the lower Snake River during October to January, returning to their natal streams January to March (Bretz 2011, DeHaan and Bretz 2012).

Bull Trout Critical Habitat – In 2010, the USFWS finalized revisions to designated critical habitat for bull trout. Within the watershed study area, critical habitat was designated for Unit 15: Lower Snake River Basins (USFWS 2010). The entire LSRP is included in the designation.

Within designated critical habitat, the primary constituent elements for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering:

- Springs, seeps, groundwater sources, and subsurface water connectivity (known as ***hyporheic flows***) to contribute to water quality and quantity and provide thermal ***refugia***;
- Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers;
- An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish;
- Complex river, stream, lake, reservoir, and shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure;
- Water temperatures ranging from 36 to 59°F, with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life history stage and form, geography, elevation; ***diurnal*** and seasonal variation, shade (such as that provided by riparian habitat) and local groundwater influence;
- Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year (fish that have not reached the age

of one year) and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.03 inches in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions;

- A natural ***hydrograph***, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph;
- Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited; and
- Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

White Sturgeon

Upstream of Bonneville Dam in the Columbia River basin, white sturgeon are considered nonanadromous (ODFW and WDFW 1998). In the Snake River basin, white sturgeon historically made extensive seasonal migrations in response to changing habitats (Bajkov 1951). Today, however, they occur as residents, and do not migrate extensively due to blockage by dams (Corps 2005). This species is considered relatively abundant in the Snake River upstream of Lower Granite (Corps 2002b). The area upstream of Lower Granite is diverse with approximately 53 miles of reservoir habitat and approximately 160 miles of free-flowing habitat in the Snake and Salmon Rivers. Between the confluence with the Columbia River and Lower Granite Dam white sturgeon migrations are short and limited to within the reservoirs between dams. Landlocked populations of white sturgeon in the Snake River basin are classified as a species of special concern (Mosley and Groves 1990) for the states of Washington and Idaho.

Studies in the Columbia River basin have shown that juvenile white sturgeon diets are highly dependent on benthic invertebrates, particularly the amphipod *Corophium salmonis* (McCabe et al., 1992a; McCabe et al. 1992b). Sprague et al. (1993) indicated that white sturgeon may be feeding on organisms in the water column rather than exclusively on organisms associated with the substrate. ***Corophium species*** (river drift organisms) were the predominant prey item eaten by young-of-the-year and juvenile white sturgeon in two Columbia River impoundments and the Lower Columbia River (Sprague et al. 1993; McCabe et al. 1992a; Muir et al. 1988). *Corophium* species abundance in Lower Granite Reservoir appear low (Bennett et al. 1991). Crayfish and chironomid species were dominant food items identified from white sturgeon stomachs in the middle Snake River (Cochnauer 1981); crayfish and chironomid species are abundant near the upper end of the Lower Granite Reservoir (Bennett et al. 1991). The presence of these food species may explain the high density of juvenile white sturgeon in the upper section of Lower Granite Reservoir relative to lower areas of the reservoir.

Presence of young-of-the-year and high abundance of juvenile white sturgeon in Lower Granite Reservoir indicate recruitment has been occurring in the Lower Granite to Hells Canyon population. The high abundance of juvenile and young-of-the-year fish near the upper end of Lower Granite Reservoir also suggests that the reservoir may serve as rearing habitat. McCabe and Tracy (1993) suggested that wide dispersal of white sturgeon larvae allowed more use of feeding and rearing habitats while minimizing competition. Lepla (1994) assumed no spawning occurred in Lower Granite Reservoir as velocities measured in the reservoir (0.0 to 1.96 fps) are below threshold levels perceived to elicit spawning (3.28 fps) (Anders and Beckman 1993). However, white sturgeon may spawn in higher-velocity habitats with sandy substrate in the unimpounded, free-flowing reach of the lower Snake River above the river/reservoir pool transition zone of Lower Granite near RM 147 (Lepla 1994).

Seasonal changes in distribution of white sturgeon occur in Lower Granite Reservoir (Lepla 1994). Relative numbers of white sturgeon in the upper section of the reservoir increased from May through November, implying upriver redistribution/movement as the season progressed from summer to fall. However, multiple comparison tests indicated seasonal use of mid- and lower reservoir transects was not significant, with the exception of RM 116.8 (1.6 RM upriver of Knoxway Bay). The number of white sturgeon sampled at RM 116.8 was highest (0.31 fish/hr) during April-July 1991 and declined sharply as summer progressed. Catch rates at RM 116.8 in 1990 were low and were also similar in 1992 (Bennett et al. 1994, 1995b). Catch rates at remaining mid- and lower reservoir locations were low regardless of season. Movements from 0 to 16 miles were observed from recaptured white sturgeon with the majority of fish traveling 0.6 to 3.1 miles. Differences in fish size did not appear to affect distance traveled in the reservoir. Approximately 65 percent of the fish recovered were collected within the upper 6.2 miles of Lower Granite Reservoir where densities of white sturgeon were highest.

Predatory Species

During recent sampling of all four reservoirs in the lower Snake River, studies found that smallmouth bass were the most common predator of all of the eight predatory species (northern pikeminnow, smallmouth and largemouth bass, walleye, yellow perch, white and black crappies, and channel catfish) (Seybold and Bennett 2010). Smallmouth bass were most abundant in Lower Granite Reservoir, while northern pikeminnow were more abundant at sampling stations downstream of Lower Granite Dam. Walleye were caught only in Lower Monumental and Ice Harbor Reservoirs. Largemouth bass, crappies, yellow perch, and channel catfish were most frequently caught in Lower Monumental and Ice Harbor Reservoirs, though catch rates were low.

Larger predatory individuals may seasonally forage for juvenile salmonids residing in, or migrating through, the reservoirs. However, other than juvenile fall Chinook salmon, fish predation appears to be relatively low for yearling Chinook salmon and steelhead (Corps 1999b, 2002b). Due to their abundance, the most prevalent predator on juvenile salmonids is likely smallmouth bass (Corps 1999b). Smallmouth bass catch rates were high in created shallow-water habitats in the lower Snake River; however, no yearling or subyearling Chinook salmon were identified in piscivore stomachs (Seybold and Bennett 2010). This may be attributed to the fact that most smallmouth bass were caught in the fall, and outmigrating salmonid juveniles were only abundant during spring. Further, approximately half of the smallmouth bass captured were below the predatory size threshold of 6 inches (i.e., too small to prey on juvenile salmonids).

Recent sampling by Arntzen et al. (2012) found that smallmouth diets consisted of less than six percent of juvenile Chinook salmon by weight, indicating that salmonids were not a significant portion of their diet at shallow-water habitat sites.

Recently, predation by northern pikeminnow on juvenile salmonid migrants in the Columbia River Basin has been reduced from 8 percent to 6 percent of all predation-related mortality. This reduction has been accomplished by the Sport Reward Program under the Northern Pikeminnow Management Program (NMFS 2004) and by scientific sampling funded by the Bonneville Power Administration (BPA) (Corps 2002b). Both of these programs removed significant numbers of northern pikeminnows from the basin.

Bull trout are also predatory species present in the LSRP and were addressed previously in this section.

3.1.5 Threatened and Endangered Species

Five anadromous salmon populations and three anadromous steelhead trout populations present in the LSRP are listed as threatened or endangered under the ESA (Table 3-2). These include Snake River sockeye, Snake River spring/summer Chinook, Snake River fall Chinook, upper Columbia River spring Chinook, Snake River steelhead, and upper and middle Columbia River steelhead. The presence of Columbia River stocks is likely limited to infrequent straying in the lower Snake River. Snake River basin stocks occur throughout the LSRP.

Table 3-2 below lists the populations within the watershed study area that are threatened or endangered. Descriptions of the life histories and use of the LSRP and designated critical habitat are provided in Section 3.1.4 above.

Table 3-2. ESA-Listed Anadromous Populations Present in the LSRP

Population (ESU)	Designation
Snake River Sockeye	Endangered
Snake River Spring/Summer Chinook	Threatened
Snake River Fall Chinook	Threatened
Snake River Steelhead	Threatened
Upper Columbia River Spring Run Chinook*	Endangered
Middle Columbia River Steelhead*	Threatened
Upper Columbia River Steelhead*	Threatened
Bull Trout	Threatened

**Possible occurrence in the Snake River below Ice Harbor Dam of strays entering the mouth from the Columbia River*

3.1.6 Current Immediate Need Action

In addition to the descriptions above of affected environment that involve the entire project watershed study area, the following description provides site-specific environmental resources for consideration in the current immediate need action. The current immediate need action would involve maintenance dredging at four locations in the lower Snake River and lower Clearwater River in Washington and Idaho consistent with the proposed long-term PSMP and concurrent with the PSMP's implementation. These sites are described in Appendix L and include the downstream navigation lock approach for Ice Harbor Dam, the federal navigation channel in the vicinity of the Snake River/Clearwater River confluence, and maintenance sites at the Port of Clarkston and Port of Lewiston. The proposed in-water disposal site for the upstream areas is near Knoxway Canyon in Lower Granite Reservoir and would be used to create shallow-water rearing habitat for Snake River fall Chinook salmon.

Substrates for the Ice Harbor downstream navigation lock approach are composed primarily of cobble and are in an area that typically has relatively high velocities associated with tailrace environments. Substrates associated with the federal navigation channel in the vicinity of the Snake River/Clearwater River confluence and the berthing areas for the Port of Clarkston and Port of Lewiston are primarily composed of substrates of silt. Aquatic resources in the vicinity of the Ports are identical to those identified for the federal navigation channel in the vicinity of the Snake River/Clearwater River confluence area. Substrates of the Knoxway Canyon disposal area is primarily composed of silt and sand.

Wetlands are not present at the current immediate need action sites or the in-water disposal site. Sanctuaries and refuges, mud flats, vegetated shallows, and riffle and pool complexes are not present at the current immediate need action sites or in-water disposal site.

3.2 Terrestrial Resources

This section describes the generalized vegetative communities, terrestrial wildlife presence and use, and ESA-listed terrestrial wildlife species in the geographical area of the potential affected environment.

3.2.1 Vegetation

The Snake River corridor exists within the high desert steppe and shrub-steppe communities of the Columbia Basin. The vegetation is dominated by a variety of grasses with greater or lesser amounts of sagebrush and other semiarid shrub species (Franklin and Dyrness 1973). Trees are practically nonexistent in this arid region, except at scattered sites within riparian areas along the river. Big sagebrush (*Artemisia tridentata*), rabbitbush (*Chrysothamnus* spp), and antelope bitterbush (*Purshia tridentata*), dominate the shrub layer, covering 10-60 percent of the ground. A variety of native bunchgrasses, herbaceous plants, moss and crust-forming lichens dominate groundcover. In disturbed areas, cheatgrass has replaced native plants and ground cover can approach 100 percent in many areas. Within the shrub-steppe many wildflowers are abundant and most bloom in the spring after the winter rains.

The historic riparian vegetation of the lower Snake River was lost to inundation by construction of four hydropower dams (Ice Harbor, Lower Monumental, Little Goose and Lower Granite) and the resulting reservoirs. Thus, most riparian areas along the reservoir shorelines and the lower reaches of their tributaries are highly altered. Non-native invasive species such as false indigo (*Amorpha fruticosa*) and Russian olive (*Eleagnus angustifolia*) are often dominant species within the riparian vegetation. Black locust (*Robinia pseudoacacia*) is also frequently present. The herbaceous layer is frequently dominated by dense monoculture stands of reed canarygrass (Phalaris arundinacea), a non-native species that has displaced much of the historic native herbaceous component. A wide variety of invasive weed species are common to dense along the shorelines and adjacent slopes, including poison hemlock (Conium maculatum), Canada thistle (Cirsium arvense), teasel (*Dipsacus fullonum*), purple loosestrife (*Lythrum salicaria*), spiney cocklebur (*Xanthium spinosum*), perennial pepperweed (*Lepidium latifolium*), and sweetclover (*Melilotus spp*.) (Carey and Clark 2013).

Natural riparian vegetation in the region is typically comprised of black cottonwood (Populus trichocarpa), white alder (*Alnus rhombifolia*), black hawthorn (*Crataegus douglasii*), tree-forming willows such as Pacific willow (*Salix lasiandra*) and peachleaf willow (*S. amygdaloides*), shrubby, thicket-forming willows, namely coyote willow (*S. exigua*), and a variety of additional, native shrub species (Carey and Clark 2013).

Most of the islands that were a valuable part of the original riparian complex were also inundated. The current riparian area along the river shoreline consists of a narrow band (7 to 20 feet on average) of vegetation (Bailey 2008). Because of the position of most HMUs along rivers, the vegetation growing near and adjacent to the bank can be considered a riparian habitat, even though most sites are essentially former uplands that became "riparian" when water levels rose after dam construction. However, even though these sites have a land/water interface, the semi-arid climate allows for only a small margin of riparian vegetation to grow naturally (Bailey 2008). Hence, several HMUs are irrigated with river water through a pumping system and a series of high-pressure sprinkler heads. This water is delivered during the growing season, which leads to significant plant growth within the circular range of the rotating sprinkler heads. Ultimately, this pattern of water delivery creates a mosaic of dense, lush vegetation in a matrix of otherwise semi-arid shrubland.

There are a variety of plant communities present on all HMUs, reflected in the diversity of vascular plants found along the lower Snake River. The riparian fringe is a combination of small patches of riparian forest dominated by contiguous shrub communities. The two significant native plant communities that grow along riparian edge within this area are the black cottonwood community and coyote willow/false indigo community. Other dominant trees along the riparian edge are non-native black locust and the native white alder. However, the riparian areas have been so impacted that only very small groves or single trees are now growing along the riverbank. As the elevation increases from the river’s edge, the riparian fringe ends quickly, changing to drier grass-dominated communities and sagebrush uplands. The upland is dominated by the sagebrush and rabbitbush community in non-irrigated areas. In some HMUs, basaltic cliff bands contain unique herbaceous plant communities. Wetlands and ponds contained within several HMUs also consist of some distinct plant communities.

3.2.1.1 Typical Vegetation Community Types

Black Cottonwood Community: Black Cottonwood requires abundant, well-oxygenated water for good growth. It is very tolerant of flooding but can not tolerate standing water that is collected in stagnant pools. It also has a low drought tolerance, and therefore is most abundant on sand bars, floodplains, stream-banks and terraces throughout Eastern Washington. This plant community occurs on large rivers and was historically more prevalent before dam construction. The major association present on the lower Snake River is the Black Cottonwood/ Red-osier Dogwood association. Other species that are dominant in this association include other shrubs and horsetail (Equisetum species).

Coyote Willow / False Indigo Community: This community grows along the riparian edge in a narrow band from 2 -5 meters (average width) on the shore of the Snake River. It is a very important association for bank stabilization and controlling erosion. This association will grow wider and cover low riparian benches; sometimes with other mesic herbaceous forbs such as sedges (Carex species) and horsetail (Bailey 2008). Willow communities most often grow along broad valleys with little gradient (Kovalchik and Clausnitzer 2004). False indigo has replaced other native species that historically grew with willow, and has become the dominant species in the palustrine shrub-scrub eco-type.

Herbaceous Wetland Community: Herbaceous plants found in river and pond edges and wetland communities form dense monotypic stands of dominant wetland plants (Bailey 2008). The most common native species are cattail (Typha latifolia) and great bulrush (Scirpus validus). Reed canary grass (Phalaris arundinacea) and phragmites (Phragmites communis), are invasive species found growing profusely in recently disturbed areas, and have come to dominate many of the wetland areas. Other more interesting and less profuse wetland plants are the sedges. Water sedge (Carex aquatilis) is a wetland component in some HMU areas.

Sagebrush / Rabbitbush Community: This community is dominant in the dry upland areas that have not been cultivated or irrigated. This shrub association grows with either bunchgrasses or cheatgrass depending on how disturbed the site is. Undisturbed shrub-steppe has very little bare ground and a larger proportion of grasses than shrubs. However, with disturbance and particularly grazing, sagebrush coverage increases and highly flammable invasive annual cheatgrass replaces the native bunchgrasses (Turner and Gustafson 2006). Differences in moisture, soils, and exposure create microclimates that favor different flowering plants. There are also a number of native and introduced herbaceous plants and wildflowers found growing within these lands. Some of the dominant native bunchgrasses are bluebunch wheatgrass (Agropyron spicatum), Sandberg’s bluegrass (Poa sandbergii), and intermediate wheatgrass (Agropyron intermedium).

Native Grassland Community: This diverse grassland is dominated by native grass species and interspersed with many wildflowers. The most notable area of this community type is on Refuge Island (also referred to as Keger Island), and it persists due to the fact that it is an island and is relatively undisturbed. Grass species most prevalent are thread and needle grass (Stipa comata), bluebunch wheatgrass (Agropyron spicatum), with some cheatgrass. The forbs that are dominant were arrowleaf balsamroot, and phlox (Phlox longifolia). Others are larkspur (Delphinium nuttalianum), green-banded mariposa lily (Calochortus macrocarpus), snowy buckwheat (Eriogonum niveum), phacelia (Phacelia linearis), white microcera (Plectritis macrocera), bastard toadflax (Comandra umbellate), yarrow (Achillea millefolium), and Lomatium species.

A cover-type map of the lower Snake River was developed in 2014) showing current cover vegetation classification. Grass/forbs encompass approximately 30 percent of the land along the lower Snake River. The next-highest cover type is low density shrub-steppe at approximately 8 percent. Riparian cover types including palustrine forest, palustrine scrub-shrub and palustrine emergent accounting for 4 percent cover combined.

3.2.2 Terrestrial Wildlife

The geographical area of the potential affected environment includes land adjacent to the LSRP and provides habitat for numerous birds, reptiles, amphibians, small non-game-mammals, furbearers, and big game animals. The following section presents a general description of the wildlife species present in the terrestrial wildlife potential affected environment.

Table 3-3. Number of Terrestrial Wildlife Species Known to Occur in the Watershed Study Area

Wildlife Species Type	Lower Snake River[1]
Mammals	80
Birds	224
Amphibians	12
Reptiles	16
Total	332

[1]Source: Southeast Washington Subbasin Planning Ecoregion Wildlife Assessment (Ashley 2004) Lower Snake

Much of the wildlife in the potential affected environment is generally found to be dependent on tree-shrub riparian habitat associated with the reservoirs and river systems (Lewke and Buss 1977). In general, habitats associated with water, e.g., riparian and wetland areas, support higher population densities and species numbers than dry grassland and shrub community habitat. Habitats associated with the river generally support trees/shrub or dense hydrophytic emergent grass-forb cover, which provides more structurally complex habitat and more abundant forage resources than adjacent uplands.

The reservoirs and river systems provide food, water, and cover for numerous wildlife species and are especially important where moisture is extremely limited. Riparian areas serve as important wildlife habitat and are integral to the overall function of river ecosystems (Corps 2002a). Wildlife that typically uses riparian and wetland habitats associated with the LSRP can be divided into four main groups: birds, mammals, and amphibians and reptiles.

Birds

Over 30 species of waterfowl have been documented to occur in the project area (Asherin and Claar 1976; Lewke and Buss 1977; Rocklage and Ratti 1998). Resident breeding waterfowl numbers are generally low except for Canada geese (*Branta canadensis*), mallard (*Anas platyrhynchos*), and American widgeon (*Anas americana*), which occur throughout the projects. Waterfowl nesting is limited within the lower Snake River reservoirs because of a shortage of suitable nesting habitat.

Songbirds (also referred to as ***passerines*** or perching birds) represent the most diverse category of birds. Songbirds exhibit a wide range of seasonal movements; some species are year-round residents in some areas and migratory in others and still other species migrate hundreds of miles or more (Lincoln et al. 1998). Nesting occurs in vegetation from near ground level to the upper canopy of trees. Some species, such as the thrushes and chickadees, are relatively solitary throughout the year, while others such as swallows and blackbirds, may occur in small to large flocks at various times of the year. Foraging may occur in flight (i.e., swallows and swifts), in vegetation, or on the ground (i.e., warblers, finches, thrushes).

Upland game birds in the potential affected environment include ring-necked pheasant (*Phasianus colchicus*), chukar (*Alectoris chukar*) and, California quail (*Callipepla californica*). All of the gallinaceous birds within the potential affected environment are year-round residents and are relatively common. They are ground-dwelling birds that utilize myriad habitat types. Quail and pheasant use riparian zones, upland shrub-steppe and agricultural fields for roosting, foraging and nesting. Chukars use the basalt cliffs and upland grass and shrub-steppe.

Raptors (birds of prey) in the potential affected environment include hawks, falcons, eagles, and osprey, owls, and vultures; many of these species represent the top avian predators in the area. Common species include the sharp-shinned hawk (*Accipiter striatus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), bald eagle (*Haliaeetus leucocephalus*), and osprey (*Pandion haliaetus*). Owls are also present in the area, including the great horned owl (*Bubo virginianus*), short-eared owl (*Asio flammeus*), and burrowing owl (*Athene cunicularia*). The raptors and owls vary considerably among species with regard to their seasonal migrations; some species are nonmigratory (year-round residents), others are migratory in the northern portions of their ranges and nonmigratory in the southern portions of their ranges, and still other species are migratory throughout their ranges.

Riparian areas provide perching and nesting opportunities, and concentrated prey (e.g., small mammals, insects, songbirds) for raptors (Asherin and Claar 1976; Tabor 1976; Asherin and Orme 1978). In general, cliffs and large trees along riverbanks typically support diverse raptor populations. The lower Snake River reservoirs include cliff areas in proximity to the rivers that provide potential nest and roost sites for bald eagles, red-tailed hawks, osprey, and prairie falcons (Payne et al. 1975; Asherin and Claar 1976; Tabor 1976).

The LSRP lies within the Pacific Flyway, which includes the Pacific Coast Route and occurs between the eastern base of the Rocky Mountains and the Pacific coast of the United States. This ***flyway***, or migratory route, encompasses the states of California, Nevada, Oregon, and Washington, and portions of Montana, Idaho, Utah, Wyoming, and Arizona. Birds migrating south from Canada pass through portions of Montana and Idaho and then migrate either eastward to enter the Central Flyway, or turn southwest along the Snake and Columbia River valleys and then continue south across central Oregon and the interior valleys of California (Birdnature 2004). This route is not as heavily used as some of the other migratory routes in North America (Lincoln et al. 1998).

Mammals

Small, non-game mammals are relatively common throughout the potential affected environment. Small mammals are defined as those species that are primarily nocturnal and weigh less than 200 grams. Common species include deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), Great Basin pocket mouse (*Perognathus parvus*), house mouse (*Mus musculus*), montane vole (*Microtus montanus*), Townsend's big-eared bats (*Corynorhinus townsendii*), Western pipistrelle (*Pipistrellus hesperus*), pallid bat (*Antrozous pallidus*), and Western small-footed myotis (*Myotis ciliolabrum*), (Asherin and Claar 1976;

Johnson and Cassidy 1997; Rocklage and Ratti 1998). These small mammals use a variety of available habitat throughout the area. Based on a recent survey conducted in 2010, rodents were captured in riparian cover types as well as shrub-steppe. Bats in the potential affected environment utilize rock cliffs, caves and trees near water as roosting habitat.

Furbearers occur in the potential affected environment and include beaver (*Castor canadensis*), river otter (*Lontra canadensis*), coyote (*Canis latrans*), and raccoon (*Procyon lotor*). In general, the furbearers are dependent on riparian corridors and vegetated draws along the Snake River for den sites and foraging areas. Beaver distribution within the area is strongly associated with the presence of cottonwoods and protected areas (Asherin and Claar 1976). River otter use the project reservoirs and associated rip-rap for foraging and denning.

Big-game animals are found throughout the watershed study area. These large mammals include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and cougar (*Puma concolor*). Mule deer make up approximately 80 percent of the deer population with the white-tailed deer making up the remaining 20 percent (Asherin and Claar 1976). Deer use a wide variety of habitats including shrub communities for cover and fawning as well as grassland for foraging. These species utilize riparian corridors as migration routes as well as foraging areas. Cougars will use a wide range of habitat that contains prey species. Dense riparian trees and shrubs provide cover and ambush areas for cougars.

Amphibians and Reptiles

Amphibians in the potential affected environment include frogs, toads, and salamanders that occupy a variety of wildlife habitat types, including riparian forest and scrub-shrub, wetlands and grasslands. Common species include the Pacific tree frog (*Pseudacris regilla*), American bullfrog, (*Rana catesbeiana)* long-toed salamander (*Ambystoma macrodactylum*) and western toad (*Bufo boreas boreas*). Other species that are known to occur along the Snake River include the Great Basin spadefoot (*Spea intermontana*) and Rocky Mountain toad (*Bufo woodhousii woodhousii*). Amphibians use riparian corridors for migration, forage and shelter.

Reptile species in the area include a wide variety of turtles, snakes, and lizards. Commonly occurring species include the Great Basin gopher snake (*Pituophis catenifer deserticola*), northern desert night snake (*Hypsiglena chlorophaea*), northern Pacific rattlesnake (*Crotalus oreganus oreganus*), western yellow-bellied racer (*Coluber constrictor mormon*), western skink (*Plestiodon skiltonianus skiltonianus*), and painted turtle (*Chrysemys picta*). Reptiles utilize all habitat areas from wetland and riparian zones to dry upland shrub-steppe and rock talus.

3.2.2.1 Habitat Management Units

As part of the Lower Snake River Fish and Wildlife Compensation Plan, a terrestrial wildlife mitigation program was initiated to compensate for habitat lost in the development of the LSRP. The plan called for the creation of a number of HMUs to provide high-quality upland habitat for a variety of wildlife and for the acquisition of additional land to fully compensate for upland game habitat losses that resulted from the construction of the lower Snake River dams (Corps 2004). HMUs help address the LSRP-authorized purposes of fish and wildlife conservation.

HMUs are Corps-owned lands designated primarily to be managed as wildlife habitat. These areas provide essential habitat for the vast array of plants and wildlife species that use the LSRP and adjacent areas. The HMU habitats were developed either purposefully by restoration activities, including irrigation intake facilities, or established naturally over time through long periods of normal reservoir conditions. There are 62 designated HMUs along the lower Snake River; 11 of these are irrigated to provide intended habitat conditions and 51 are dry-land (nonirrigated) (Corps 2002a). Sedimentation around some HMU irrigation intakes can interfere with their operation.

3.2.3 Threatened and Endangered Species

The potential affected environment provides habitat that supports species of terrestrial plants and animals that are threatened, endangered, or of special concern at the national, regional, and state level. Currently, there are 15 terrestrial plant and animal species that are listed under these criteria within the LSRP and adjacent areas. However, based on known occurrences and habitat requirements, only 12 of the 15 species could potentially occur within the geographical area of the potential affected environment (Table 3-4).

Table 3-4. Lower Snake River ESA-listed Species (Threatened, Endangered, Proposed, Candidate)

Species	Listing Status
Burrowing owl (*Athene cunicularia*)	Federal SOC[1]; state candidate
Bald eagle (*Haliaeetus leucocephalus*)	Federal SOC; state sensitive
Golden eagle (*Aquila chrysaetos*)	State candidate
Ferruginous hawk (*Buteo regalis*)	Federal SOC; state Threatened
Loggerhead shrike (*Lanius ludovicianus*)	Federal SOC; state candidate
American white pelican (*Pelecanus erythrorhynchos*)	State Endangered
Black-tailed jackrabbit (*Lepus californicus*)	State candidate
Washington ground squirrel (*Urocitellus washingtoni*)	Federal SOC; state candidate
Western toad (*Bufo boreas*)	Federal SOC; state candidate
Sagebrush lizard (*Sceloporus graciosus*)	Federal SOC; state candidate
Ute ladies'-tresses (*Spiranthes diluvialis*)	Threatened
Spalding's catchfly (*Silene spaldingii*)	Threatened

[1]SOC = Species of Concern

3.2.3.1 Burrowing Owl

The burrowing owl is a small owl that inhabits grassland and shrub-steppe habitats in the western U.S., including eastern Washington. In the past few decades burrowing owl range in Washington has diminished compared to historical levels and they have become uncommon to rare outside of Benton, Franklin, Grant, and western Adams counties (WDFW 2013). Burrowing owls use the abandoned burrows of mammals such as badgers and ground squirrels for nesting, food caching, and roosting. General reductions in the numbers of ground squirrels, marmots and badgers are a potential factor for the population decline in Washington (Conway and Pardiek 2006). Loss of habitat to the intensification of agriculture and development has also affected the species (WDFW 2013).

WDFWs Priority Habitat and Species (PHS) data indicate burrowing owl occurrence in the lower Snake River area; therefore, they could potentially occur in the project vicinity. Burrowing owls inhabit abandoned burrows of mammals that inhabit upland areas and therefore are not often found in riparian areas along the Snake River, but could be present throughout for roosting and foraging.

3.2.3.2 Bald Eagle

Bald eagles (*Haliaeetus leucocephalus*) live near rivers, lakes, reservoirs, estuaries, marshes and some seacoasts where they can find fish, their staple food. They can be found in all the forested parts of Washington throughout the year, but they are much more abundant in the cooler, maritime region west of the Cascade Mountains than in the more arid eastern half of the state.

Bald eagles require a good food base, perching areas, and nesting sites. Breeding bald eagles need large trees near open water with a relatively low level of human activity. In winter, the birds congregate near open water, using tall trees for spotting prey and night roosts for sheltering. Bald eagles are opportunistic foragers but feed most consistently on fish and waterfowl which are usually associated with large, open expanses of water (Stinson et al. 2007).

The bald eagle population in Washington has made a dramatic recovery in recent decades since its' listing under the federal Endangered Species Act and the banning of the pesticide DDT. The species was finally removed from the Endangered Species Act in August 2007. Bald eagles continue to be affected by shoreline development, fisheries, and forest management and there is a continued need to conserve nesting habitat and foraging opportunities.

Roosting areas occur along the Columbia River including the Hanford Site outside the project vicinity; there are no known nesting sites along the lower Snake River (Stinson et al. 2007). Bald eagles could potentially occur intermittently in the project area while migrating through or foraging.

3.2.3.3 Golden Eagle

Golden eagles (*Aquila chrysaetos*) build nests on cliffs or in the largest trees of forested stands that often afford an unobstructed view of the surrounding habitat. They use both existing and newly constructed nests formed from sticks with added soft material to create strong, flat- or bowl-shaped platforms. They typically avoid urban and developed areas and prefer predominantly open environments which allow for better foraging. Golden eagles forage in grasslands and shrublands and prey primarily on mammals such as jackrabbits, cottontails, ground squirrels, and marmots, and secondarily on birds such as ring-necked pheasants and chukars.

Threats to golden eagles in Washington include lead poisoning from feeding on injured or dead waterfowl, small mammals, or deer shot by hunters. Declining prey bases, including jackrabbits, ground squirrels, and marmots are another threat to golden eagles and are commonly caused by habitat loss, alteration, and fragmentation, as well as past and ongoing control efforts (WDFW 2013).

Golden eagles may be present roosting or foraging in the project area. WDFW PHS data indicates a breeding area in the vicinity of the Lower Granite pool.

3.2.3.4 Loggerhead Shrike

The loggerhead shrike is a small predatory bird that hunts from perches and sometimes impales its prey on thorns or barbed wire. Shrikes do not possess large feet and talons like raptors, and this habit is an adaptation to eating large prey. In Washington, loggerhead shrikes are primarily a breeding resident of shrub-steppe habitat in the eastern part of the state and use open habitat with scattered shrubs during both breeding and non-breeding seasons. Loggerhead shrikes are generalists, feeding on any animal they can subdue, including insects, small mammals, birds, reptiles, and amphibians. During the breeding season in Washington, shrikes are largely insectivorous.

Loggerhead shrikes typically nest in shrub-dominated plant communities with a mosaic of tall shrubs, particularly old sagebrush or bitterbrush, and openings of grass or sand dune, and rarely in grasslands, and areas dominated by rabbitbrush and cheatgrass (Poole 1992). Poole (1992) also noted that shrikes did not nest in riparian zones or within 500 m of water, possibly to avoid nest predation by magpies and ravens.

WDFW PHS data indicate the presence of loggerhead shrikes in the project vicinity. Although they are not known to nest in riparian areas, as mentioned above, this species could be present in foraging in upland disposal sites.

3.2.3.5 Ferruginous Hawk

Ferruginous hawks inhabit semi-arid and prairie ecosystems of North America. In Washington, nests have been found in steppe or shrub-steppe habitat. Franklin and Benton counties together account for about 60 percent of the ferruginous hawk territories in the state (WDFW 2013). Nests can be built on cliffs, rock outcrops, small trees, transmission line towers, and artificial platforms. Territories often contain more than one nest, which allows the pair to relocate if disturbed early in the nesting cycle.

Ferruginous populations can exhibit numeric responses to changes in cyclic prey such as ground squirrels. Significant loss of hares and ground squirrel species in Washington and dietary shifts to insects and smaller mammals suggest that the declining population trend of ferruginous hawks may continue (WDFW 2013).

Ferruginous hawks are known to inhabit the Hanford Site, and WDFW PHS data indicate their presence in the project vicinity and in occupied territories north of the lower Snake River (WDFW 2013).

3.2.3.6 American White Pelican

American white pelicans breed primarily on isolated islands in freshwater lakes and rivers, and forage in shallow areas of inland marshes, lakes, and rivers. In 1994, a breeding colony was established on Crescent Island, which was constructed for nesting birds in the Columbia River, Walla Walla County in 1985 (Ackerman 1994, 1997). In 1997, pelicans began nesting on nearby Badger Island, which is a part of McNary National Wildlife Refuge. Since that time, the Badger Island colony has grown to over 1,000 breeding pairs and there is little current use of Crescent Island.

American white pelicans feed largely on nongame fish, amphibians, and crustaceans (Evans and Knopf 1993); many of these are small schooling fish, but larger bottom fish, salamanders, and crayfish are also eaten. White pelicans do not dive for their prey like brown pelicans do; foraging occurs in shallow marshes, rivers, and lake margins in summer and shallow coastal marine waters in winter. Foraging areas can be 30 miles or more from breeding colonies. Non-breeding white pelicans on the Columbia and Snake rivers are sometimes observed foraging below hydroelectric dams, including Ice Harbor. They may be foraging on out-migrating juvenile salmonids, but their impact on salmonid smolts is not well understood.

Inland waters of eastern Washington also support significant numbers of non-breeding white pelicans year-round, especially along the Columbia River from The Dalles to Chief Joseph Pool (WDFW 2013). The only known breeding colony in the region is on Badger Island in the Columbia River outside the project area, but non-breeding birds congregate and forage in the tailrace and gravel bars downstream of Ice Harbor Dam.

3.2.3.7 Black-tailed Jackrabbit

Historically, black-tailed jackrabbits were not present in Washington, but they moved into Walla Walla County in the late 1800s and spread north to the Snake River, and beyond it when the Snake froze over around 1908 (WDFW 2013). Currently, black-tailed jackrabbit distribution is concentrated in the semi-arid Columbia Plateau shrubsteppe and grassland habitats, and extends south into Oregon. Areas used include sagebrush- and rabbitbrush-dominated habitats as well as areas of mixed grassland and shrub (Johnson and Cassidy 1997). Black-tailed jackrabbits tend to occupy areas with shrubs and grass. Their diet varies seasonally, consisting of a higher percentage of shrubs in winter, forbs in spring, and mostly grasses with almost no shrub ingestion in summer (WDFW 2013).

Animals known to prey on black-tailed jackrabbits include coyotes, badgers, bobcats, golden eagles, several species of hawk, owls, rattlesnakes, and gopher snakes. Additionally, they are at considerable risk for increased mortality from vehicle traffic, persecution, and harassment by pets. Jackrabbits are vulnerable to loss of habitat connectivity from all four major connectivity threats: clearing and vegetation removal, development, roads and traffic, and the presence of people and domestic animals (WDFW 2012).

3.2.3.8 Washington Ground Squirrel

The Washington ground squirrel spends much of its time underground. Adults emerge from hibernation between January and early March, depending on elevation and microhabitat conditions, with males emerging before females. Their active time is spent in reproduction and fattening for their six-month or longer dormancy. Adults return to their burrows by late May to early June, and juveniles return about a month later. Washington ground squirrels produce only one litter of young per year due to their limited period of activity and reproduction.

Washington ground squirrels occur in dry grassland or in patches of grass and other herbaceous plants within low open sagebrush. They prefer deep, loose soil, which they need for digging burrows. The greater part of their current range is uncultivated steppe in southeastern Washington and northeastern Oregon. There is one existing colony in Walla Walla County which is in the project area; there are additional colonies in nearby Adams, Douglas, Franklin, Grant, and Lincoln counties.

3.2.3.9 Western Toad

The western toad (*Bufo boreas*) occurs in a variety of terrestrial habitats including mountain meadows, prairies and, less commonly, in heavily forested areas. They appear absent from most of the shrub steppe and steppe zones with the exception of the canyon grasslands in southeast Washington. Adult toads are primarily terrestrial, but often occur near water bodies, especially in drier climates. Breeding occurs in areas with usually permanent water bodies including wetlands, ponds, lakes, reservoir coves and off-channel habitats of rivers. Anecdotal reports indicate that many populations return to the same egg-laying location every year (WA Herp Atlas 2014).

WDFW PHS data and the Washington Herp Atlas distribution maps show that the western toad is present in some areas of the project vicinity, particularly near the Lower Granite pool and the confluence of the Clearwater areas.

3.2.3.10 Sagebrush Lizard

This is a small (usually 2-3 inches) gray or brown lizard that primarily inhabits sand dunes and other sandy habitats that support shrubs and have large areas of bare ground. Sagebrush lizards bask in the morning and late afternoon; typically, they can be seen on the ground at the edge of shrubs or other vegetation that provide cover from predators. When ground temperatures become hot, sagebrush lizards move into the low branches of shrubs or under vegetation and at night, on rainy days and on cool cloudy days they move underground or shelter under debris (WA Herp Atlas 2014).

In Washington, all recently confirmed sites are associated with sand dunes or other sandy habitats (WA Herp Atlas 2014). Any activities that alter these habitats, such as conversion to agriculture and/or activities that promote the invasion of cheat grass, are likely detrimental to sagebrush lizard populations.

WDFW PHS data indicates the presence of sagebrush lizards within the project vicinity, but they are associated with dry upland sand habitats and would not occur in riparian areas along the lower Snake River.

3.2.3.11 Ute Ladies'-Tresses

Ute ladies'-tresses was listed as threatened in 1992. This plant was first discovered in Washington at Wannacut Lake in Okanogan County in 1997 (Bjork 1997, as referenced in Fertig et al. 2005). In 2000, the species was also found along a reservoir bordering the Columbia River near Chelan in Chelan County within the Columbia Plateau ecoregion (Fertig et al. 2005). This orchid occurs along riparian edges, gravel bars, old oxbows, high-flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers. It is also found in wetland and seepy areas near freshwater lakes or springs.

Since 1992, at least 26 new populations of Ute ladies'-tresses have been documented from perennial stream, river, lakeshore, and spring sites directly associated with human-developed dams, levees, reservoirs, irrigation ditches, reclaimed gravel quarries, roadside barrow pits, and irrigated meadows. In all, 33 of 61 documented populations (54 percent) occur in sites in which natural hydrology has been influenced by dams, reservoirs, or supplemental irrigation. Even sites with undisturbed hydrology, however, have been influenced by human agricultural practices, urban development, or road and dam construction (Fertig et al. 2005).

There are four known populations of this species within Washington. Three of the sites occur quite near each other on the Columbia River in Chelan County (Fertig et al. 2005, Beck Botanical Services 2004), Washington. The other site is located in Okanogan County.

3.2.3.12 Spalding's Catchfly

Spalding's catchfly (*Silene spaldingii*) was listed as threatened in 2001. It is an herbaceous perennial in the pink family (*Caryophyllacea*). The species is endemic to the Palouse region of southeast Washington and adjacent Oregon and Idaho, and is disjunct in northwestern Montana and British Columbia, Canada. This species is found predominantly in the Pacific Northwest bunchgrass grasslands and sagebrush-steppe, and occasionally in open-canopy pine stands. Occupied habitat includes five physiographic regions: 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in east-central Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands along major river systems in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana and British Columbia, Canada.

All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name 'catchfly.' Plants emerge in mid- to late May. Flowering typically occurs from mid-July through August, but may occasionally continue into October. Above-ground vegetation dies back at the end of the growing season and plants either emerge in the spring or remain dormant below ground for one to several consecutive years. Spalding's catchfly reproduces solely by seed. It lacks rhizomes or other means of reproducing vegetatively.

3.2.4 Current Immediate Need Action

There are no vegetation species or riparian zones within any of the proposed dredging or disposal sites associated with the current immediate need action.

There are no HMUs located within the proposed dredging or disposal areas associated with the current immediate need action.

There are no terrestrial threatened or endangered species associated with the current immediate need action.

3.3 Recreation

The watershed study area provides a variety of opportunities for outdoor recreation, which in turn provide intrinsic value to residents as well as economic opportunities through tourism. Due largely to its rural nature and scenic terrain, the watershed study area provides many areas used for recreation that attract visitors to the region.

3.3.1 Recreation in the LSRP

Recreation facilities and land available for recreational use in the LSRP are managed and operated by the Corps, USFWS, local and state recreation agencies, and public port authorities. Recreation sites in the LSRP include parks, rivers, trails, lakes/reservoirs, marinas, boat ramps, and wildlife areas. A list of these areas is presented in Table 3-5. The Corps owns most of the water-based recreation areas and facilities located along the lower Snake River reservoirs and manages many of them. Some Corps-owned facilities are managed under lease agreements by other agencies or organizations.

Recreational facilities adjacent to the lower Snake River reservoirs provide opportunities such as picnicking, camping, boating, swimming, hiking, wildlife viewing, fishing, and hunting. Most recreation is related to the water resources provided by the Snake River. Recreation activities take place throughout the year, with the most use occurring during the late spring, summer, and early autumn when fair weather is typical. Table 3-6 presents information on annual visitation to facilities located within each of the lower Snake River Reservoirs (McNary Reservoir is not included because visitation figures do not distinguish between facilities on the Snake and Columbia rivers). Visitation reflects the number of facilities, recreation opportunities, and proximity to large groups of potential users. For example, because of its proximity to the Tri-Cities area and the number of facilities it offers, the Ice Harbor recreation facilities have significantly higher levels of visitation than those in the more remote Lower Monumental reservoir. Lower Granite reservoir also experiences high visitation numbers because of its proximity to Clarkston and Lewiston.

Table 3-5. Partial Listing of Recreation Sites in the LSRP

Reservoir	River	Approx. River Mile[1]	Site Name	Purpose
Lower Granite	Clearwater	2.0	Clearwater Park	Recreation
		3.5	Clearwater Boat Ramp	Recreation
	Snake/ Clearwater	140.0-143.0/ 0.0-2.0 South Bank, 2.0-7.0 North Bank	Lewiston Levee Parkway	Recreation
	Snake	108.0	Offield Landing	Recreation
		110.5	Wawawai County Park	Recreation
		111.0	Wawawai Landing	Recreation
		119.0	Blyton Landing	Recreation
		123.0	Nisqually John Landing	Recreation
		132.0	Chief Timothy Park	Recreation
		132.0	Chief Timothy HMU	Fish and wildlife
		134.0	Evans Pond	Fish and wildlife
		137.0	Golf Course Pond	Fish and wildlife
		138.0	Hells Canyon Resort	Recreation
		138.3	Recreation Dock	Recreation
		139.0	Granite Lake RV Resort	Recreation
		139.0	Tour Boat Dock	Recreation
		140.0	Greenbelt Recreation Area	Recreation
		141.0	Southway Boat Ramp	Recreation
		142.0	Swallows Park	Recreation
		142.0	Chestnut Beach	Recreation
		143.0	Hells Gate State Park	Recreation
		146.0	Chief Looking Glass Park	Recreation
		147.0	Asotin Slough HMU	Fish and wildlife
		147.0	Asotin Slough	Recreation
Little Goose	Snake	72.0	Little Goose Landing	Recreation
		82.5	Central Ferry HMU	Fish and wildlife
		88.0	Willow Landing HMU	Fish and wildlife
		91.0	Penawawa HMU	Fish and wildlife
		91.0	Penawawa Bay	Recreation
		93.0	Rice Bar HMU	Fish and wildlife
		101.0	Lambi Creek	Recreation
		102.0	Illia Dunes	Recreation
		103.0	Illia Landing	Recreation
		105.5	Boyer Park and Marina	Recreation
Lower Monumental	Snake	42.0	Devils Bench	Recreation
		43.0	Magallon HMU	Fish and wildlife

Table 3-5. Partial Listing of Recreation Sites in the LSRP

Reservoir	River	Approx. River Mile[1]	Site Name	Purpose
		48.0	Skookum HMU	Fish and wildlife
		51.0	Ayer Recreation Area	Recreation
		51.0	Ayer HMU	Fish and wildlife
		55.0	55-Mile HMU	Fish and wildlife
		56.5	Joso HMU	Fish and wildlife
		59.0	Lyons Ferry Marina	Recreation
		59.5	Lyons Ferry Park	Recreation
		59.5	Lyons Ferry Natural Area	Fish and wildlife
		62.5	Tucannon HMU	Fish and wildlife
		66.0	Texas Rapids Recreation Area	Recreation
		67.0	Riparia	Recreation
Ice Harbor	Snake	9.0	South Shore Recreation Area	Fish and wildlife
		10.0	North Shore Boat Ramp	Recreation
		10.0	Shoreline Road Fishing Access	Fish and wildlife
		11.5	Charbonneau Park	Recreation
		13.5	Levey Park	Recreation
		15.0	Big Flat HMU	Fish and wildlife
		18.0	Fishhook Park	Recreation
		19.0	Lake Emma	Fish and wildlife
		23.0	Lost Island HMU	Fish and wildlife
		24.5	Hollebeke HMU	Fish and wildlife
		30.0	Walker HMU	Fish and wildlife
		39.0	Windust Park	Recreation
		41.0	Matthews Boat Ramp	Recreation
McNary	Snake	0.0	Sacajawea State Park	Recreation
		1.5	Hood Park Boat Ramp	Recreation
		5.5	Locust Grove/Martindale	Fish and wildlife

Table 3-6. Total Recreation Visits and Visitor Hours at Lower Snake River Recreation Facilities

Reservoir	Fiscal Year (FY) 2008		FY 2009		FY 2010		FY 2011		FY 2012	
	Visitor Hours	Visits	Visitor Hours	Visits	Visitor Hours	Visits	Visitor Hours	Visits	Visitor Hours	Visits
Ice Harbor (Lake Sacajawea)	3,823,791	336,112	6,780,371	482,234	5,036,047	479,553	4,512,101	444,441	3,488,426	346,197
Lower Monumental (Lake Herbert G. West)	497,848	92,256	585,316	102,755	605,947	103,427	587,161	94,927	590,242	115,869
Little Goose (Lake Bryan)	1,302,838	198,847	1,297,889	205,715	2,338,880	225,777	6,042,380	214,094	3,580,468	168,900
Lower Granite (Lower Granite Lake)	4,856,524	1,494,504	5,717,187	1,682,042	7,398,244	2,090,904	6,202,317	1,735,101	5,462,867	1,915,804

Source: Corps of Engineers

3.3.2 Current Immediate Need Action

Recreational use occurs at all of the sites that are part of the proposed current immediate need action. Recreational boating occurs in the federal navigation channel at the Snake/Clearwater River confluence, the navigation lock approach at Ice Harbor, and the proposed disposal site at Knoxway Canyon. Recreational fishing occurs at all three locations, either from boats or from the river bank. Most of the boating and fishing occurs during spring, summer, and fall. A large number of people fish for steelhead in the fall at the confluence and along the south shore of the Snake River immediately upstream of Ice Harbor Dam. Recreational use of the shoreline adjacent to the proposed dredging and disposal sites is greater at the confluence than at the Ice Harbor and Knoxway Canyon sites because the confluence is located adjacent to several recreation sites near two large population centers (Lewiston and Clarkston). The most extensive site at the confluence is the Lewiston Levee Park, which has a multi-use trail that runs for several miles along the top of the levees. There are also several parks, boat ramps, and recreation areas within a few miles of the confluence. The peak usage for these facilities is summer, but they receive light to moderate use during the other seasons, depending on the weather. The Knoxway Canyon site does not get much recreational use as the site is accessible only by boat.

Recreational use in the vicinity of the Port of Clarkston and Port of Lewiston are similar to that of the federal channel at the Snake/Clearwater confluence. However, the Port of Clarkston provides recreational opportunities on Port-owned or -leased sites at the confluence, while the Port of Lewiston does not own or operate recreation facilities. Port of Clarkston recreational facilities include a marina, a recreational vehicle park, a riverside park, and several boat docks. Two of the berthing areas the Port of Clarkston proposes to dredge are located at these docks: the recreation dock used primarily by recreational boaters, and the tour boat dock used primarily by tour boat operators to offload passengers. The recreation dock experiences seasonal use similar to the rest of the recreation facilities at the confluence. The tour boat dock is used in the spring and fall with peak usage in the fall.

3.4 Cultural Resources

Cultural resources encompass a variety of resource types including archaeological sites, places of significant traditional importance to specific communities of people, and historically significant elements of the built environment. The following sections provide a context for cultural resources within the LSRP and adjacent areas, and a summary of the general character and condition of those cultural resources.

The LSRP study area is of particular interest because the fluvial systems within the region concentrated settlements along the Snake River. As noted by Chatters (1998:33) the scarcity of water away from the major drainages tended to concentrate human activity near available water sources. Unique subsistence strategies within the Plateau region, most notably extensive utilization of anadromous fish, also influenced the patterns of archaeological site distribution within the geographical area of the potential affected environment. This phenomenon is not unique to pre-contact archaeology; rivers always have been inextricably linked to human settlement patterns within a project area. Therefore, the LSRP contains significant archaeological resources encompassing the entire time of human settlement in the region. Over such a lengthy period of time many places within the potential affected environment took on deeper meaning to the inhabitants, a concept captured within the idea of ***traditional cultural properties*** (TCPs). All of these resources types are included under the heading of cultural resources.

Cultural resource laws require the Corps, in consultation with the public, tribal governments, and other interested parties to take into account the affects of proposed activities on cultural resources.

3.4.1 Cultural Resources Property Types

Cultural resources within the potential affected environment are composed of precontact (i.e., pre-EuroAmerican contact and settlement) sites, historical period archaeological sites, elements of the historical built environment (historic buildings and structures), cultural landscapes, and TCPs. These can be individual sites, landscapes, buildings, structures, objects, and districts. Archaeological resources, historic buildings and structures, and TCPs that are eligible for listing in the NRHP are referred to as historic properties.

3.4.1.1 Archaeology

Archaeological resources are the locations of the tangible, physical remains of human activity. The age of these resources within the potential affected environment ranges from thousands of years to recent time. Resources date from the post-glacial arrival of humans in the area approximately 10,000-11,000 years ago, up until the ***protohistoric*** period when first European explorers documented their forays into the region, and into the historic period characterized by intensive immigration and settlement.

Ames et. al (1998) offers a straight-forward description of the cultural history of the Southern Plateau, which encompasses the LSRP potential affected environment. This three-part system is described chronologically as Periods I, II, and III, with corresponding dates of 11,500-4,400 B.C., 4,400-1900 B.C., and 1,900B.C. – A.D. 1,720, respectively. Of particular interest here is the fact that many of the sites used to define this culture history are located within the area. Examples include Marmes Rock Shelter, Hatwai, Granite Point, and Tucannon. Precontact archaeological sites include habitation sites such as pit house villages, caves, rock shelters, and open campsites, and sites related to resource procurement activities such as hunting stations, fishing stations, butchering sites, rock alignments, quarry sites, and resource-specific task areas and sites related to resource processing such as ***lithic*** tool scatters, fire pits and hearths, and shell ***middens***.

Historical archaeological resources are related to a number of different historic themes during and following post-contact settlement and development of the area, such as exploration, industry (mining and logging), settlement and community development, commerce, transportation, agriculture and stock-raising, public lands management, and recreation. In particular, terraces adjacent to the Snake River were attractive locations for farmsteads in the region because of level, deeper soils and easy access to river-based irrigation and transportation networks. Many of these locations would develop into early settlements along the river at locations such as Silcott, which no longer exists except as an archaeological site.

3.4.1.2 Traditional Cultural Properties

A TCP is a type of cultural resource that is associated with cultural practices or beliefs of a modern community that are rooted in that community's history and play an important role in maintaining the continuing cultural identity of the community. These properties may be archaeological sites but may also be represented by nonarchaeological features such as distinctive shapes in the natural landscape, named features in local geography, natural habitat for significant faunal and floral resources, traditional fisheries, and sacred religious sites. Although most properties in the area are associated with Native American groups, they can also be related to other ethnic communities, e.g., African American, Chinese, or Japanese groups. Other types of properties include those of importance to maintaining the cultural identity of rural communities. Because a property is defined in relation to a specific group, the intangible qualities associated with such resources may be known only to that group or a subset of their members. Federal cultural resources law, specifically Section 106 of the NHPA and its implementing regulation 36 CFR 800, also refers to properties of this type as *historic properties of religious and cultural significance to an Indian tribe*. The Corps has been actively engaged with regional tribes to identify sites of this type within the LSRP area. The results of these studies are of a sensitive nature, and are not available for public release, but have resulted in a number of these property types being identified within the LSRP.

3.4.1.3 The Built Environment

Historic buildings and structures refer to extant elements of the built environment and are evaluated for significance in the context of themes identified in the potential affected environment: exploration, missions and settlement, industry (mining and logging), transportation (trail systems, railway systems, road systems, ferry crossing and bridges), agriculture and stockraising, and modern land use (dam projects, federal land management). Historically significant sites within these context areas may be listed on, or be eligible for listing on, the NRHP. Properties of this type are found throughout the LSRP. Some, such as the remnants of early railroads, may occur across long stretches of the project area; others, such as ferry crossings, actually traverse the expanse of the river.

3.4.2 Cultural Resources in the Watershed Study Area

This section of this PSMP Final EIS provides general information about the character and condition of cultural resources within the potential affected environment, with some expanded description of representative sites included.

During the period prior to the completion of McNary Dam in 1953 through the completion of the Lower Granite Dam in 1975, salvage archaeology was carried out in areas scheduled for inundation within the LSRP area. Much of this work was carried out by WSU under the supervision of Richard Daugherty and Frank Leonhardy. Salvage excavations were undertaken at a number of places along the Snake River and on major tributaries, including the Palouse River and Alpowa Creek. Most of the data were never formally reported and many of the artifact assemblages were not analyzed. Site-specific salvage excavations also included several other important precontact sites, including Marmes Rock shelter (45FR50) on the Lower Palouse River, the Tucannon site (45CO1A &B), Squirt Cave (45WW25), and the Alpowa Village (Alpaweyma) site (45AS81 and 45AS82). Leonhardy and Rice (1970) developed a cultural sequence for the lower Snake River based on results of their excavation at pit house villages, rock shelters, and burials that yielded rich artifact assemblages and good chronological markers dating back to 10,800 B.C., but provided a limited understanding of land use systems or functional changes. Subsequent studies in the area have contributed to refine the model.

The LSRP area also contains a number of NRHP-listed precontact archaeological districts and sites, and a number of other sites potentially eligible for listing on the NRHP. Examples of archaeological districts include the Lower Snake River Archaeological District near the confluence of the Snake and Columbia rivers, the Palouse Canyon Archaeological District, and the Snake River Archaeological District located on the Snake River south of the confluence of the Snake and Clearwater rivers. Archaeological districts are typically groups of sites of similar age, cultural affiliations, or contextual affiliations, but with sites of distinct functional types, grouped for management purposes. Examples of distinct function types grouped within a precontact archaeological district might include villages, seasonal camp sites, storage shelters/pits, pictographs, petroglyphs, fish walls, and burials. Individual pre-contact sites listed on, or eligible for listing on, the NRHP are found throughout the LSRP area. Many of these sites have yet to be formally evaluated to determine their significance.

Today, ongoing survey, evaluation, and condition monitoring are being carried out in the LSRP watershed study area under the FCRPS Cultural Resources Management Program. The first annual report to the FCRPS (BPA 2010), in conjunction with the System-wide Programmatic Agreement for Management of Historic Properties (BPA 2009), provided summary information to date for the four lower Snake River dam projects. Current reporting indicates that only approximately 40 percent of all the acres of Corps-owned lands within the LSRP have actually been surveyed to identify the presence of cultural resources. Those surveys have identified a total of 536 cultural resources sites on the Corps-owned lands. The Corps actively continues to conduct archaeological survey and evaluations as a function of routine operation and maintenance of the LSRP.

The Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Colville Reservation, the Nez Perce Tribe, and the Wanapum Band, as well as specific Tribes and bands included therein, have interests in traditional resources in this area. These groups have provided confidential preliminary information on TCPs within the Ice Harbor, Lower Monumental, Little Goose, and Lower Granite areas on the lower Snake River as part of the FCRPS cultural cooperating group consultation. Property types include sacred and sensitive locales, legendary locales, and resource utilization locales, including base camps, work camps, hunting and fishing camps, special resource camps (e.g., lithic resources, medicinal plants), and village sites. Some of the properties included within this category overlap with archaeological sites, but others do not.

NRHP-listed or-eligible resources of the historic period built environment found in this area include community buildings (including historic houses, courthouses, and libraries), commercial and industrial buildings, bridges, railroad depots, and viaducts. Most of these are found in urban areas, and specifically within the cities of Lewiston, Idaho and Clarkston, Washington. Other kinds of resources that could be found in nonurban areas include the remains of early town sites, early farms and ranches (foundations, irrigation improvements, fence lines and rock piles, farm machinery, debris scatters, privies, orchard remnants), and railroad-related sites (tracks and grades, construction camps). Buildings and structures associated with the Ice Harbor Lock and Dam itself have reached 50 years of age, and have been determined to be NRHP- eligible.

Within the LSRP area, a variety of human activities have altered the landscape, particularly vegetation in the river bottoms where agricultural practices have replaced native grass and shrub lands, riparian areas, and wetlands. Road building has contributed to sedimentation in areas with ***loess*** (windblown deposition) soils, concentrating runoff which results in gullying. Agricultural conversion of grasslands to annual cropping systems and grazing has increased runoff and erosion of fine sediments. Construction of the four lower Snake River dams led to inundation of large stretches of floodplains and lower terraces where archaeological sites had been identified. Channel modifications such as the construction of levees and armoring of banks have also altered portions of the river and its tributaries. Current and historic operations of the reservoirs involve varying water levels within the reservoirs' operating ranges; periodic fluctuations of pool levels within the operating range have been known to cause erosion of the shoreline and exposure of archaeological material. All of these forces have created impacts to cultural resources within the LSRP.

3.4.3 Current Immediate Need Action

Narrowing the focus down to the area of the current immediate need action further focuses the context and discussion of cultural resources, in this case within the Ice Harbor downstream navigation lock approach, the federal navigation channel in the vicinity of the Snake River/Clearwater River confluence and the Knoxway Canyon in-water disposal area. Looking specifically at the Ice Harbor downstream navigation lock approach, this area was extensively re-worked during construction of the dam. No cultural resources are present within this area. Areas adjacent to the federal navigation channel at the Snake and Clearwater rivers confluence do contain cultural resources including pre-contact archaeological sites that existed into the historic period. These cultural resources were villages associated with the Nez Perce Tribe. These former village sites were all located along the free-flowing Clearwater and Snake rivers prior to the construction of Lower Granite Dam. Cultural resources from the historic period and significant elements of the built environment also persist, and are largely associated with the early era of Clarkston, Washington and Lewiston, Idaho. Finally, cultural resources are also known to be present within the vicinity of the Knoxway Canyon disposal area. Precontact sites in this locale are described as camp sites, and in that regard differ from the larger, more permanent sites located near the federal navigation channel at the Snake and Clearwater rivers confluence. The Knoxway Canyon disposal area was also a level terrace above the pre-Lower Granite Dam Snake River, and early aerial photographs clearly show a farm and what appears to be an orchard on this terrace. Elements of early irrigation here have also been recorded as a cultural resource.

The Ports' maintenance activities would also take place in the vicinity of the cities of Clarkston and Lewiston. Discussion of the cultural resources in the vicinity of the Ports is identical to those identified for the federal navigation channel in the vicinity of the Snake River/Clearwater River confluence area.

3.5 Socioeconomics

The watershed study area includes parts of six counties in Washington State (Asotin, Columbia, Franklin, Garfield, Walla Walla, and Whitman) and one county in Idaho (Nez Perce).

The population of the watershed study area and surrounding region has grown continually over the last 20 years, with a trend of migration from rural areas into urban centers. The watershed study area population is predominantly white and educational levels generally match state averages. Area employment has been affected by the recent national recession in 2008-2010, but incomes have continued to increase throughout the region.

The following sections describe the current socioeconomic conditions of the communities in the watershed study area. Socioeconomic conditions that are considered include population demographics, employment and income, and environmental justice concerns. This section also presents information on transportation, including commercial navigation, and its role in the regional economy.

3.5.1 Population and Demographics

Population for each county in the watershed study area is presented in Table 3-7, below. The watershed study area is generally rural in nature with generally low population densities. The main population centers in the watershed study area and surrounding region are the Lewiston-Clarkston area, near the confluence of the Clearwater and Snake Rivers in Nez Perce County, Idaho and Asotin County, Washington, and the Tri-Cities area, near the confluence of the Snake and Columbia Rivers in Franklin County, Washington. The watershed study area population generally increased between 1990 and 2010, with the exception of Garfield County, Washington.

Table 3-7. Watershed Study Area Population Projections by County (2010-2030)

State	County	2010	2015	2020	2025	2030	Change 2010 – 2030 (%)
Idaho*	Nez Perce	39,265					
State of Idaho		1,517,291	1,630,045	1,741,333	1,852,627	1,969,624	30
Washington	Asotin**	21,198	23,241	24,321	25,341	26,222	24
Washington	Columbia**	3,984	4,096	4,096	4,096	4,088	3
Washington	Franklin**	69,757	80,348	90,654	100,666	109,861	57
Washington	Garfield**	2,129	2,494	2,566	2,632	2,683	26
Washington	Walla Walla**	57,795	63,139	65,593	67,895	69,828	21
Washington	Whitman**	41,793	44,274	45,581	46,786	47,743	14
State of Washington		6,541,963	6,950,610	7,432,136	7,996,400	8,624,801	32
United States		308,935,581	322,365,787	335,804,546	349,439,199	363,584,435	18

Sources: U.S. Census Bureau: 2010 Decennial Census (USCB 2011a); Idaho Department of Labor (IDL 2011); Oregon Office of Economic Analysis (OOEA 2011); and Washington Office of Financial Management (WOFM 2011).
*Notes: * Projections not available for Idaho counties; * *2010 Census estimates unavailable; 2005-2009 5-year American Community Survey (USCB 2011b) estimates used instead.*

The majority of the population in the watershed study area is white as shown in Table 3-8. The remainder of the population in the watershed study area is primarily Hispanic and American Indian within the counties. Hispanics in the rural communities are primarily migrant farm workers located within the counties.

Table 3-8. Race and Hispanic Ethnicity of Population within the Watershed Study Area (2012)

State	County	Hispanic Ethnicity						
		Hispanic (%)	White (%)	Black or African American (%)	American Indian and Alaska Native (%)	Asian (%)	Native Hawaiian and Other Pacific Islander (%)	Population of Two or More Races (%)
Idaho	Nez Perce	3	91	1	6	1	0	2
State of Idaho		12	94	1	2	1	0	2
Washington	Asotin	3	95	1	2	1	0	2
Washington	Columbia	6	95	0	1	0	0	2
Washington	Franklin	51	91	3	1	2	0	4
Washington	Garfield	5	96	0	0	2	0	2
Washington	Walla Walla	21	93	2	1	1	0	2
Washington	Whitman	5	85	2	1	8	0	4
State of Washington		12	82	4	2	8	1	4

Source: U.S. Census Bureau: http://quickfacts.census.gov

Per capita income, a measure of economic prosperity in the watershed study area, increased over the period 2000-2009 as shown in Table 3-9. Although the economy entered recession in 2008, the trend shows that incomes continue to increase.

Table 3-9. Watershed Study Area Income per Capita by County 2000-2009

State	County	2000	2005	2009	2000 - 2009 Change (%)
Idaho	Nez Perce	25,677	29,676	34,215	33.3
Washington	Asotin	24,331	29,066	34,077	40.1
Washington	Columbia	27,997	27,315	34,971	24.9
Washington	Franklin	19,901	22,188	26,342	32.4
Washington	Garfield	25,095	25,716	32,470	29.4
Washington	Walla Walla	23,680	26,484	33,059	39.6
Washington	Whitman	20,236	22,107	28,320	39.9

Source: Corps 2009b

3.5.2 Environmental Justice Communities

As outlined in Executive Order 12898, federal agencies must evaluate environmental justice issues related to any project proposed for implementation. This evaluation includes identification of minority and low-income populations, identification of any negative project impacts that would disproportionately affect these low-income or minority groups, and proposed mitigation to offset the projected negative impacts. The evaluation of environmental justice issues includes an identification of high minority and low-income populations in the watershed study area. The identification of any negative project impacts that would potentially have disproportionately high and adverse effects on these low-income or minority groups is presented in Section 4.0.

Two watershed study area census tracts (9901 Nez Perce County, Idaho, and 201 Franklin County, Washington) have poverty percentages that are more than double the state level. Only one of the watershed study area census tracts for which minority data is reported had a minority population higher than the state average minority population percentage. Tract 201 in Franklin County, Washington has a minority population greater than the statewide average (69 percent for the tract compared to 24 percent for the state) due to the high Hispanic population in the area. All other tracts were below the statewide minority average.

3.5.3 Transportation

An overview of regional transportation systems is presented in this section. Commercial barge navigation on the lower Snake River is of key importance because navigation is one of the existing authorized project purposes of the LSRP and is a major element of the regional economy. The watershed study area is served by a network of roads and railroads, in addition to the commercial navigation system of the lower Snake River. Aviation is not addressed in this EIS as a PSMP is unlikely to affect aviation.

3.5.3.1 Commercial River Navigation

The Snake River federal navigation channel extends approximately 140 miles, from the confluence of the Columbia and Snake Rivers at Pasco, Washington to the confluence of the Clearwater River with the Snake River at Lewiston, Idaho. The Snake River channel is the eastern end of the Columbia-Snake River shallow-draft channel, which extends 330 miles from Portland, Oregon and Vancouver, Washington to Lewiston, Idaho, and allows for commercial navigation between the Pacific Ocean and Lewiston, Idaho. Deep-water ports on the Lower Columbia River are major international export terminals and are the destination of most of the barge traffic originating on the Snake River.

Approximately 10 million tons of commercial cargo is shipped on the inland portion of the Columbia-Snake River system each year with an annual value of between $1.5 and $2 billion. Downbound movements (i.e., movements from upstream ports toward the Columbia River) of grain account for most of this cargo, of which the largest share is wheat. Approximately half of all the wheat exported from export terminals on the Lower Columbia River arrives by barge.

The federal navigation channel in the LSRP is maintained at the congressionally authorized depth of 14 feet at MOP. The actual level of each pool varies depending on uncontrolled runoff, precipitation, wave action, and powerhouse operations. The facilities in each reservoir were designed to operate between minimum operating pool and maximum pool elevation (full pool; Table 3-10).

Table 3-10. Lower Snake Pool Levels

Reservoir	Minimum Pool Elevation	Maximum Pool Elevation
Ice Harbor	437	440
Lower Monumental	537	540
Little Goose	633	638
Lower Granite	733	738

Source: The Federal Caucus (Federal Caucus 2011)

The locks on the Snake River are located at Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam. The navigation locks on the lower Snake River share similar dimensions, with a width of 86 feet and length of 665 to 675 feet and depth of 15 feet. The maximum lift of each of the locks is also similar, ranging between 101 and 105 feet.

Grain terminals account for the largest number of facilities. The Snake and Clearwater have a total of 14 grain terminals. Wood products are handled by eight facilities, all of which are on the Snake River. Other commodity types are handled by between one and four facilities on the Snake and Clearwater Rivers. Table 3-11 through Table 3-13 provides an overview of the facilities on the Clearwater River and lower Snake River.

Table 3-11. Lower Snake River Barge Facilities – Lower Granite Reservoir

River	Name	Mile	Bank (facing downstream)	Grain	Petroleum Products	Fertilizer	Chemicals	Wood Products	Pulp and Paper	Containers	General Cargo	Heavy Lift	Passenger Vessels	Vessel Services
Lower Granite Pool														
Snake	Tidewater Terminal Co, Wilma Dock	135.3	Right		X	X				X	X			X
Snake	Granger Co, Wilma Dock	135.5	Right					X						
Snake	Port of Whitman County, Site I Wharf	135.8	Right					X						
Snake	Foss Maritime Co, Wood Chip Dock	135.9	Right					X						
Snake	Mountain Fir Chip Co, Wilma Division Dock	136.1	Right					X						
Snake	Stegner Grain Terminal Dock	136.6	Right	X										
Snake	Port of Whitman County, Site A Dock	137	Right					X			X			X
Snake	Port of Clarkston Dock	137.8	Left					X		X	X	X		
Snake	Lewis-Clark Terminal, Clarkston Grain Terminal	138.3	Left	X										
Clearwater	Mountain Fir Chip Co, Lewiston Division Dock	0.5	Right					X						
Clearwater	Port of Lewiston, Container Terminal Dock	1.1	Right					X	X	X	X			
Clearwater	Continental Grain Co, Lewiston Elevator Dock	1.3	Right	X										
Clearwater	Lewis-Clark Terminal, Lewiston Dock	1.4	Right	X										

Source: Corps of Engineers Port Series No. 34

Table 3-12. Lower Snake River Barge Facilities – Little Goose, Lower Monumental and Ice Harbor Pools

River/Pool	Name	Mile	Bank	Grain	Petroleum Products	Fertilizer	Chemicals	Wood Products	Pulp and Paper	Containers	General Cargo	Heavy Lift	Passenger Vessels	Vessel Services
Little Goose Reservoir														
Snake	Pomeroy Grain Growers Dock	83	Left	X										
Snake	Columbia Grain International, Central Ferry Elevator	83.5	Right	X										
Snake	Central Ferry Terminal Association, Grain Dock	83.7	Right	X										
Snake	Port of Whitman, Boettcher Landing Dock	84	Right			X								X
Snake	Almota Elevator Co Dock	103.6	Right	X										
Snake	S & R Grain Co, Port of Almota Dock	103.7	Right	X										
Lower Monumental Reservoir														
Snake	Columbia County Grain Growers, Lyons Ferry Dock	61.1	Left	X										
Ice Harbor Reservoir														
Snake	Walla Walla Grain Growers, Sheffler Dock	29	Left	X										
Snake	Louis Dreyfus Corp, Windust Elevator Dock	38.5	Right	X										

Source: Corps of Engineers Port Series No. 34

Table 3-13. Lower Snake River Barge Facilities – McNary Pool

River/Pool	Name	Mile	Bank	Grain	Petroleum Products	Fertilizer	Chemicals	Wood Products	Pulp and Paper	Containers	General Cargo	Heavy Lift	Passenger Vessels	Vessel Services
McNary Reservoir														
Snake	Port of Walla Walla Dock	1.7	Left										X	
Snake	Co-Grain, Burbank Elevator Barge Slip	1.8	Left	X										
Snake	Cargill, Burbank Grain Elevator Dock	2	Left	X										

Source: Corps of Engineers Port Series No. 34

The total tonnage moved on the lower Snake River fluctuates from year to year, depending on crop production, the state of the U.S. economy, and trends in world trade. Table 3-14 presents the total tonnages of cargo moved through the lower Snake River, and includes McNary Reservoir since cargo statistics do not differentiate between the Snake and Columbia River portions of McNary Reservoir.

Table 3-14. Lower Snake River Navigation Lock Detail (tons)

Year	Lower Granite	Little Goose	Lower Monumental	Ice Harbor	McNary*
1994	2,314,000	3,542,000	3,678,000	4,278,000	7,976,000
1995	2,414,000	3,776,000	3,924,000	4,581,000	8,670,000
1996	1,771,000	2,912,000	3,098,000	3,564,000	7,886,000
1997	1,952,000	3,180,000	3,675,000	4,205,000	8,294,000
1998	2,221,000	3,554,000	4,018,000	4,571,000	8,591,000
1999	1,987,000	3,128,000	3,496,000	4,067,000	7,604,000
2000	2,264,000	3,103,000	4,110,000	4,560,000	8,461,000
2001	1,820,000	2,811,000	3,408,000	3,952,000	8,102,000
2002	1,349,000	2,427,000	2,687,000	3,086,000	6,372,000
2003	1,527,000	2,579,000	2,866,000	3,210,000	6,998,000
2004	1,749,000	2,951,000	3,267,000	4,119,000	7,508,000
2005	1,661,000	2,724,000	2,991,000	3,519,000	6,652,000
2006	1,570,000	2,717,000	2,915,000	3,371,000	6,950,000
2007	1,763,000	2,933,000	3,268,000	3,611,000	7,351,000
2008	1,164,000	1,840,000	2,119,000	2,161,000	5,301,000
2009	1,226,000	2,503,000	2,536,000	2,867,000	6,125,000
2010	1,265,000	2,225,000	2,554,000	2,830,000	6,244,000
2011	1,167,000	2,034,000	2,325,000	2,631,000	5,542,000
2012	1,510,000	2,593,000	2,776,000	3,175,000	6,187,000

**Note: McNary Pool includes facilities on both the Snake and Columbia Rivers.*
Source: Corps of Engineers

Grain movements on the Snake River are all downbound, and are destined for export elevators or mills at deep-draft ports on the Lower Columbia River. Most of the grain moving on the Snake River originates in the upper two reservoirs (Lower Granite and Little Goose). Since 1994 the uppermost reservoir, Lower Granite, has accounted for an average of 37 percent of originating grain tonnage. The Little Goose Reservoir, immediately below Lower Granite, accounted for an average of 38 percent. The remaining tonnage is split between Lower Monumental (10 percent) and Ice Harbor (15 percent). Figure 3-2 illustrates trends in volumes of grain shipments by reservoir.

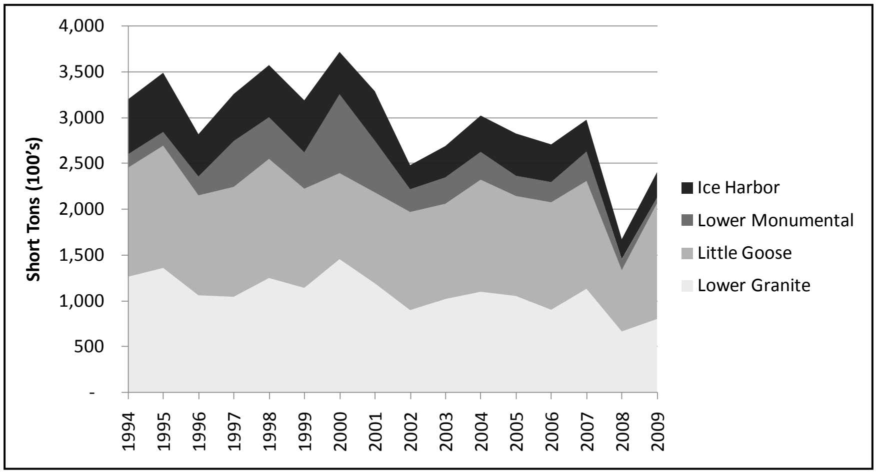


Figure 3-2. Snake River Grain Volume Originating by Reservoir (excluding McNary Pool)

Source: U.S. Army Corps of Engineers

Several grain elevators are located in the Snake River below Ice Harbor Dam. The McNary Reservoir includes these elevators, and there are several others located on the Columbia River. Available statistics do not differentiate the volume of the grain traffic in the McNary Reservoir that is generated in the Snake River from that generated in the Columbia River.

Table 3-15. Origin of Grain Shipped on the lower Snake River, by State

Origin	Bushels	Metric Tons	% of Total
Oregon	1,180,000	32,100	0.96
Idaho	27,260,000	741,900	22.10
Washington	84,730,000	2,306,000	68.69
Montana	6,780,000	184,500	5.50
North Dakota	3,270,000	89,000	2.65
Utah	140,000	3,800	0.11
Total	123,360,000	3,357,300	100.00

Source: Corps 1999c

Essentially all of the pulp and paper on the Snake River moves downbound from Lewiston, Idaho. Between 2000 and 2010, the amount of pulp and paper shipped by barge dropped sharply, falling from approximately 175,000 short tons in 2000 to less than 30,000 tons in 2005. Volumes rebounded to 90,000 tons in 2006 and 2007, but then fell below 50,000 short tons in 2008 and below 20,000 tons in 2009.

Petroleum products are an upbound move, with most of the volume originating in Vancouver, Washington. Most petroleum products are offloaded above the McNary lock and below the Ice Harbor lock. The primary facilities for handling this type of product are located in Pasco, on the Snake River between RM 2 and 3. Above Ice Harbor there is one facility for petroleum products, located in the Lower Granite Reservoir at Wilma, approximately 3.5 miles below the Clearwater River.

All of the facilities in the Snake River used for handling wood products are located above the Lower Granite lock and dam. Most of these are located at Wilma, approximately 3.5 miles below the Clearwater River on the Snake River, while two docks in the Clearwater River also handle wood products.

The volume of wood products shipped by river dropped sharply during the recession of 2000, falling from nearly 400,000 short tons in 2000 to less than 140,000 tons in 2002. Volumes rebounded above 320,000 tons by 2004, but also declined during the recession of 2007-2009.

In accordance with the general guidance contained in ER 1105-2-100, the Corps has determined the ongoing/anticipated commercial use of the lower Snake River navigation channel warrants continued maintenance under the PSMP. ER1105-2-100 E-15h(3)(i)(1) states, "continuation of ongoing dredged material management studies [e.g., PSMP] is conditioned on a confirmation that continued maintenance is warranted. Therefore, for each ongoing study, a review of indicators of continued economic justification will be conducted."

To ensure that continued maintenance is warranted, the Corps considered the current amount of traffic and the increased cost of transporting goods by alternative modes (rail or trucks) as opposed to barge. A variety of products are transported by barge on the lower Snake River, including grain, containers, fertilizer, and machinery. Based on the 2002 *Final Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement*, (http://www.nww.usace.army.mil/Library/2002LSRStudy.aspx), the increased cost to transport grain by rail or truck is about $8.45 per ton in current dollars. Total tonnage on the lower Snake River is currently estimated at about 3 million tons with the majority being grain. Therefore, annual transportation savings of approximately $25M can be expected if the navigation system is maintained. In reality it is likely that benefits will increase in the future as traffic continues to recover from the recession. Annual costs to maintain the lower Snake River navigation channel are estimated to be in the $1-5M range. Therefore based on the estimated transportation savings, ongoing channel maintenance on the lower Snake River is warranted from the navigation perspective.

Congress has funded multiple federal navigation channel maintenance (dredging) actions for the LSRP since the 1980s, including the most recent in the winter of 2005/2006, all to restore the federal navigation channel to the congressionally authorized dimensions (14-feet deep and 250 feet wide). For site-specific navigation channel maintenance actions under the PSMP in the future, the Corps will identify the least costly manner consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process (See, 33 CFR 335-336).

The Corps has included a request in its fiscal year 2014 budget for funding to implement the proposed current immediate need action to reestablish the congressionally authorized dimensions of the LSRP navigation channel.

3.5.3.2 Current Immediate Need Action

The navigation lock approach to Ice Harbor Dam is a critical feature for commercial navigation in the LSRP as all tows entering or leaving the Snake River portion of the Columbia/Snake River system must pass through the Ice Harbor navigation lock.

The federal navigation channel at the Snake/Clearwater confluence provides commercial navigation access to both the Port of Clarkston and the Port of Lewiston, two of the three ports located in Lower Granite reservoir. Sediment accumulation in the federal channel at the confluence interferes with the access to these two ports. The third port, the Port of Whitman at Wilma, is located on the right bank of the Snake River about three miles downstream of the Port of Clarkston. The federal navigation channel adjacent to the Wilma site is outside of the area of sediment accumulation at the confluence.

Port of Lewiston is a public agency with a primary objective to encourage economic growth in Nez Perce County and the state of Idaho. The Port oversees harbor operations, terminal facilities, international trade, and industrial and economic development. Commercial transportation of cargo in the Lewiston area consists primarily of shipments by rail, trucks and commercial navigation. The Port competes with other ports and transportation modes and its current operation is focused primarily on the transport of containerized cargo and oversized cargo. After unloading cargo at the Port facility, it is shipped by rail or truck to its final designation.

The Port of Clarkston is also a public agency and operating port that manages a 120-acre waterfront site for a diversity of business tenants and emphasizes economic development, tourism, and recreational development. The Port is involved in marine commerce, property development for industrial and commercial purposes, and recreation/tourism facilities.

The Knoxway Canyon site, where dredged material placement is proposed, is located along the shoreline and is outside of the federal navigation channel in Lower Granite reservoir.

3.5.3.3 Tour Boats

The lower Snake River is used by a variety of passenger vessels, including cruise ships, tour boats, and recreational vessels.

American Safari Cruises operate two vessels on the lower Snake River, the *Safari Explorer* and *Safari Spirit*. The *Explorer* is the larger of the two, at 145 feet in length and with an 8.5-foot ***loaded draft***. The *Spirit* is 105 feet long and has a loaded draft of 6 feet. American Cruise Lines operates the *Queen of the West*, a 230-foot paddle wheeler with a loaded draft of 11 feet. Lindblad Expeditions operates two vessels on the lower Snake River, the *National Geographic Sea Bird* and the *National Geographic Sea Lion.* Each of the vessels is 152 feet long, with loaded drafts of 8 feet each.

The cruise business on the Snake River is highly seasonal, with most of the activity occurring during spring and fall. The peak month for Snake River cruises is October, which typically accounts for one quarter of annual cruise lockages.

The smaller cruise vessels have generally not been impacted by ***shoaling*** in the navigation channel. In contrast, the larger *Queen of the West* has had to shift its base of operations in Clarkston from the Port of Clarkston cruise boat dock to a cargo dock across the river due to sediment accumulation at the Port of Clarkston.

3.5.4 Rail

The railroad system in the watershed study area is integrated with and competes with the barge transportation system described above, particularly with respect to shipments of grain. The rail system consists of two Class 1 railroads[1], as well as a number of regional railroads. The Class 1 railroads include the Burlington Northern Santa Fe (BNSF) and the Union Pacific Railroad (UPRR).

The BNSF operates two main rail lines through eastern Washington. These lines enter Washington via a single line from Sandpoint, Idaho, which branches near Spokane. One of the two main lines runs from Spokane to Pasco, and then follows the Washington bank of the Columbia River to Vancouver and beyond. The other BNSF main line runs west from Spokane to Seattle, crossing the Cascade Mountains between Wenatchee and Everett. Bulk movements of grain and other cargos typically follow the Spokane-Pasco-Vancouver route.

The UPRR operates one main line in eastern Washington and another that crosses Idaho and Oregon. The UPRR Washington line roughly parallels that of the BNSF Spokane-Pasco line, running from Spokane to Wallula, Washington, south of Pasco. Between Lyons Ferry, Washington and the Ice Harbor dam this line follows the south bank of the Snake River. At the Hinkle Yard near Hermiston, Oregon, this line joins the other UPPR main line, which runs through southern Idaho and eastern Oregon, before following the Oregon bank of the Columbia River to Portland and beyond.

Regional railroads in the vicinity of the lower Snake River include the Palouse River and Coulee City Railroad (PCC) and the Great Northwest Railroad (GRNW).

- The PCC operates between Walla Walla and Dayton, Washington, on track owned by the Port of Columbia County. It also includes 300 miles of rail in three branches that are owned by the State of Washington:
    - The PV Hooper Branch runs from Thornton to Winona, and from Hooper through Winona to Colfax. A portion of this line from Colfax to Pullman was severed by a fire and is currently used for storage.
    - The CW Branch runs from Coulee City to Cheney.
    - The P&L Branch runs from Marshall through Pullman to the Idaho border near Moscow, and from Palouse directly east to the Idaho.

[1] Class I railroads are large railroad companies that have annual operating revenues of $250 million or greater, as defined by the U.S. Surface Transportation Board. They generally have large regional networks that include many states.

- The GRNW operates 77 miles of railroad in Idaho and Washington, most of which runs along the Snake River between Lewiston, Idaho and Lyons Ferry, Washington. This line joins the UPRR Spokane-Wallula line at Ayer, Washington.
- Between Wallula and Walla Walla a line is operated by the Watco Companies. This line was named the Blue Mountain Railroad, but now operates under the PCC label. Unlike the lines listed above, this line is owned by the UPRR.

The mix of products carried by each of the regional railroads is currently dominated by grains, but also includes fertilizer, lumber and lumber by-products, agricultural products, chemicals for making paper, and other bulk products. This list reflects current market demands but the commodities will vary over time as market demands change.

3.5.4.1 Current Immediate Need Action

A rail line runs parallel with and adjacent to the right bank of the Snake River in Lower Granite reservoir and crosses the Clearwater River at RM 0.5. A feeder line of the GRNW provides the Port of Lewiston with a link to the main lines of the UPRR and the BNSF. The Port of Clarkston does not have rail service. The rail line that ran parallel with and adjacent to the right bank of the Snake River in Ice Harbor reservoir has been removed and the rail bed has been designated as part of the Columbia Plateau Trail.

3.5.5 Roads and Highways

Several major roads and highways serve areas within the watershed study area, including U.S. Highway 12 (generally runs east-west) and U.S. Highway 95 (north-south). Highway 12 intersects the LSRP at Pasco on the western end of the watershed study area and Lewiston/Clarkston at the eastern end. Highways 95 and 195 pass through Lewiston. Two Washington state highways, 261 (north-south) and 127 (north-south), cross the Snake River at Lyons Ferry and Central Ferry respectively, the only two bridges across the Snake between Pasco and Clarkston. Washington state highway 129 (north-south) connects northeastern Oregon with Asotin and Clarkston.

The region's roadway network is used for transportation of freight on truck and for personal commuting and travel. Because of the flexibility of motor freight, road and highways have become the primary mode of transport in the region; several motor freight companies are based in the Lewiston area. Two major U.S. highways, 12 and 95, intersect at Lewiston. Trucks carry a significant volume of grain and other cargo in the region. These trucks are chiefly from eastern Washington and northern Idaho, with some from as far east as North Dakota and eastern Montana. Roads and highways also provide the primary transportation facilities used for personal and recreational travel in the region.

3.5.5.1 Current Immediate Need Action

The Ice Harbor site is accessed from a local road connecting to the Pasco-Kahlotus Highway to the north of the dam. The site can also be accessed from the south by a local road connecting to Washington State Highway 124.

Highway access to the federal navigation channel at Lewiston/Clarkston is from local streets and roads connecting with U.S. Highways 12 and 95. Highway 12 passes through the northern end of Clarkston, crossing the Snake River into Lewiston just to the south of the federal channel. It crosses the upstream end of the federal channel in the Clearwater River near the Port of Lewiston and intersects with U.S. Highway 95.

There is no road access to the Knoxway Canyon disposal site. A county road, Wawawai River Road, runs adjacent to and parallel with the right bank of the Snake River across the river from the site.

3.6 Water Quality and Sediment Quality

3.6.1 Water Quality

The state of Washington has designated the lower Snake River and its tributaries to be protected for the following uses: salmon spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (WAC 173-210A-600). The segment of the lower Snake River in Idaho has been designated by the Idaho Administrative Procedures Act (IDAPA) for cold water aquatic life, primary contact recreation, domestic water supply, wildlife habitats, and aesthetic beneficial uses (IDAPA 58.01.02.130). Tributaries to the lower Snake River in Idaho are designated for a variety of beneficial uses, as specified in IDAPA 58.01.02.

The Corps undertook an extensive study to characterize water quality in the lower Snake River between 2008 and 2010 that built upon years of previous water quality monitoring. Hourly turbidity values recorded throughout the system were relatively low, averaging less than 10 nephalometric turbidity units (NTUs). The number of measurements greater than 10 NTU was three to five percent higher in the Snake River, and the frequency of measurements between 5 and 50 NTU increased down river. However, the incidence of values greater than 50 NTU was greater in the Clearwater River than at any of the Snake River monitoring locations, and the highest hourly value (655 NTU) was recorded in the Clearwater River (Corps 2011b). Correlation coefficients between daily average turbidity measurements and river discharge were also calculated. The results showed a correlation of 0.72 at the upstream monitoring station in the Snake River and a much lower correlation of 0.32 in the Clearwater River. The relationship between river discharge and turbidity near the mouth of the Snake River was intermediate at 0.55.

Larger particles transported by the lower Snake River settle out in the transition zone near Lewiston, Idaho and downstream in the Lower Granite Reservoir; finer particles can remain suspended downstream of the Lower Granite Reservoir. Total suspended solids (TSS) concentrations are typically higher at greater depths in the water column; however, concentrations can also be high near the water surface as a result of algal growth, Port operations, and tributary inflows. The 2008-2010 study determined that the median TSS concentrations were similar throughout the Snake River, ranging from 4.7 to 5.0 mg/L. The calculated median for the Clearwater River was lower at 2.0 mg/L. The highest TSS concentrations were typically associated with the spring runoff, reaching 160 and 100 mg/L in the Snake and Clearwater rivers, respectively (Corps 2011b).

Dissolved oxygen (DO) concentrations were found to be lower in the mainstem Snake River than in the Clearwater River during the 2008-2010 study. The median concentration decreased from 10.9 mg/L at RM 141 to 10.3mg/L at Lower Granite Dam forebay and rebounded to 10.9 mg/L at RM 2. The seasonal reservoir lows may be partially attributed to algal senescence in the water column (Corps 2011b). Similarly, short-term super-saturated conditions were associated with algal blooms. DO concentrations also fluctuate with seasonal cycles in the lower Snake River system. The lowest concentration typically occurs in late summer and early fall and maximum concentrations are measured in January and February, both due to the inverse relationship between water temperature and DO.

Water temperature in the lower Snake River varies by time of year and location. Generally, water temperature is low in January and February, increases slowly during spring runoff from March to May, and then increases more rapidly from June to early August. Temperatures plateau through mid-September and decrease steadily through January. Trends in the mainstem Snake River measured at a USGS gauging station near Antone, Washington (RM 167) indicate that the average daily maximum water temperatures at this station are very similar for the periods 1975 through 1991 and 1992 through 2010. Maximum daily temperatures at this station exceeded 68°F (20°C) each year for 35 to 91 days between 1 June and 1 October (Corps 2011b).

Clearwater River temperatures recorded at the USGS gaging station at Spalding, Idaho, historically displayed a seasonal cycle similar to the one at Anatone, but changed significantly beginning in 1992. That was the first year when cold-water releases during July, August, and September were initiated. The temperatures of these summer discharges range from 43 °F (6 °C) to 54 °F (12 °C) and are intended to maintain Lower Granite tailwater temperatures at, or below, 68°F (20°C). The impact to the Clearwater River has been to reduce summer temperatures from about 68°F (20°C) to 59°F (15°C), or less. An evaluation of the effect of these released cold-water flows at Lower Granite Dam showed that average summer water temperatures at the project reached 75°F (24°C) prior to 1991 while the average of the daily maximum temperatures recorded at the tailwater station between 1995 and 2010 were less than 68ºF (20ºC) (Corps 2011b). The cooling effects diminish downstream as the water is heated by solar radiation. However, during July and August from 1995 through 2010 when the average maximum daily temperatures at Lower Granite Dam tailwater were 3.5 ºC (6.3 ºF) less than at Anatone, the Ice Harbor Dam tailwater temperatures were still 2.4 ºC (4.3 ºF) lower than the temperatures at Anatone.

The pH of the mainstem lower Snake River is typically more ***alkaline*** than the Clearwater River. Results from the 2008-2010 water quality study showed that the median pH of the Clearwater River was 7.3 while the analogous value for the Snake River at RM-141 was 8.2. The pH decreased slightly down river with calculated medians at RM-108 and RM-2 of 8.1 and 7.9, respectively (Corps 2011b). Frequency distributions of the hourly data sets illustrate additional differences between the Snake and Clearwater Rivers. Almost 50 percent of the hourly data from the Clearwater River was between pH 7.0 and 7.5. An additional 26 percent was between pH 7.5 and 8.0. Only four data points (0.02 percent) measured in the Clearwater River were less than 6.5 and none were greater than 9.0. The Snake River stations displayed markedly different pH frequency distributions. Almost 89 percent and 92 percent of the hourly data recorded at RM-141 and RM-108, respectively, were between 7.5 and 8.5. The upper boundary of the Washington State standard of 8.5 was exceeded 8.7 percent of the time at RM-141, as well as 5.8 percent and 5.7 percent of the time at RM-108 and RM-2, respectively. These elevated values cannot be attributed to specific anthropogenic sources and have been documented in Snake River water quality studies as far back as the late 1960s and early 1970s. Natural geological conditions, agricultural fertilizers, and aquatic primary productivity contribute to the elevated pH conditions.

2008-2010 median calculated pH values slightly decreased from RM 141 to RM 28 (0.3 units). Nutrients – particularly nitrogen and phosphorus – are of interest due to their effects on biological activities within aquatic systems. The soluble forms of nitrogen include ammonia (NH_3-N) and nitrate (NO_3-N). Based on the 2008-2010 data set, the lowest nitrate concentrations were consistently identified in Clearwater River samples; higher values were usually found in the free-flowing Snake River. The median nitrate concentration at the Clearwater River station was 0.03 mg/L compared to a relatively uniform range of 0.32 mg/L to 0.42 mg/L through the four-reservoir reach. The inflowing Snake River had a higher median nitrate concentration of 0.56 mg/L. Ammonia concentrations in the lower Snake River have historically been less than the nitrate concentrations, and were often close to or less than instrument detection limits (Corps 2005). The median ammonia concentration at RM-147 was 0.02 mg/L during the 2008-2010 investigation, and increased to 0.03 mg/L at RM-108. Downstream from Lower Granite Dam the median concentrations declined to 0.01 mg/L, the same as the calculated concentration in the Clearwater River. Total nitrogen (TN) includes inorganic and organic components with nitrate comprising 65 to 70 percent of the TN in the Snake River and 33 percent in the Clearwater River. TN concentrations at the upstream Snake River station (RM-147) were generally higher than those observed at the other sampling locations, having a range of 0.26 mg/L to 2.30 mg/L and a calculated median of 0.82 mg/L. Concentrations were lower but relatively uniform throughout the lower Snake River where median values ranged from 0.51 mg/L to 0.62 mg/L.

The dominant forms of phosphorus of interest in aquatic systems are orthophosophorus (ortho-P) and total phosphorus (total-P). Ortho-P concentrations in the Clearwater River were relatively low during the 2008-2010 investigation, ranging from 0.001 mg/L (the same as the median value) to 0.075 mg/L in December 2009. The concentrations in the inflowing Snake River were considerably higher. The calculated median at RM-147 was 0.026 mg/L, with individual values ranging from 0.006 to 0.072 mg/L. Ortho-P levels were very similar throughout the lower Snake River reach where median concentrations at six of the stations ranged from 0.020 to 0.023 mg/L. The one exception was RM-82, where the calculated median was 0.015 mg/L; however, given the range of data values this was not a statistically significant difference. Ortho-P concentrations in the lower Snake River are highest in the fall and winter and relatively low in the summer, likely due to biological uptake by aquatic plant and algal growth in the summer. In the fall, primary productivity decreases and phosphorus levels increase as there is reduced biological uptake and algal decay (Corps 2011b). Total-P concentrations generally followed the spatial pattern set by ortho-P. This occurred because, on average, 49 to 57 percent of the total-P concentrations in the Snake River were ortho-P. Median total-P levels for the reservoir system ranged from 0.037 mg/L to 0.041 mg/L while the inflowing Snake River was higher with a calculated median of 0.049 mg/L. The relationship between ortho-P and total-P was not as strong in the Clearwater River, where the median value was 14 percent and the median total-P concentration was relatively low at 0.011 mg/L. The highest total-P concentrations generally occurred during the fall and winter when the concentrations of most ions increases as a result of less dilution, and during runoff events when the suspended solids concentrations increase. Total-P concentrations are often used as ***trophic state indicators***. ***Eutrophication*** of a lake, or in this case a reservoir, is a natural aging process that can be unnaturally accelerated by the presence of too many nutrients. In the eutrophication process, a lake will gradually appear cloudier due to the increased growth of microscopic plants and animals. Based on the measurements from the 2008-2010 study, the lower Snake River reservoirs would be classified as lower eutrophic (Corps 2011b).

3.6.1.1 Current Immediate Need Action

The action to re-establish the congressionally authorized dimensions of the federal navigation channel would occur between 15 December and 1 March. Some seasonal water-quality trends can be inferred from the results of the 2008-2010 monitoring program. Water temperatures are at a seasonal low during this period, averaging 38.3 ºF (3.5 ºC) to 38.7 ºF (3.7 ºC) in both the Clearwater and Snake River. Turbidity and suspended solids concentrations are typically low during this time of the year with water-column turbidity averaging 2 to 5 NTU while the corresponding suspended solids concentrations average 3 to 7 mg/L. Short-term values can be significantly higher as a result of rain-on-snow events or during a mild winter when most of the precipitation is in the form of rain. Winter pH values tend to be lower in the Clearwater River where the average value is 7.4 units, while the mean in the Snake River typically ranges from 7.9 to 8.3 units. The concentrations of the nitrogen and phosphorus constituents, as well as most of the other dissolved ions, are higher during low-flow conditions and usually less in the Clearwater River than in the Snake River. The median nitrate plus nitrite and total nitrogen concentrations in the Clearwater River are about 0.3 mg/L and 0.5 mg/l, respectively, while the corresponding concentrations in the Snake River are two to three times greater. The same pattern is evident for the phosphorus species, with median ortho-P and total-P concentrations in the Clearwater River of 0.009 mg/L and 0.028 mg/L, respectively. Corresponding median ortho-P and total-P concentrations in the Snake River were 0.031 mg/L and 0.044 mg/L, respectively.

3.6.2 Sediment Quality

Agriculture and urban land cover accounts for most of the total study (TetraTech 2006). Agriculture within the watershed study area and surroundings predominantly consists of dryland crop farming, for which fungicides, pesticides, and herbicides are typically used, consistent with regulatory standards. Sediments from agricultural and urban land could potentially carry chemical constituents into the lower Snake River.

Sediment samples have been collected from various locations within the lower Snake River projects since at least 1985 (Crecelius and Gurtisen 1985; Crecelius and Cotter 1986; Pinza et al. 1992a, 1992b; Anatek 1997; HDR 1998; CH2M Hill 1997, 1999, 2000; Corps 1987a, 1988, 2002a, 2002b, 2013b; Heaton and Juul 2003; Gravity Consulting 2013; SEE et al. 2014). Most of these studies were linked directly to the Corps dredging authorities and projects, and focus predominantly on the Snake and Clearwater rivers confluence area.

Sediment sampling for the PSMP/EIS was initially completed in June 2011. This was a synoptic program that encompassed areas of the Lower Snake and Clearwater rivers where sediments have historically accumulated and did not focus on specific areas proposed for dredging. The sediment results were evaluated primarily using the 2006 Sediment Evaluation Framework (Corps 2006) freshwater and marine guidelines for the chemicals of concern (COCs) where screening limits were available, and secondarily with the DMMP marine guidelines (Corps 2013) for all other COCs. The results of the conventional analyses from the sampling event were similar to previous findings. The grain size from the federal navigation channel and the Ports' grain elevator locations showed that the sand component ranged from 89 percent to 100 percent. The substrate at the Port of Clarkston Cruise Dock had a higher percentage of fines, resulting in a sand component that ranged from 74 to 87 percent. The total organic carbon (TOC) content did not exceed 1.9 percent in any of the samples. The metals analyses showed that concentrations of the sixteen COCs did not exceed the applicable screening limits. Using multiple EPA methods, 177 agricultural organic chemicals were evaluated; none were detected in the sediment samples from the Ports or the federal navigation channel. Small amounts of polycyclic aromatic hydrocarbons (PAHs) and semi-volatile organic compounds were detected in the sediments at most locations, but again did not exceed the 2006 SEF screening limits or the DMMP guidelines (Corps 2013). Dioxin and furan toxic equivalents (TEQs) were calculated for the samples that were processed for those parameters, and the results ranged from 0.128 to 0.509 parts per trillion (pptr); less than the 4 pptr DMMP guideline.

The reach downstream from the Ice Harbor navigation lock was also sampled in 2011. This area has been sampled and dredged prior to 2011 and has always yielded cobbles ranging in size from 1 to 10 inches or more in diameter with some sands but no silts. The grab samples retrieved during the 2011 sampling again yielded only large material, and no samples were forwarded to the laboratory for further analyses. However, photos were taken of the substrate material retrieved for documentation.

Elutriate analyses were also completed for some of 2011 samples to evaluate the potential release of chemical constituents from disturbed sediments. The water samples were analyzed for the same parameters as the sediments. The results showed that for the cases when quantitative data was available, the numerical values did not exceed the water quality criteria presented in the 2009 Sediment Evaluation Framework (Corps 2009a).

Sediments from the Port of Clarkston Crane Dock were characterized in 2012 to determine suitability for in-water disposal (Gravity Consulting 2013). Three core samples were retrieved and analyzed for the organic and inorganic constituents identified in the approved sample analysis plan (Gravity Consulting 2012). The results were compared to the 2006 SEF freshwater guidelines for the COCs where screening levels exist and to DMMP marine guidelines for all other COCs. The characterized sediments were primarily sand and gravel, 58.6 and 36.6 percent respectively, and only 4.4 percent fines. The chemistry results indicated that chemical concentrations were below all applicable screening levels. The chemical results were also compared to the elutriate testing trigger values using the relatively conservative assumptions of 1 percent total organic carbon, 100 mg/L total suspended solids and the default water hardness of 100 mg/L. No elutriate testing triggers were exceeded by this dataset. Based on this analysis, the DMMP agencies concluded that the proposed dredge material was suitable for open-water placement at the Knoxway Canyon site.

Sediment samples were again collected by the Corps for chemical analyses between August 2 and 6, 2013 from the Snake and Clearwater rivers in the vicinity of Lewiston, Idaho, and Clarkston, Washington to obtain information that could be used by the Dredged Material Management Office (DMMO) to determine if the sediments are suitable for unconfined in-water disposal. Field and laboratory protocols followed the approved *Sampling and Analysis Plan for Lower Snake and Clearwater Rivers Proposed 2013/2014 Channel Maintenance Dredging* (Corps 2013c). The summer 2013 sediment sampling also included z-layer samples from the dredge material management units (DMMU) where sediment cores were retrieved. These samples were archived but not analyzed since the dredge prism results were below the screening limits

The results of the August 2013 sampling were, in several ways, similar to those reported for the 2011 sampling event (Corps 2013, SEE et al. 2014). Sediment samples from the Clearwater River DMMUs had a higher percentage of sand and total solids than those collected from the lower Snake River DMMUs. Concentrations of most COCs such as metals, pesticides, PCBs, phthalates, PAHs, and chlorinated hydrocarbons were either non-detected, or below the Screening Level 1 (SL1) guidelines provided by the DMMO.

An unexpected result from the August sampling event was the detection of phenols at elevated concentrations in some of the samples. The concentrations of 4-methylphenol in six of the eight Snake River DMMUs (1, 2, 3, 5, 6, and the Port of Clarkston grain elevator) exceeded the SL1 guideline of 260 ppb, with values ranging from 340 parts per billion (ppb) to 4,900 ppb. Phenol also exceeded SL1 guidelines in DMMU 6 where a concentration of 170 ppb was determined (the SL1 is 120 ppb). Benzoic acid, though not detected at concentrations greater than the SL1 guideline (2,900 ppb), was identified at an unusually high 890 ppb in DMMU 6. Additionally, the highest concentrations of these three constituents all occurred in DMMU 6, the one farthest upstream in the Snake River.

The elevated concentrations of phenolic compounds prompted the DMMO to inform the Corps that additional sampling was required to make the suitability determination. The re-sampling occurred in November 2013 and consisted of composite grab samples from the previously visited sample locations in DMMUs 1, 2, 3, 5, 6 and the Port of Clarkston grain elevator. These composite samples were analyzed for the conventional parameters (e.g., grain size, TOC and solids, sulfide and ammonia) as well as the phenols and miscellaneous extractables. Additionally, the samples were submitted for bioassay tests using the 20-day *Chironomus dilutus* survival and growth tests, and the 10-day *Hyalella azteca* survival test.

The physicochemical results from the November sampling were similar to those observed in the August-collected samples, with some notable differences. The TOC concentrations measured in the November DMMU 2, 3, and 6 samples were between 2 to 4.7 percent higher than the analogous samples collected in August. Grain size was generally similar, except at DMMUs 5 and 6 which had 25.6 and 17.8 percent higher percent fines, respectively, than the August samples. The samples submitted from the November collection confirmed the presence of 4-methylphenol at levels above the SL1 for DMMUs 1, 3, 5 and 6, but for DMMUs 2 and the Port of Clarkston grain elevator the reported levels were below the SL1. For DMMU 6, the phenol level in the August sample was reported above the SL1; for the November sample phenol concentration was below the SL1.

The 10-day *Hyalella azteca* survival test and the 20-day *Chironomus dilutus* survival and growth test were conducted on the six DMMU composite samples and on two reference sediment samples. The bioassay results showed that:

- The 10-day freshwater amphipod mortality test indicated that all tested sediments (control, reference, and DMMUs) had mortality that was less than 5 percent, well below the one- and two-hit criteria and considered to have passed relative to these guidelines.
- The 20-day freshwater midge mortality test demonstrated that all tested DMMU composite sediments had mortality that was less than that observed in the control sediment (18.8 percent); i.e., greater survival of the midge was observed in the test sediments relevant to the controls. Relative to the respective reference sediment, all tested DMMU sediments were within the range of ±3.8 percent. All test sediments were well below the one- and two-hit criteria, and are considered to have passed relative to these guidelines.
- The 20-day freshwater midge growth test showed that all tested DMMU composite sediments had mean individual growth rates that were at least 80 percent of that observed in the control sediment, and at least 91 percent of that observed in the relevant reference sediment. In several cases the mean individual growth rates exceeded that observed in the control and reference sediments. All test sediments were well below the one and two-hit criteria, and are considered to have passed relative to these guidelines.

Given the confirmation of 4-methylphenol at levels above the SL1 at these locations, the bioassays were decisive for the suitability determination. For the two organisms and three end-points tested, the proposed dredge sediments passed the Dredged Material Management Program and SEF biological guidelines. In consideration of all test data from 2011 and 2013, the sediments were considered suitable for in-water disposal.

3.6.2.1 Current Immediate Need Action

Re-establishing the federal navigation channel to its congressionally authorized dimensions would occur in the areas where sediment characterizations were completed in 2012 and 2013. The project area has been ranked by the DMMP as low to low-moderate, which means that the chemical and biological characterization of the dredge prism is considered adequate and valid for decision making without further testing for a period of six to seven years.

3.7 Hydrology and Sediment

The origination, movement, and accumulation of sediment within the lower Snake River reservoirs are complex processes and involve a variety of natural and human-caused factors. This section provides information on sediment sources and transport from areas outside the watershed study area (but within the sediment-contributing watershed). Sediment erosion is caused by processes such as wind, rainfall, snow-melt, runoff, and channel migration. These and other related processes transport eroded sediment to streams. Naturally occurring events such as wildfires, large storms, and landslides can increase the potential for these processes to contribute higher sediment loads to watershed streams. Human disturbance of the land through activities such as development, timber harvesting, mining, agricultural activities, and construction of roads can expose or loosen soil and also increase sediment loads.

Eroded sediment in a stream or reservoir moves when the moving water that contains it reaches a certain flow velocity. The flow velocity required to move sediment is higher for large particles (boulders and gravel), and lower for fine particles (fine sand and silt). A portion of the sediment that is eroded and enters streams within the watersheds of the lower Snake River is conveyed to Lower Granite Reservoir and the reservoirs downstream. The fraction of sediment that is composed of larger particles, or the coarser-grained sediment, moves very slowly through the river system and is not a major component of sediment deposition in the reservoirs. The finer-grained sediment fraction, composed of clay, silt and sand, is the more mobile portion of the sediment load that enters the reservoirs.

Finer sand and silt sediment is deposited in the upper portion of the Lower Granite Reservoir in the vicinity of the confluence of the Clearwater and Snake rivers, moves downstream, and eventually may be deposited further downstream within the reservoir. A small portion of the sediment load that is suspended in the reservoir water column (usually clay and silt) may be transported over Lower Granite Dam and into Little Goose Reservoir and downstream. A study conducted by the UI and WSU found that sediments deposited in the upper areas of Lower Granite Reservoir and upstream of the confluence in the Snake and Clearwater rivers came from nonagricultural lands in the upstream watershed, while sediments downstream of Silcott Island tended to come more frequently from agricultural sources (UI/WSU 2011). The Tucannon and Palouse Rivers are the Snake River's two major tributaries which enter it downstream of Silcott Island, and they both empty into the Snake River within Lower Monumental Reservoir.

Sediment deposited in deep areas of Lower Granite reservoir downstream of RM 120 or transported over the dam and out of the reservoir does not influence flow conveyance or the risk of flooding in the Lewiston, Idaho area, nor does it generally accumulate in the federal navigation channel or affect other existing authorized purposes in the lower Snake River. These problems arise only when sediment is transported to the relatively shallow upper portions of the reservoirs (Lower Granite Reservoir in particular), or deposited in slow-moving waters near ports, recreational facilities (such as recreation areas), or HMU irrigation water intakes. Deposition of sediment in the upper portion of the reservoirs may deposit within the federal navigation channel (restricting barge traffic) and could potentially reduce the flow conveyance capacity of the Lewiston levee system and increase the risk of flooding during extreme high flow events. As noted in Section 1, dredging has historically been used by the Corps in the past to remove sediment from this part of the river to maintain the federal navigation channel and flow conveyance capacity. Figure 3-3 illustrates an area of sediment accumulation causing navigation issues near the confluence of the Snake and Clearwater Rivers.

Figure 3-3. Sediment Encroachment in 2009 at the Confluence

This section evaluates the physical characteristics of watershed hydrology and of sediment transport and deposition in the LSRP. The Corps has studied extensively the processes that contribute to sedimentation in the lower Snake River, as described in Section 1.

3.7.1 Geomorphology and Sediment Transport in the Snake River Basin

The sediment-related processes leading to accumulation that affects existing authorized purposes are schematically shown in Figure 3-4. The following subsections provide a general description of sediment dynamics in a watershed to illustrate the types of processes that lead to sediment being delivered from the sediment-contributing watershed to the LSRP.

3.7.1.1 Sediment Generation in Upper Watershed

Sediment is produced by natural and human-influenced erosion in the watershed and transported into the tributary river channels. The tributary rivers drain mostly forested or agricultural lands. Sediment eroded from the upper watersheds is generally finer-grained (clays, silts, and sands). The fine sediment may be transported into smaller river channels and eventually down to the major tributaries. See (1) in Figure 3-4.

3.7.1.2 Sediment Transport to Snake River

The Clearwater, Salmon, and Grande Ronde Rivers have gradients steeper than that of the relatively flat lower Snake River. Because of their steeper gradients and the availability of coarse-grained sediment, the bed load of these rivers is typically gravel and cobble and is transported relatively slowly through the river systems. Most fine sediment (clay, silt, sand) that enters the tributaries of the Clearwater, Salmon, and Grande Ronde Rivers is ultimately transported into the Snake River.

The river channels themselves may also erode and transport fine to coarse sediment by channel migration and by moving landslide and ***mass-wasting*** debris that makes its way into or near the channel. Most coarse sediment is derived from the actual erosive force of the river channels and their tributaries and from mass-wasting and landslides in the vicinity of the rivers. The mobile fine sediment bedload moves quickly through the river systems (days to months to years) while the coarse gravel/cobble bedload requires longer time frames to move through the system (years, decades, and centuries). See (2) in Figure 3-4.

3.7.1.3 Sediment Deposition in Upper End of Lower Granite Reservoir

Upstream of the confluence of the Clearwater and Snake rivers the bedload is coarse gravel, and sand and silt are actively moved into the Lower Granite Reservoir in suspension. Beginning at the upper end of the Lower Granite Reservoir, sand is deposited in greater quantities into the Snake River system. Silt begins to be dominantly deposited approximately 10 miles downstream at RM 131. The amount of sediment entering the Lower Granite Reservoir at the confluence is approximately 2.2 million cubic yards per year (mcy/yr) (Corps 2011b).

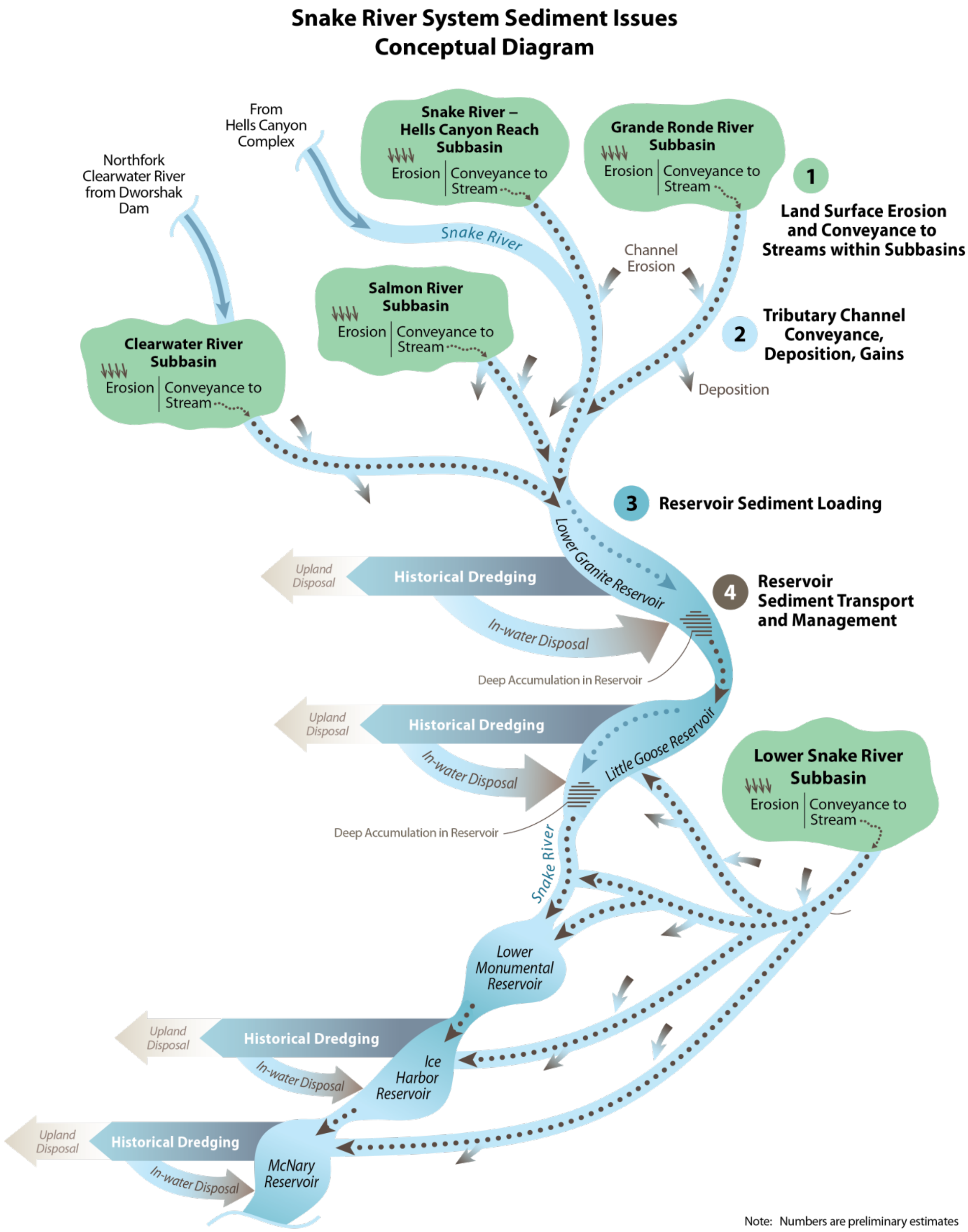


Figure 3-4. Lower Snake River System Sediment Issues – Conceptual Diagram

Sand and silt deposits in the upper end of the Lower Granite Reservoir can create a problem by depositing within the navigation channel and reducing the capacity of the river to convey flows, thereby increasing the river stage (i.e., water surface elevation) and flood risk. Approximately 2.0 mcy/yr of sediment has been deposited into the upper end of the Lower Granite Reservoir (Corps 2011b). Maintenance dredging has periodically occurred in Lower Granite Reservoir to remove accumulated sediments that interfere with authorized purposes of the LSRP (see Table 1-3, and (3) in Figure 3-4).

3.7.1.4 Sediment Accumulation in Deep Reservoir or Transport Downstream

Most fine-grained sediment, generally comprised of clay and silt, is transported past the upper end of the reservoir and accumulates in the deeper portion of the reservoir. Some of the fine sediment is transported in suspension over Lower Granite Dam and downstream to the other reservoirs and lower reaches of the Snake River. Of the 2.2 mcy/yr of sediment entering the Snake River at the confluence of the Clearwater River, 0.2 mcy/yr is deposited in the deep water portions of the reservoir or moves downstream of the dam. See (4) in Figure 3-4.

This section describes the hydrology of the watershed, estimates the volume of sediment produced in the watershed, and describes the movement of sediment into and through the lower Snake River system. The information presented in this section is organized by geographic area, as described in the subsections below.

The LSRP extends approximately 140 river miles from the confluence of the lower Snake River with the Columbia River near Pasco, Washington, through the confluence of the Snake and Clearwater Rivers and up the Clearwater River to Lewiston, Idaho. The Snake River drainage area upstream of Lower Granite Dam is approximately 103,200 square miles (mi^2) (Corps 2011c). However, the watershed that contributes sediment to the LSRP is limited to the portion of the Snake River drainage area that contributes sediment to the lower Snake River system. The size of the watershed study area is approximately 32,500 mi^2 and includes thousands of miles of stream channels. There are five distinct subbasins within the watershed (Salmon, Clearwater, Grande Ronde, Snake River Hells Canyon Reach, and Lower Snake); characteristics of these subbasins are described in the following sections.

3.7.2 Watershed Sediment Production

Hydrologic processes primarily drive the production of sediment, its conveyance to the reservoirs, and its transport within the reservoirs. This section presents available information on the production of sediment from each of the five subbasins that are tributary to the lower Snake River system. Table 3-16 provides a summary of the geographic areas of each of the subbasins in the watershed (Tetra Tech 2006). Figure 1-2 provides an overview of the subbasins. The hydrology and estimated sediment production associated with each subbasin are described in the subsections below.

Table 3-16. Watershed Subbasins

Subbasin	Area (mi^2)	Percent of Watershed
Salmon River Subbasin	13,994	43
Clearwater River Subbasin	6,907	21
Grande Ronde River Subbasin	4,101	13
Snake River – Hells Canyon Reach Subbasin	2,104	6
Lower Snake River Subbasin	5,471	17
Watershed Area Total	32,576	100

Source: Tetra Tech 2006

3.7.2.1 Sediment Contribution to Lower Snake System

As noted in Section 1, studies of sediment contribution from subbasins in the Lower Snake Basin have been conducted by the Corps based on monitoring and measurements of sediment contributions from major tributaries flowing into the lower Snake River. This approach uses measurements of the actual sediment load coming out of each subbasin and into the lower Snake River. From these measurements the Corps estimated that the Salmon River makes the largest annual sediment contribution to Lower Granite Reservoir (approximately 69 percent of the total sediment contribution) (Corps 2011b).

The sediment load estimates from instream monitoring are significantly more accurate than the sediment yield estimates based on land use and average erosion and yield and, as such, were used by the Corps as a basis of evaluating the existing environmental conditions and trends. Monitoring of sediment load was conducted on the Salmon, Grande Ronde and Clearwater Rivers, and on the Snake River below the Grande Ronde. Monitoring was also conducted in Lower Granite Reservoir, below the confluence of the Snake River and Clearwater River.

Salmon River Subbasin

The Salmon River subbasin covers nearly 14,000 mi^2 of land in Idaho and is composed of 10 major tributaries and their associated watersheds. The Salmon subbasin comprises 43 percent of the watershed area (Tetra Tech 2006). The Salmon River flows from its headwaters 410 miles north and west through central Idaho to its confluence with the Snake River in Lower Hells Canyon. Tributaries to the Salmon River include the Lemhi, Pahsimeroi, Middle Fork Salmon, South Fork Salmon, and Little Salmon Rivers.

The western portion of the subbasin is Pacific ***maritime***-influenced with a majority of its precipitation falling as snow. In contrast, the eastern portion of the subbasin typically receives approximately 50 percent less precipitation than the western portion, due to the ***rain shadow*** effect of the Pahsimeroi Mountains (Tetra Tech 2006). Peak flows generally occur in May and June due to snowmelt.

Sediment transport is associated with streamflow velocities; higher flow velocities generally transport more sediment. Peak streamflow events tend to produce higher flow velocities and result in movement of larger volumes of sediment downstream. The USGS measures streamflow on the Salmon River at White Bird, Idaho (USGS 2011). The mean annual discharge in 2010 was 10,330 cubic feet per second (cfs). The average monthly discharge between 1999 and 2009 ranged from 3,770 cfs in September to 31,900 cfs in May. Figure 3-5 shows annual average streamflow for the Salmon River at White Bird, Idaho.

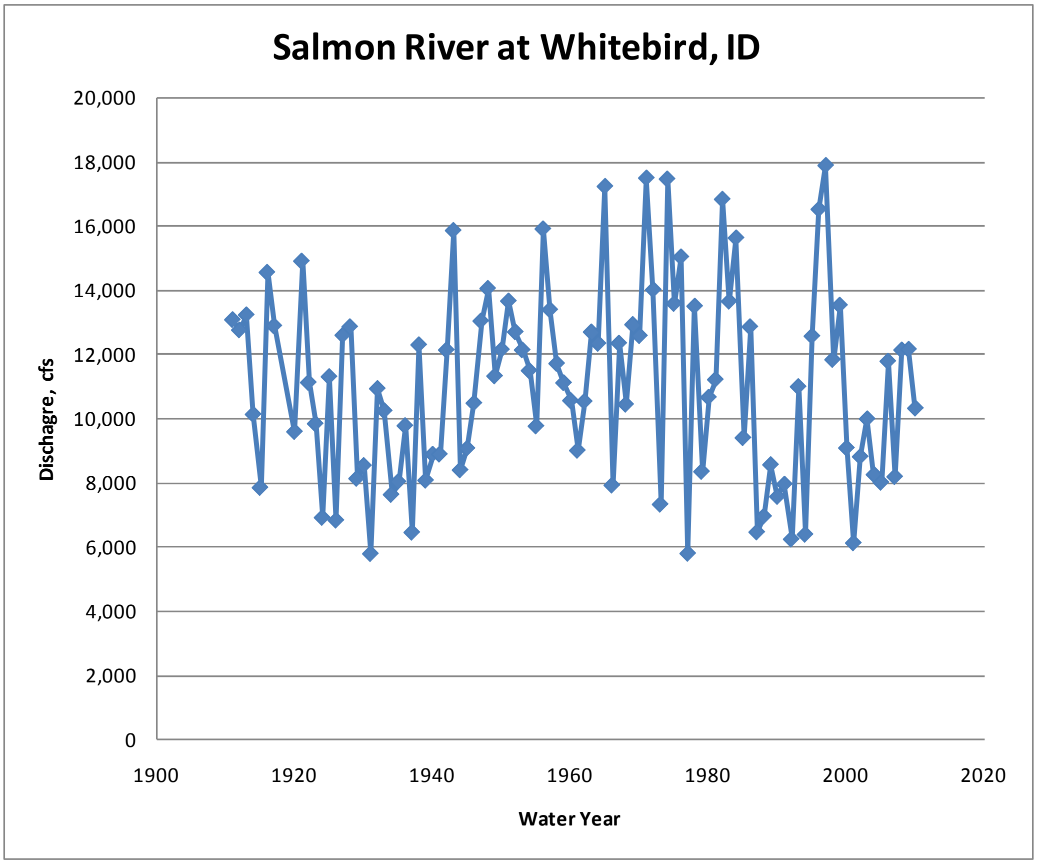


Figure 3-5. Annual Average Streamflow, Salmon River at White Bird, Idaho

Source: USGS

Landscape features and land uses in a watershed can affect erosion and sediment delivery to waterbodies. In general, land that has been disturbed by humans for uses such as agriculture, logging, mining, road networks, or urban development has greater potential for erosion and delivery of sediment to waterbodies. Changes in land use, particularly the development or use of land for logging or agriculture, will tend to increase the amount of sediment generated. However, undisturbed land can also have high potential for sedimentation due to naturally-occurring factors such as soil type, topography, and frequency or magnitude of events that can cause erosion and sedimentation, such as landslides, forest fires, or storms. The USFS (Goode et al. 2011) predicts that future climate change, by increasing the risk of wildfire, may increase the amount of sediment produced by forested lands tributary to the Snake River system. All of these factors interact to affect the quantity of sediment produced within a subbasin. For example, land that is heavily forested may be less likely to erode than land with sparse vegetation, while a forest fire or human-caused disturbance such as logging and roads can result in greater erosion in a forested area.

The land cover in the Salmon River subbasin is primarily forest, although shrub and grasslands are also significant in the drier eastern watersheds of the subbasin. The subbasin is sparsely populated with low road densities. Agricultural and urban land cover is more prevalent in the Lower Salmon watershed, but still represents a small portion (3 percent) of the Salmon River subbasin. The large majority (approximately 90 percent) of the watershed is federally owned by the BLM and the USFS.

The Corps conducted a review of literature that evaluated the level of hydrologic and riparian disturbance found in the watershed, and compiled ratings of the relative level of disturbance found in each watershed (Tetra Tech 2006). The ratings related to the degree of disturbance found in a watershed are based on the level of human-caused disturbance (e.g., roads, mining, or agriculture) and the sensitivity of the landscape to disturbance. The overall level of land disturbance in the Salmon River subbasin is considered to be low; however, the Lemhi watershed has a high level of disturbance (Tetra Tech 2006). Highly erodible soils exist throughout the basin, particularly in the Lemhi, Pahsimeroi, and Lower Salmon watersheds. Historic activities associated with land disturbance such as timber harvesting and mining have declined in recent years, although past activities are still important sources of sediment in the subbasin (Tetra Tech 2006). Approximately 27 percent of the subbasin is federally protected and thus not subject to human-caused disturbance that could result in sediment production.

Disturbances, including forest fires and roads, are the primary source of sediment loading in the Salmon River subbasin (Goode et al. 2011). Studies conducted over several decades suggest that sediment yields within a subbasin are highly variable based on a wide variety of factors. For example, USFS studies report that estimated levels of sediment yield from forested roads and from forest fire damaged areas can range from 285 tons/mi^2 up to more than 5,000 tons/mi^2 (Appendix C).

As with forested and range lands, estimating sediment load from agricultural areas dependent of a wide variety of factors; however, more data is available on agricultural areas which allows for a planning-level analysis and estimate of sediment eroded from agricultural lands. Annual erosion from agricultural areas in the Lower Salmon and Little Salmon River watersheds (approximately 3 percent of the subbasin acreage, but where the majority of agricultural use in the subbasin is located) was estimated to be 0.05 million tons per year (Appendix N). This is roughly equivalent to 46,000 cy/yr.

Erosion is related to sediment deposition in streams and sediment accumulation in reservoirs; however, the relationship between these processes is complex and is influenced by a wide variety of factors. Stream systems like the Salmon River and other tributaries hold large quantities of sediment that are mobilized during high flow events. Further, not all eroded material is necessarily transported to a waterbody.

Analysis of measured suspended sediment loads indicates that the Salmon River contributes approximately 1.5 mcy, or approximately 69 percent, of the total sediment load entering Lower Granite Reservoir (Corps 2011b).

Snake River–Hells Canyon Reach Subbasin

The Snake River–Hells Canyon Reach subbasin includes all of the drainages upstream of the mouth of the Clearwater River and downstream of Hells Canyon Dam, exclusive of the Salmon and Grande Ronde River subbasins. This subbasin includes portions of Idaho, Oregon, and Washington and is approximately 2,100 mi^2 in size, which comprises 6 percent of the watershed. The subbasin excludes all of the Snake River Basin upstream of Hells Canyon Dam.

The climate in this region is generally temperate and dry, with most precipitation occurring during short intense summer storms and longer, milder winter storms. A large portion of the streamflow contributed by this area originates from snowpack or large rain-on-snow events that historically have resulted in major flooding on tributary streams (Tetra Tech 2006).

The USGS measures streamflow on the Snake River near Anatone, Washington, which includes streamflow coming from the Hells Canyon Dam and the Upper Snake River. (USGS 2011). The mean annual discharge in 2010 was 29,130 cfs. The average monthly discharge between 1999 and 2009 ranged from 15,300 cfs in November to 62,300 cfs in May. Figure 3-6 shows annual peak streamflow for the Snake River near Anatone, Washington.

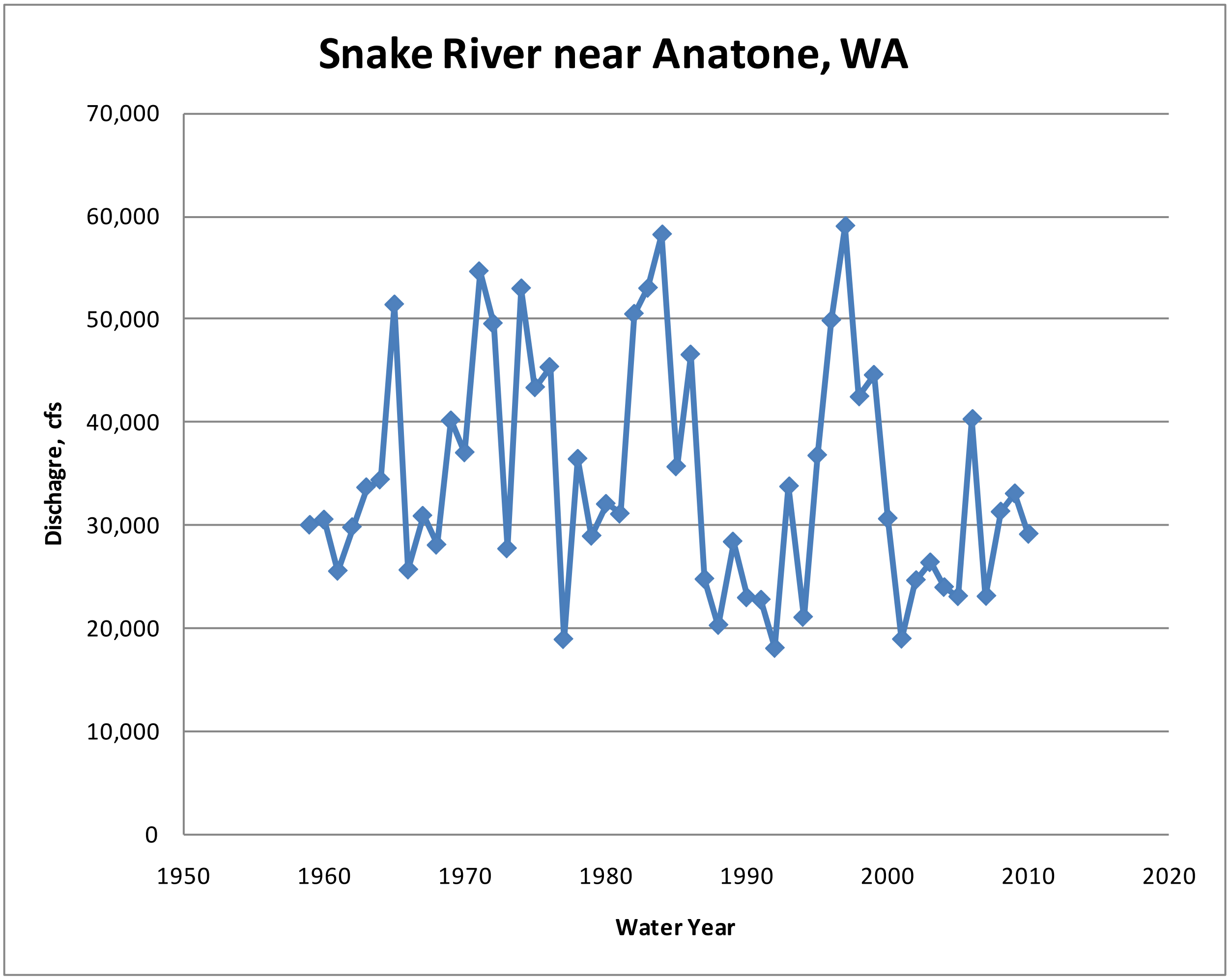


Figure 3-6. Annual Average and Annual Peak Streamflow, Snake River near Anatone, Washington
Source: USGS 2011

Land cover in the subbasin consists mostly of prairie and canyon grasslands and shrub-steppe vegetation. These types of land covers are generally in lower elevations and are mainly used for agriculture. As elevation increases, forests become more prominent. Similar to the other subbasins described above, the majority of this subbasin is federally owned. The majority of privately owned land is located within the Lower Snake-Asotin watershed. Rensities are low throughout the watershed with the exception of the Lower Snake–Asotin watershed, where agricultural/urban uses are more prevalent.

The level of land disturbance in the Snake River–Hells Canyon Reach subbasin is considered low to moderate, except in the Lower Snake-Asotin watershed, where disturbance levels range from moderate to high (Tetra Tech 2006). Erosion hazards are high throughout the subbasin (Appendix N).

The UI/WSU study reported average annual erosion from agricultural areas in the Hells Canyon and Asotin watersheds (approximately 22 percent of the subbasin acreage) is estimated to be 0.1 million tons per year (Appendix N). This is roughly equivalent to 93,000 cy/yr.

The Snake River–Hells Canyon Reach subbasin carries sediment contributions from both the Salmon River and Grande Ronde River subbasins to Lower Granite Reservoir. Studies conducted by the Corps suggest that these subbasins contribute the bulk of sediment delivered to Lower Granite Reservoir; little additional sediment is delivered directly from the Hells Canyon Reach (Corps 2011b).

Grande Ronde River Subbasin

The Grande Ronde River subbasin drains approximately 4,100 mi^2, which comprises 13 percent of the watershed, and spans regions in northeastern Oregon and southeastern Washington. Major tributaries include the Upper Grande Ronde, Wallowa, and Lower Grande Ronde Rivers.

The climate of the Grande Ronde River Basin is variable as a result of the high relief of the Blue and Wallowa Mountains; winters are generally cold and moist, while summers are warm and dry (Tetra Tech 2006). The Grande Ronde River and its tributaries are snowmelt runoff streams. Peak runoff occurs from April through June.

The USGS measures streamflow on the Grande Ronde River at Troy, Oregon (USGS 2011). The mean annual discharge in 2010 was 2,400 cfs. The average monthly discharge between 1999 and 2009 ranged from 622 cfs in September to 7,110 cfs in May. Figure 3-7 shows annual peak streamflow for the Grande Ronde River at Troy, Oregon.

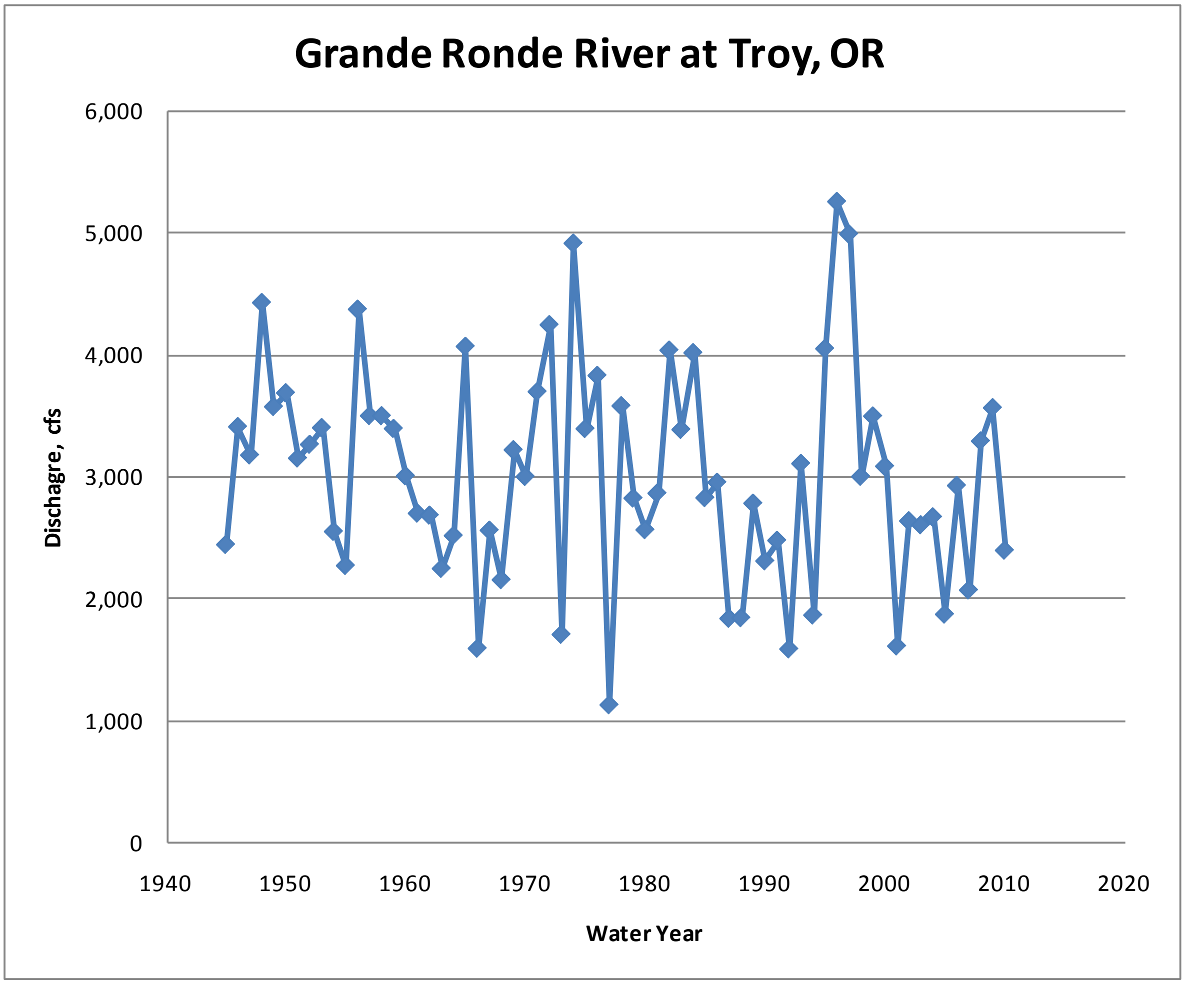


Figure 3-7. Annual Average and Annual Peak Streamflow, Grande Ronde River at Troy, Oregon

Source: USGS 2011

Land cover is predominantly forest in the higher elevations of the subbasin; in the lower elevations, grasslands are prevalent. Seventeen percent of the Grande Ronde River subbasin is covered by agricultural and urban land uses. Land ownership is roughly split between federal and private ownership.

In contrast to the subbasins described above, the level of land disturbance in the Grande Ronde River subbasin is considered high (Tetra Tech 2006). Road densities are moderate to high throughout the subbasin. Historical activities, including road construction, agriculture, timber harvest, and grazing, have contributed to this condition (Tetra Tech 2006). High erosion hazards have been identified in all watersheds within the subbasin (Appendix N).

The Corps' analysis of sediment contribution suggests that the Grande Ronde subbasin contributes approximately 9 percent of the total sediment contribution of the Snake River to Lower Granite Reservoir (Corps 2011b). This is roughly equivalent to 200,000 cy/yr.

The 2010 UI/WSU study reported that average annual erosion specifically from agricultural areas in the Grande Ronde subbasin is estimated to be 0.08 million tons per year. This is roughly equivalent to 74,000 cy/yr.

Clearwater River Subbasin

The Clearwater River subbasin is located primarily in Idaho and is bordered by the Salmon River subbasin to the south. Within the watershed, the Clearwater River drains approximately 6,900 mi^2, or 21 percent of the watershed. Major tributaries within the subbasin include the South Fork of the Clearwater River and the Lochsa and Selway Rivers. As discussed previously, the North Fork of the Clearwater River is not included in the watershed because sediment from this portion of the subbasin is blocked by Dworshak Dam. The mainstem of the Clearwater River accounts for approximately a third of the flow contributed to the Snake River by the watershed.

The Clearwater River subbasin is maritime-influenced, similar to the western portion of the Salmon River subbasin (Tetra Tech 2006), with most of the precipitation occurring as snow. Peak flows generally occur in May and June due to snowmelt.

The USGS measures streamflow on the Clearwater River at Spalding, Idaho (USGS 2011). The mean annual discharge in 2010 was 10,830 cfs. The average monthly discharge between 1999 and 2009 ranged from 3,540 cfs in October to 35,700 cfs in May. Figure 3-8 shows annual peak streamflow for the Clearwater River at Spalding, Idaho.

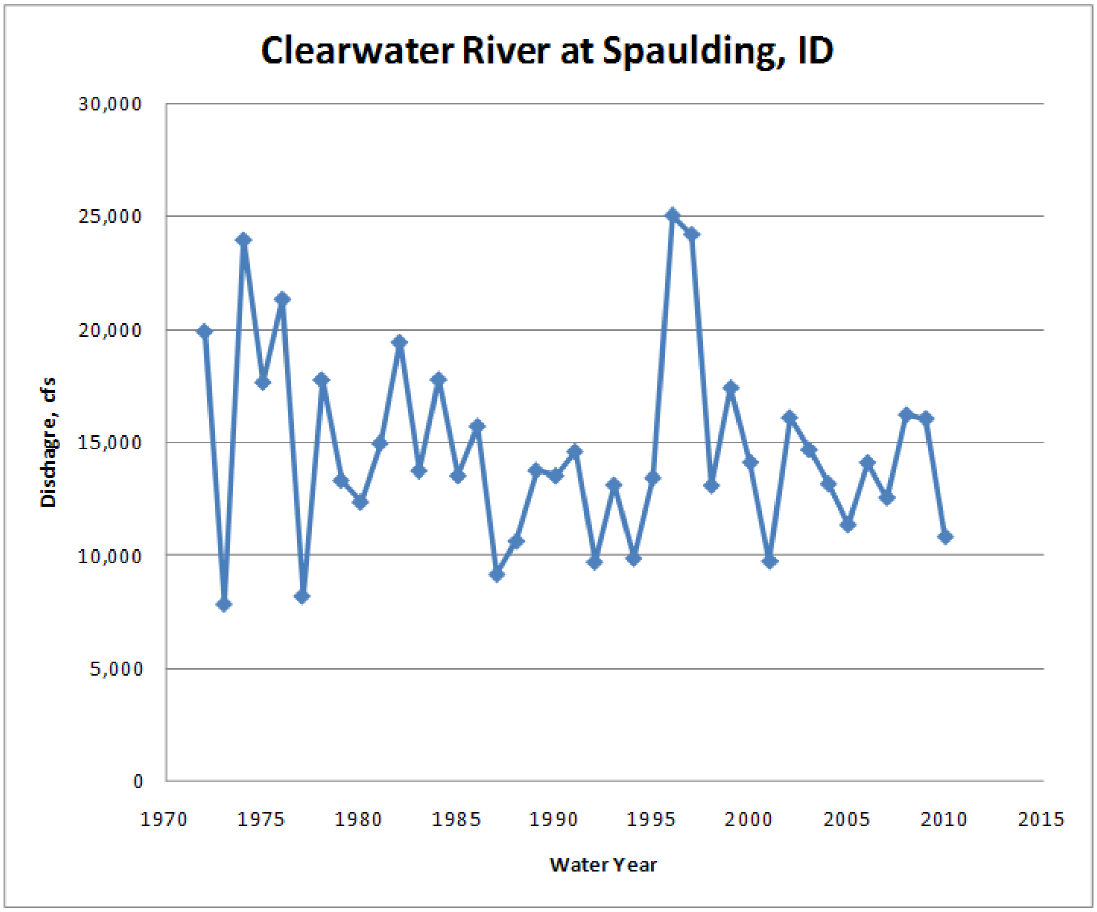


Figure 3-8. Annual Average Streamflow, Clearwater River at Spalding, Idaho

Similar to the Salmon River Basin, the land cover in the Clearwater River subbasin is primarily federally owned forest, although privately owned, agricultural/urban land cover is significant, and is more prevalent than in the Salmon River subbasin. See discussions of land use and socioeconomics elsewhere in this section for additional detail.

Approximately 45 percent of the Clearwater River subbasin is designated wilderness forest, protected from activities or disturbance that would result in human-caused erosion or sediment production. Aside from the protected lands, agriculture and grazing are common of the land uses in the western part of the subbasin. Mining historically occurred throughout the entire watershed, but has decreased dramatically in recent years. The level of land disturbance is considered low in the eastern portion of the watershed due to its protected status. In contrast, land disturbance in the western portion of the watershed ranges from moderate to high (Tetra Tech 2006). Highly erodible lands occur in the South Fork and Clearwater River watersheds; agricultural areas in the Potlatch River watershed are also at high risk for erosion (Appendix N).

Wildfires are a key source of sediment in the Clearwater River Basin (Appendix C). The potential for reducing sediment deposition associated with wildfires is limited in the wilderness areas where forest land is protected and active management of the land, including fire management, is limited. The forest road network is the second greatest source of sediment in the subbasin (Appendix C).

The UI/WSU study reported that average annual erosion from agricultural areas in the South Fork, Middle Fork, and Clearwater River watersheds (approximately 24 percent of the subbasin acreage) is estimated to be 1.8 million tons per year (Appendix N). This is roughly equivalent to 1.7 mcy/yr.

As described above, only a small portion of this eroded material makes its way through the drainage system to accumulate within the rivers and reservoirs as sediment.

The Corps' analysis of sediment measurement indicates that the sediment contribution from the Clearwater River at Spalding comprises 22 percent of the total contribution to Lower Granite Reservoir (Corps 2011b). Converting this value to a volumetric estimate indicates that the load of sediment contributed to the reservoir by the Clearwater River subbasin is approximately 0.5 mcy/yr.

Lower Snake River Subbasin

The lower Snake River subbasin, from the mouth of the Clearwater River to the Snake River's confluence with the Columbia River, is located in the southeast corner of Washington and also includes areas in western Idaho. The subbasin comprises approximately 5,471 mi^2, or 17 percent of the sediment-contributing watershed.

The climate in the Lower Snake subbasin is semi-arid; the western portion of the subbasin receives as little as 5 inches of mean annual precipitation, while the eastern part receives as much as 50 inches in the Palouse Mountains (Tetra Tech 2006).

Streamflow in the Lower Snake subbasin may be regulated to a minor extent by the Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams. These projects are 'run of the river' projects having minimal storage capability and thus provide minimal flow regulation capabilities. The average annual discharge measured near Clarkston, Washington, just downstream of the confluence of the Snake and Clearwater Rivers, is 50,300 cfs (Corps 2011c). This essentially comprises the flow entering Lower Granite Reservoir.

The Palouse and Tucannon Rivers flow into the Snake River between Little Goose Dam and Lower Monumental Dam. The USGS measures streamflow on the Palouse River at Hooper, Washington (USGS 2011). The mean annual discharge in 2010 was 264 cfs. The average monthly discharge between 1999 and 2009 ranged from 31 cfs in August to 1,700 cfs in March. The mean annual discharge of the Tucannon River in 2010, measured near Starbuck, Washington, was 141 cfs (USGS 2011). The mean monthly discharge between 1999 and 2009 ranged from 59 cfs in August to 312 cfs in May.

While the discharges from the Palouse and Tucannon Rivers are small compared to the flow of the Snake River, the drainage areas of these watersheds are relatively large. The Palouse River watershed includes approximately 3,300 mi^2 and comprises 60 percent of the Lower Snake subbasin drainage area. The Tucannon River watershed includes approximately 1,400 mi^2, or 27 percent of the total subbasin drainage area (Tetra Tech 2006). Together the Palouse and Tucannon River watersheds comprise 87 percent of the Lower Snake subbasin drainage area. Therefore, the majority of the Lower Snake subbasin drains into the Snake River, downstream of Little Goose Dam and upstream of Lower Monumental Dam.

Land cover in the subbasin is notably different than in the other watershed subbasins in that it is primarily agricultural and privately owned. Dryland agriculture and grazing are prevalent; urban areas include Clarkston and Pullman, Washington, and Lewiston and Moscow, Idaho. The dryland agricultural practices and geology of the area (loess deposits) are the primary source of sediment from this subbasin (Appendix N). Agricultural soils tend to be fine-grained and, as such, agricultural areas contribute mostly silts and clays to the lower Snake River (Appendix N); these fine materials typically remain in suspension through the reservoirs.

The level of land disturbance in the lower Snake River subbasin is considered high (Tetra Tech 2006). The land cover throughout the subbasin has been highly altered by conversion of grasslands primarily to agricultural use. Surface soil erosion hazard is high in all watersheds within the subbasin (Appendix N).

The Palouse River watershed is historically known as an area prone to high rates of erosion and sediment contribution to the Lower Snake system. The prevalence of loess soils, rolling hills, and high winds all contribute to highly erodible land in the Palouse region; disturbance of the soil for agricultural uses can exacerbate these issues. A study conducted by the Soil Conservation Service (now known as the Natural Resources Conservation Service (NRCS) in the 1970s estimated erosion in Palouse River Basin to be approximately 19 million tons per year (SCS 1979); this is roughly equivalent to 18 mcy/yr. Sediment yield was estimated to be approximately 5.4 million tons per year; this is roughly equivalent to 5.0 mcy/yr (SCS 1979). In recent years, agricultural best management practices have been implemented in the Palouse River watershed and other agricultural areas throughout the Snake River basin, which have reduced sediment load to the Snake River system. The UI/WSU study reported average annual erosion from agricultural areas in the lower Snake River subbasin (approximately 79 percent of the total subbasin acreage) to be 4.12 million tons per year (Appendix N). This is roughly equivalent to 3.8 mcy/yr.

Due to the prevalence of agricultural land uses in the Palouse and Tucannon watersheds, agricultural lands represent the primary contributor of sediment within this subbasin. The total estimated yield from the forest and agricultural lands in the lower Snake River subbasin is approximately 187,000 cy/yr. This load contributes sediment to the Little Goose, Lower Monumental, and Ice Harbor Reservoirs, with the majority accruing to Lower Monumental due to it receiving the runoff from the Palouse and Tucannon Rivers. Sediments entering from the

Palouse and Tucannon Rivers are estimated to be predominantly of agricultural origin and therefore likely composed of finer (clay and silt) particle sizes. These are less likely to settle out in areas where they would interfere with authorized purposes of the lower Snake River. Further, the location and quantities of sediments entering the lower Snake River below Lower Granite Dam are minor in comparison to the quantities entering Lower Granite Reservoir.

3.7.3 Lower Snake River System and Sediment Transport

This section provides an overview of the lower Snake River system and sediment transport and accumulation in the lower Snake River system. A portion of the accumulated sediment interferes with flow conveyance, navigation, HMU irrigation intakes, and recreation facilities.

Lower Granite Reservoir, also known as Lower Granite Lake, was created by the construction of Lower Granite Dam. The Salmon River, Clearwater River, Grande Ronde River, and Snake River–Hells Canyon Reach subbasins all drain into and contribute sediment to this reservoir. The Lower Granite Dam is located approximately 13 miles from Pullman, Washington, near Mayview, Washington. The towns of Lewiston, Idaho and Clarkston, Washington are located along the upstream end of the reservoir. The reservoir extends 39.3 miles east behind the dam, to Lewiston, Idaho (Corps 2010b). A 14-foot-deep, 250-foot-wide navigation channel is authorized through the length of Lower Granite Reservoir (and each of the other lower Snake River reservoirs).

The Lower Granite Lock and Dam Project is located on the Snake River near RM 107 (see Figure 3-9). The dam and reservoir provide hydroelectric power, a controlled channel for navigation, 13 developed recreation areas, a navigation lock, wildlife habitat areas, fish passage facilities, water for 6 municipal and industrial pump stations, and access to 3 port facilities on Lower Granite Lake (Corps 2010b). The reservoir has a total volume of 440,000 acre-feet and a surface area of 8,900 acres. The normal operating pool elevation for the Lower Granite Reservoir ranges from 733-738 feet above mean sea level (msl, NGVD 20 Datum).

When the Lower Granite Dam was constructed, a backwater levee system was created to protect the business district of Lewiston (Corps 2002a). The goal of the approximately 7.6 mile-levee system is to allow the Lower Granite Reservoir to pass the standard project flood (SPF) event while protecting Lewiston from inundation. The levees are designed to have a minimum freeboard of 5 feet during the SPF event of 420,000 cfs as measured on the Snake River below the confluence of the Clearwater River (Corps 2002a; Corps 2011c). However, sediment deposition has reduced the channel capacity. This reduction in capacity has caused the rise of the SPF event water surface elevations, increasing the risk of flooding during very large flow events (Corps 2011b).

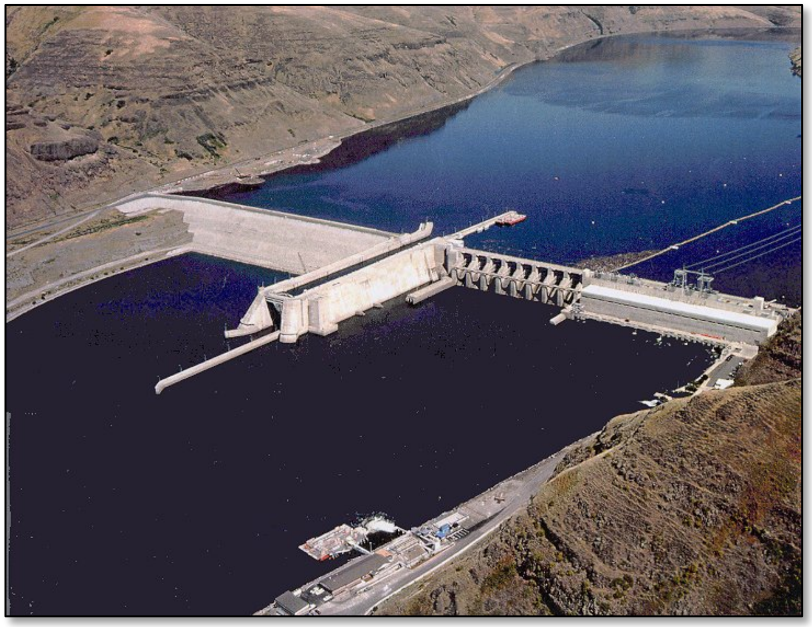


Figure 3-9. Lower Granite Dam
Source: Corps 2002a

The Corps has studied sediment inflow and accumulation by surveying sediment accumulation at a series of river sections along the Snake and Clearwater Rivers and within Lower Granite Reservoir (see Section 1 for a summary of the Corps' studies). These cross sections of the river-bed channel show how the channel would look if sliced perpendicular to flow, and show where sediment has accumulated or has been eroded at a particular section. The sediment cross sections have generally been measured every 2 to 3 years since the creation of the Lower Granite Reservoir (Corps 2011a). The Corps has not conducted detailed sediment cross section surveys outside of Lower Granite Reservoir because the magnitude of sediment accumulation that affects existing authorized purposes is notably less in other reservoirs. Figure 3-10 and Figure 3-11 present examples of the cross sections analyzed in the Corps studies, and show the accumulated sediment between 1974 and 2009 as the difference between the two lines in each figure. Figure 3-10 is from RM 137.69, just downstream of the Port of Clarkston, and shows little accumulation of sediment. Figure 3-11 is from RM 123.3 downstream of Silcott Island, and shows significantly accumulation of sediment in the deep water portion of the reservoir.

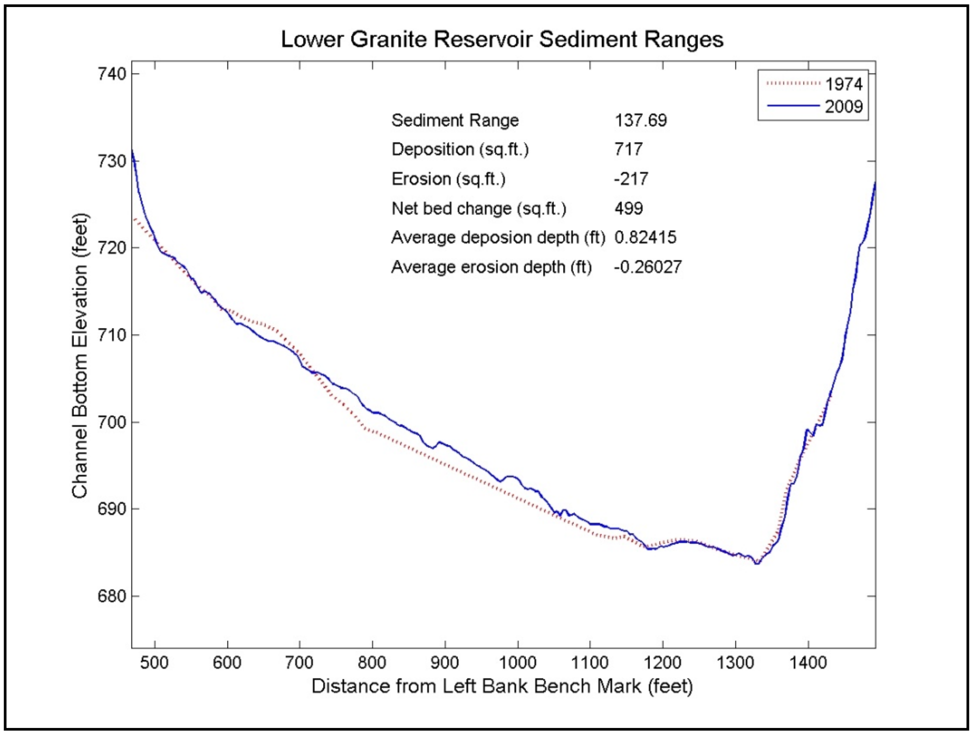


Figure 3-10. Comparison of 1974 and 2009 Sediment Ranges at Snake River Mile 137.69

Source: Corps 2011b, Figure 6, Comparison of 1974 and 2009 sediment ranges at Snake River mile 137.69.

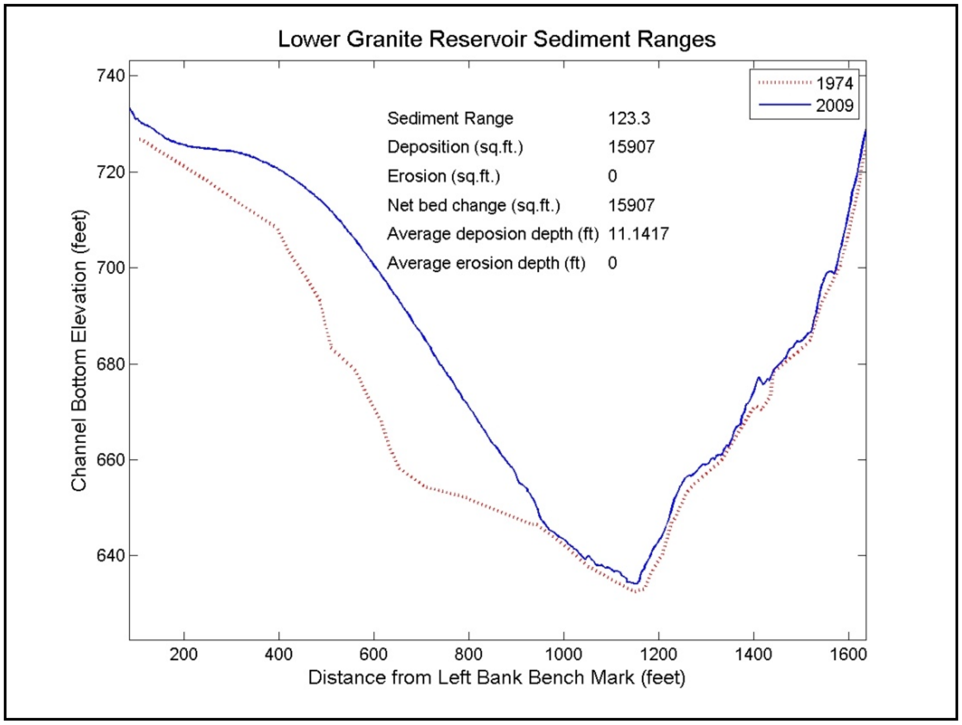


Figure 3-11. Comparison of 1974 and 2009 Sediment Ranges at Snake River Mile 123.30

Source: Corps 2011b, Figure 8, Comparison of 1974 and 2009 sediment ranges at Snake River mile 123.30.

The total estimated gross sediment accumulation in Lower Granite Reservoir from 1974 (when the dam construction was completed) to 2010 is 79.8 mcy (Corps 2011a). The average annual inflow of sediment to the reservoir is estimated to be 2.2 m cy/yr. The actual annual sediment loads vary significantly by year and between sediment range surveys (Corps 2011a). Table 3-17 shows the estimated sediment accumulation in the Lower Granite Reservoir from the Snake and Clearwater Rivers, the accumulation above and below Silcott Island, and the total and average annual volume of sediment (Corps 2011a). Table 3-17 shows that most of the sediment is deposited deep into the reservoir downstream of the Clearwater River confluence. Table 3-18 presents the relative contributions of sediment and sand from the tributaries to the Clearwater and Snake Rivers during water year 2009-2010. Sand is the largest component of sediment accumulating in the confluence area. Larger loads of sediment (particularly of sand) on the Snake River upstream of the confluence with the Clearwater River indicate that the load of sediment being contributed by the Salmon River may be increasing (Corps 2011a). The USFS (Goode et al., 2011) estimates that sediment loads into the Lower Snake system are likely to increase if the amount of wildfire activity increases in the future due to predicted climate change.

Table 3-17. Sediment Accumulation in Lower Granite Reservoir, 1974 – 2010

	Sediment Volume (mcy)				
	Snake River Above Confluence with Clearwater River	Clearwater River Above Confluence with Snake River	Snake River Below Confluence with Clearwater River	Dredged Sediment Volume	Period Total Volume
Total Volume (mcy)	1.30	1.03	74.74	2.76	79.83
Percent of Total	1.6%	1.3%	93.6%	3.5%	100.0%
Average Volume (mcy/yr)	0.04	0.03	2.08	0.08	2.22

Source: Corps 2011a, Table 44, Summary of Sediment Accumulation in Lower Granite Reservoir

Table 3-18. Relative Contributions of Subbasins to Sediment and Sand Load at Lower Granite Reservoir, 2009 – 2010

	Percent of Total Load at Lower Granite Reservoir	
Tributary	Percent of Total Suspended Sediment Load	Percent of Total Suspended Sand Load
Salmon River at Whitebird	53.5	65.2
Grande Ronde River at Mouth	5.8	2.2
Clearwater River at Spalding	12.5	9.5

Source: Corps 2011a, Table 27, Relative Contributions of Tributaries to Total Load at Lower Granite Reservoir

The sediment cross section surveys were also used to analyze the changing distribution of sediment in the Lower Granite Reservoir. This analysis shows that sediment has accumulated downstream of Silcott Island at approximately RM 130, and that the upper reach of the Lower Granite Reservoir between Silcott Island and the confluence is gaining sediment at a reduced rate. The Corps studies indicate that the majority of the sediment load to Lower Granite Reservoir has accumulated below the Clearwater confluence, and the rate of accumulation above Silcott Island has diminished, and some areas above Silcott Island have lost sediment (Corps

2011a). These observations indicate that the confluence area of the reservoir may be at or approaching a localized equilibrium in terms of sediment accumulation (Corps 2011a). This means that sediment accumulating near the confluence of the Snake and Clearwater Rivers is generally being transported downstream during high flow conditions, such that over time there is little change in the flow conveyance capacity of the Lewiston levee system.

Sediment core samples were examined to evaluate the composition of sediment found in Lower Granite Reservoir (Corps 2011a). The size and type of grains that make up sediment affect the way that sediment moves into and through the reservoir. The study found that core samples taken above Silcott Island were composed mostly of medium-grained sand, while core samples taken below Silcott Island were composed of finer-grained sand and silt (Corps 2011a). Above the confluence, the Snake River and the Clearwater River have gravel and cobble beds because flow velocities transport the finer sand and silt downstream into the backwater of the reservoir. In the confluence area, the bed material is almost entirely medium to coarse sand. These results are important indicators of what type of sediment would need to be controlled in order to potentially affect deposition in upstream versus downstream sediment problem areas. To reduce accumulation in the confluence area, it would be necessary to control the load of sand entering the reservoir. Reducing accumulation in the Silcott Island area would require controlling the load of silt and fine sand.

The Corps has also conducted detailed reservoir sediment transport modeling and flood hydrology and hydraulics studies (Corps 2011a). The primary purpose for these studies was to understand the level of existing and future risk of overtopping associated with the levees in the vicinity of the Clearwater River confluence area, and to what extent sediment management measures might alter the deposition and accumulation of sediment that creates issues that impede the Corps' ability to fulfill its existing authorized project purposes and the PSMP EIS' purpose and need. Sediment deposition in this area has the potential to raise the maximum water surface level during extreme flood events such that it would result in the levees associated with the Lower Granite Dam being overtopped. The sediment transport modeling and flood hydraulics and hydrology studies indicate the following (Corps 2011a):

- The SPF [2] on the lower Snake River system has a peak flow of 420,000 cfs. The SPF was the basis for the design of the levee system to provide sufficient flood protection, although Corps studies consider a range of probabilistic factors to estimate flood risk, in accordance with Corps current policy[3].
- Model simulation of 50 years of accumulation and transport of sediment in the Clearwater River above the confluence indicates that the increase in the bed level varies from 5 to 9 feet

[2] The SPF on the lower Snake River System is a very rare and severe flood condition; however its derivation is not based on probability.
[3] Corps ER 1105-2-101 requires that uncertainties in the key parts of the analysis must be quantified and combined to estimate the overall project performance and potential for loss-of-life or economic or environmental consequences. Elements included in the risk analysis are described in Corps 2011a.

in the segment up to the Canadian Pacific Railroad bridge. Total predicted accumulated sediment volume in the 2 miles of the Clearwater River above the confluence is 1.9 mcy over 50 years.

- Model simulation of 50 years of accumulation and transport of sediment in the Snake River above the confluence indicates that the increase in the bed level could be between 1 foot and 5 feet in the segment between the confluence and Interstate Bridge. Total predicted accumulated sediment volume in the Snake River reach above the confluence is 2.9 mcy over 50 years.
- Based on the requirements of ER 1105-2-101, the existing levee systems appear adequate to provide protection from overtopping during the SPF and exceed the requirements for levee systems under the National Flood Insurance Program. After 50 years of simulated sediment accumulation, the model predicts that the levee systems would be adequate to provide protection from overtopping during the SPF.

The Corps' simulations of sediment accumulation used historically-based estimates of future sediment loading to Lower Granite Reservoir. Recognizing that future sediment loads may be greater or less than historic loading due to the effects of climate change, watershed erosion control measures, or other factors, a sensitivity analysis was conducted on the 50-year sediment transport modeling studies to estimate the Lower Granite Reservoir sediment accumulation associated with sediment loads of 125 percent and 75 percent of the historically predicted load. These simulations showed that the greater or lesser loads into the reservoir would produce proportionally greater or lesser accumulation volumes. However, in some locations, a greater load does not produce greater accumulation. Under these scenarios, the channel between RM 130 and 132 and in the vicinity of RM 136 would be stable and would not increase any more if a sediment load greater than 75 percent of the historically predicted load is assumed. In other areas of the reservoir, bed levels would increase or decrease (respectively) by between approximately 1 and 2 feet when sediment load is increased or decreased by 25 percent.

The historic accumulation of sediment in the Lower Granite Reservoir has affected existing authorized purposes of the lower Snake River, including navigation, fish and wildlife conservation, recreation, and flow conveyance at the confluence of the Snake and Clearwater Rivers. Historically, the Corps has used periodic dredging to manage sediment as part of operating and maintaining the reservoir. The Corps has dredged a portion of the accumulated sediment from specific problem areas and disposed of the material, either upland of the reservoir, or "in-water" within the reservoir in an area where additional sediment will not cause problems and require further dredging (see Table 3-19). Since the 1990s, the dredged sediment has been used for creating habitat for native fish species. Table 3-19 lists the past dredging activities conducted in the Lower Granite Reservoir. Dredging of sediment that interferes with authorized purposes has been conducted approximately every 3 to 5 years since the Lower Granite Dam was put into service. The primary reasons for this dredging are: 1) to maintain the required and congressionally authorized dimensions of the federal navigation channel to provide for navigation; and 2) to maintain flow conveyance capacity to reduce the risk of flooding near the confluence of the Snake and Clearwater Rivers.

While dredging has addressed the problems associated with sediment deposits, it does not prevent more sediment from accumulating in the same or other problem areas. The Corps has identified several areas in the Lower Granite Reservoir where sediment accumulation has or could potentially interfere with authorized purposes of the lower Snake River.

Table 3-20 lists the problem areas identified by the Corps for the Lower Granite Reservoir and adjacent areas, including the confluence of the Snake and Clearwater Rivers.

Table 3-19. Historic Dredging Activities in the Lower Granite Reservoir

Dredging Location	Year	Purpose	Amount Dredged Cubic Yards	Dredged Material Placement
Port of Clarkston – Lower Granite Reservoir	1982	Navigation	5,000	Upland site
Port of Lewiston – Lower Granite Reservoir	1982	Navigation/ maintain flow conveyance capacity	256,175	Upland sites
Confluence of Clearwater and Snake Rivers	1985	Maintain flow conveyance capacity	771,002	Wilma HMU
Port of Lewiston – Lower Granite Reservoir	1986	Navigation/ maintain flow conveyance capacity	378,000	Upland sites
Confluence of Clearwater and Snake Rivers	1988	Maintain flow conveyance capacity	915,970	In-water
Confluence of Clearwater and Snake Rivers	1989	Maintain flow conveyance capacity	993,445	In-water
Confluence of Clearwater and Snake Rivers	1992	Maintain flow conveyance capacity	520,695	In-water
Ports of Lewiston, Almota, and Walla Walla	1991/92	Navigation	90,741	Upland and in-water
Confluence of Clearwater and Snake Rivers	1996/97	Navigation	68,701	In-water
Port of Clarkston – Lower Granite Reservoir	1997/98	Navigation	12,154	In-water
Port of Lewiston – Lower Granite Reservoir	1997/98	Navigation	3,687	In-water
Greenbelt Recreation Area Clarkston – Lower Granite Reservoir	1997/98	Navigation	5,601	In-water
Confluence of Clearwater and Snake Rivers	1997/98	Navigation	215,205	In-water
Confluence of Clearwater and Snake Rivers	2005/2006	Navigation	420,000	In-water
Port of Clarkston – Lower Granite Reservoir	2005/2006	Navigation	11,000	In-water
Port of Lewiston – Lower Granite Reservoir	2005/2006	Navigation	5,000	In-water

Table 3-20. Corps-Identified Potential Sediment Problem Areas in the Lower Granite Reservoir and Adjacent Areas

Reservoir	River	Approximate River Mile[1]	Site Name	Use
Lower Granite	Clearwater	1.0-2.0	Port of Lewiston	Navigation
		3.0	Clearwater Boat Ramp	Recreation
	Snake/ Clearwater	131.5-139.5/0.0-2.0	Snake River at Mouth of Clearwater River	Navigation, conveyance
	Snake	128-130	Silcott Island	Navigation
		137.0	Hells Canyon Resort	Recreation
		139.0	Port of Clarkston	Navigation
		139.5	Greenbelt Recreation Area	Recreation
		140.5	Southway Boat Ramp	Recreation
		141.5	Swallows Park Recreation Area and Swim Beach	Recreation
		142.5	Hells Gate State Park	Recreation
		146.0	Chief Looking Glass Park	Recreation

[1] River mile indicates the number of miles upstream of the mouth of the Snake River

3.7.3.1 Little Goose Reservoir

Little Goose Reservoir, also known as Lake Bryan, was created by the construction of the Little Goose Dam in 1970 (Corps 2002a). The tributaries to Little Goose Reservoir are Deadman Creek, Almota Creek, Penawawa Creek, New York Gulch, and Dry Gulch. The Little Goose Lock and Dam are located approximately 9 miles northeast of Starbuck, Washington. The reservoir extends approximately 37 miles from the Little Goose Dam east to the Lower Granite Dam (Corps 2002b).

Figure 3-12. Little Goose Dam
Source: Corps 2002b

The Little Goose Lock and Dam project is located near RM 70 on the Snake River (see Figure 3-12). The project was completed and began operating in 1970. The project provides hydroelectric power generation, a navigation lock, and fish passage facilities; in addition, recreation areas and wildlife habitat areas are located on the reservoir behind Lower Goose Dam. The reservoir has a volume of 516,000 acre-feet and a surface area of 10,025 acres. The normal operating pool elevation for the Little Goose Reservoir ranges from 633-638 msl NGVD 29 Datum (Corps 2002a; 2002b; 2010b).

The only dredging that has occurred in Little Goose Reservoir has been done in the area of Schultz Bar and the downstream lock approach at Lower Granite Dam. Other problem areas have been identified where dredging or other measures might be necessary in the future. Table 3-21 lists the past dredging activities conducted in Little Goose Reservoir. Table 3-22 lists the potential problem areas identified by the Corps for Little Goose Reservoir.

Table 3-21. Historic Dredging Activities in Little Goose Reservoir

Dredging Location	Year	Purpose	Amount Dredged Cubic Yards (m^3)	Dredged Material Placement
Schultz Bar – Little Goose Reservoir	1991	Navigation	27,335 (20,899.1)	Upland
Schultz Bar – Little Goose Reservoir	1995	Navigation	14,100 (10,780.2)	In-water
Lower Granite – Downstream Navigation Lock Approach	1997/98	Navigation	2,805 (2,144.6)	In-water
Lower Granite – Downstream Navigation Lock Approach	2005/2006	Navigation	2,000	In-water

m^3 = cubic meters

Table 3-22. Corps-Identified Potential Sediment Problem Areas in Little Goose Reservoir

Reservoir	River	Approximate River Mile[1]	Site Name	Use
Little Goose	Snake	82.5	Central Ferry State Park	Recreation
		83.0	Port of Garfield Access	Navigation
		83.5	Port of Central Ferry	Navigation
		88.0	Willow Landing HMU	Water intake/recreation
		100.0-102.0	Navigation Channel at Schultz Bar	Navigation
		103.5	Port of Almota	Navigation
		103.5	Illia Landing	Recreation
		105.5	Boyer Park and Marina	Recreation
		107.0	Lower Granite Lock Approach	Navigation

[1] River mile indicates the number of miles upstream of the mouth of the Snake River

3.7.3.2 Lower Monumental Reservoir

Lower Monumental Reservoir, also known as Lake Herbert G. West, was created by the construction of the Lower Monumental Dam in 1969 (Corps 2002a). The main drainages to Lower Monumental Reservoir are the Palouse/Rock Rivers and the Tucannon River, as well as smaller drainages including Alkali Flats Creek, and Fields Gulch. The Lower Monumental Lock and Dam is located approximately 6 miles south of the town of Kahlotus, Washington, which is approximately 43 miles north of Walla Walla, Washington. The reservoir extends approximately 29 miles from the Lower Monumental Dam east to the Little Goose Dam (Corps 2002b).

The Lower Monumental Lock and Dam project is located near RM 42 on the Snake River (see Figure 3-13). The project was completed and began operating in 1969. The dam provides hydroelectric power generation, a navigation lock, and fish passage facilities. In addition, the reservoir behind the dam includes six developed recreation areas, wildlife habitat areas, and one port facility. The reservoir has a volume of 432,000 acre-feet and a surface area of 6,590 acres. The normal operating pool elevation for the Lower Monumental Reservoir ranges from 537-540 msl NGVD 29 Datum (Corps 2002a; 2002b; 2010c). No past dredging activities have been conducted in the Lower Monumental Reservoir.

Figure 3-13. Lower Monumental Dam
Source: Corps 2002a

Table 3-23 lists the potential problem areas identified by the Corps for the Lower Monumental Reservoir.

Table 3-23. Corps-Identified Potential Sediment Problem Areas in the Lower Monumental Reservoir

Reservoir	River	Approximate River Mile[1]	Site Name	Use
Lower Monumental	Snake	48.0	Skookum HMU	Water intake/irrigation
		51.0	Ayer	Recreation
		55.0	55-Mile HMU	Water intake/irrigation
		56.5	Joso HMU	Navigation
		59.5	Lyons Ferry State Park	Recreation
		66.0	Texas Rapids Recreation Area	Recreation
		70.0	Little Goose Lock Approach	Navigation

[1] River mile indicates the number of miles upstream of the mouth of the Snake River

3.7.3.3 Ice Harbor Reservoir

Ice Harbor Reservoir, also known as Lake Sacajawea, was created by the construction of the Ice Harbor Dam in 1961. The dam is located approximately 8 miles east of Pasco, Washington. It was the first Corps dam constructed on the lower Snake River in Washington (Corps 2002a). There are only two streams that drain into the Ice Harbor Reservoir: Walker Canyon Creek and an unnamed tributary (Tetra Tech 2006). The reservoir extends approximately 32 miles from the Ice Harbor Dam upstream east to the Lower Monumental Dam (Corps 2002b).

The Ice Harbor Lock and Dam are located near RM 10 on the Snake River (see Figure 3-14). The dam provides hydroelectric power, a navigation lock, and fish passage facilities. The reservoir behind the dam includes six developed recreation areas, wildlife habitat areas, and one port facility. The reservoir has a volume of 24,900 acre-feet (between elevations 437 and 440 msl) and a surface area of 8,375 acres. The normal operating pool elevation for the Ice Harbor Reservoir ranges from 437-440 msl NGVD 29 Datum (Corps 2002a; 2002b; 2010c).

Figure 3-14. Ice Harbor Dam
Source: Corps 2002b

Past dredging was conducted near the downstream approach to Lower Monumental Dam for the purpose of maintaining navigation. The Corps has identified potential problem areas where authorized purposes, including irrigation withdrawals and recreation, may be affected in the future. Table 3-24 lists the past dredging activities conducted in Ice Harbor Reservoir since the facilities were completed.

Table 3-25 lists the potential problem areas identified by the Corps for Ice Harbor Reservoir.

Table 3-24. Historic Dredging Activities in Ice Harbor Reservoir

Dredging Location	Year	Purpose	Amount Dredged Cubic Yards	Dredged Material Placement
Downstream Approach – Navigation Channel Lower Monumental Lock and Dam	1972	Navigation	25,000	Upland and in-water
Downstream Approach – Channel Construction Lower Monumental Lock	1977	Navigation	10,000	Upland
Lower Monumental – Navigation Lock Approach	1998/ 99	Navigation	5,483	In-water
Lower Monumental – Navigation Lock Approach	2005/2006	Navigation	12,000	In-water

Table 3-25. Corps-Identified Sediment Problem Areas in Ice Harbor Reservoir

Reservoir	River	Approximate River Mile1	Site Name	Use
Ice Harbor	Snake	10.0	North Shore Boat Ramp	Recreation
		11.5	Charbonneau Park	Recreation
		13.5	Levey Park	Recreation
		15.0	Big Flat HMU	Water intake/irrigation
		18.0	Fishhook Park	Recreation
		23.0	Lost Island HMU	Water intake/irrigation
		24.5	Hollebeke HMU	Water intake/irrigation
		29.0–33.3	Walker's Elevator	Navigation
		39.0	Windust Boat Ramp	Recreation
		41.0	Lower Monumental Lock Approach	Navigation

[1] River mile indicates the number of miles upstream of the mouth of the Snake River

3.7.3.4 Snake River Downstream of Ice Harbor Dam

The reach of the Snake River downstream of Ice Harbor Dam merges into the McNary Reservoir on the Columbia River near Pasco, Washington. The Columbia River then continues south and curves west to the McNary Dam, which is located outside of the watershed study area approximately one mile east of the City of Umatilla, Oregon (Corps 2002a). The McNary Reservoir, also known as Lake Wallula, was created by the construction of the McNary Dam in 1957. The reservoir extends 64 miles upstream to the U.S. Department of Energy's Hanford Site on the Columbia River and approximately 10 miles up the Snake River to Ice Harbor Lock and Dam.

Table 3-26 lists the dredging activities conducted in the Snake River portion of McNary Reservoir since the facilities were completed. Materials dredged from below Ice Harbor Lock and Dam project have been notably different from sediments dredged in the Snake River and a portion of the lower Snake River reservoirs. Dredged material from below Ice Harbor Lock and Dam has been predominantly larger cobbles and boulders that have accumulated in the federal navigation channel and lock approach following completion of the dam's construction. It is important to note that these materials did not pass through Ice Harbor Dam as sediment transported by the Snake River. Table 3-27 lists the potential problem areas identified by the Corps for McNary Reservoir. The potential issues identified in this reservoir include maintenance of navigation and continued opportunities for recreation.

Table 3-26. Historic Dredging Activities in McNary Reservoir (Snake River Portion)

Dredging Location	Year	Purpose	Amount Dredged Cubic Yards	Dredged Material Placement
Downstream Navigation Channel – Ice Harbor Lock and Dam	1972	Navigation	80,000	Upland and in-water
Navigation Channel – Downstream of Ice Harbor Lock and Dam	1973	Navigation	185,000	Upland and in-water
Downstream Approach – Channel Construction Ice Harbor Lock	1978	Navigation	110,000	Upland and in-water
Downstream Approach – Channel Construction Ice Harbor Lock	1985	Navigation	98,826	In-water
Downstream Approach – Channel Construction Ice Harbor Lock	1978/ 81/82	Navigation	816,814	Upland and in-water
Downstream Approach – Ice Harbor Lock and Dam	2012	Navigation	400	Upland

Table 3-27. Corps Identified Potential Sediment Problem Areas in McNary Reservoir (Snake River Portion)

Reservoir	River	Approximate River Mile1	Site Name	Use
McNary	Snake	0.0	Sacajawea State Park	Recreation
		1.0	Burbank State Park	Navigation
		1.5	Hood Park Boat Ramp	Recreation
		9.2	Ice Harbor Lock Approach/Nav Coffer Cells	Navigation
		0.0–1.5	Snake River Entrance	Navigation
		2.0–10.0	Nav Channel Below Ice Harbor	Navigation

[1] River mile indicates the number of miles upstream of the mouth of the Snake River

3.7.4 Current Immediate Need Action

At the Snake River/Clearwater River confluence location, the sediments adversely encroaching on the federal navigation channel are predominantly sand-sized particles, with minor amounts of silt sizes present, which have likely been naturally eroded from upstream sources somewhere in the sediment-contributing watershed and transported downstream to the confluence by the natural sediment transport capabilities of the Snake River system's waters. In the confluence area, the sediments being transported begin to settle out of the water column due to reducing flow velocities as the Snake and Clearwater Rivers enter Lower Granite Reservoir. It is extremely difficult if not impossible to accurately determine the precise sources of the sediments being deposited, and the sediments likely are being contributed from many locations upstream within the sediment-contributing watershed.

At the Ice Harbor downstream navigation lock approach the sediments adversely encroaching on the federal navigation channel are generally coarse river cobbles which have been repositioned by the very turbulent and unpredictable hydraulic conditions encountered downstream of Ice Harbor project. These hydraulic conditions are most likely induced by the Snake River's larger flow events passing through Ice Harbor Dam through the dam's spillways, through its hydroelectric turbines, or through the use of its navigation lock facilities. It is important to note that the large coarse materials to be removed by the action to re-establish the navigation channel to its congressionally authorized dimensions have not been passed through Ice Harbor Dam by the Snake River; but rather are previously existing river-bed materials which have been repositioned by turbulent hydraulic actions immediately downstream of Ice Harbor Dam.

The Corps identified Snake RM 116 in Lower Granite reservoir as a site suitable for placing dredged material in-water to create shallow water habitat. This site is an approximately 120-acre mid-depth bench (water depth of 20-60 feet) on the left bank of the Snake River about ½-mile upriver of Knoxway Canyon and 23 miles downstream from the Snake-Clearwater Rivers confluence. This is the furthest upstream mid-depth underwater bench in Lower Granite reservoir that is still downstream of RM 120. In-water disposal in Lower Granite reservoir needs to take place downstream of RM 120 to avoid affecting the water surface elevation at the confluence of the Snake and Clearwater Rivers. Material placed in-water upstream of RM 120 can raise the water level in the upper portion of the reservoir and impede the ability of high flows to move through the channel. This diminishes the capability of the channel to pass high flows at the confluence and increases the flood risk at Lewiston, Idaho.

3.8 Hazardous, Toxic, and Radioactive Waste

This section focuses on qualitatively evaluating potential hazardous, toxic, and radioactive waste (HTRW) risks associated with land uses and materials that are manufactured, transported, or used within the area of the potential affected environment. Potential HTRW concerns, in terms of historic and ongoing activities within the area of the potential affected environment are presented as a general discussion of potential sources of HTRW in the watershed study area as a whole.

The Corps reviewed available information (such as state databases for storage and placement of hazardous material and waste), land use characteristics, and previous studies. Potential HTRW sources and concerns are discussed below.

In areas with agricultural uses, such as those in the LSRP watershed, possible contaminants of concern for agricultural and urban land uses include a broad suite of pesticides, herbicides, fertilizers, petroleum and associated compounds, chlorinated solvents, degreasers, and various heavy metals. Some of these contaminants can become waterborne and enter the LSRP through runoff. Agricultural chemicals have been used in areas surrounding the LSRP for decades. Each crop has specific chemical uses associated with it. Some agricultural chemicals have a longer residence time in soil and may break down into residual products that can accumulate to form toxic residue. Other agricultural chemicals, banned from use today, may be found in trace amounts in soils and sediments.

Urban land use areas located adjacent to the LSRP have many facilities with the potential for hazardous material releases. Common types of those facilities include gas stations, dry cleaners, automotive repair shops, and industrial operations. The most common contaminants of concern in soil and groundwater in urban areas are petroleum and associated compounds (typically gasoline and diesel releases from underground storage tanks (USTs) and spills), chlorinated solvents and degreasers (from dry cleaning and vehicle repair facilities), and various heavy metals, such as arsenic and lead. In addition, the transport of materials like petroleum and chemicals can raise HTRW concerns.

Large amounts of oils, such as transformer oil, turbine oil, and lubricating oil, are stored at each of the LSRP lock and dam facilities. Most of the oil is stored inside oil-filled operating equipment. Other hazardous material sources at the facilities include diesel oil and fuel, gasoline, propane gas tanks, carbon dioxide (for fire suppression), and various greases and refrigerants. The facilities also use a variety of solvents, paints, thinners, cleaners, aerosols, epoxy, enamel, and vinyl products stored in 55-gallon or smaller containers. Currently, each of the four dams maintain Spill Prevention, Control, and Countermeasure (SPCC) Plans to describe the handling, storage, and inspection measures each facility takes to prevent discharges from occurring and emergency response procedures should there be an uncontrolled spill event.

Sediments within the LSRP are not expected to require special management prior to handling or placement and would not be considered as industrial or hazardous waste. Sediments below navigable waters qualify as HTRW only if they are within the boundaries of a site designated by the EPA or state agency for a response action or are part of the National Priority List under CERCLA (U.S.C. Sections 9601 -9675). No HTRW sites have been identified in the lower Snake River navigation channel (Corps 2005).

3.8.1 Current Immediate Need Action

There are no HTRW sites at any of the proposed dredging sites or the proposed disposal site.

3.9 Air Quality

Air quality changes over time as economic development occurs and regulatory programs affect air emissions from sources. The following discussion provides a general summary of air quality in the broader area of the potential affected environment and specifically within the LSRP.

This section also presents information on climate change and greenhouse gases (GHG). The study area for the discussion related to climate change and GHG is considered to be the entire planet as climate change issues are global in nature and incremental effects of GHG emissions may be felt in all parts of the planet.

3.9.1 Regional Air Quality Conditions

The area of the potential affected environment has an arid climate with minimal cloud cover and elevations ranging from approximately 300 to 500 feet above sea level. The average annual rainfall ranges from 7 to 20 inches depending on location, and average temperatures range from 35 to 37^{o} F in winter and 71 to 75^{o} F in summer (WRCC 2014). Summer and fall storm activity leads to strong wind gusts creating dust storms and making the area prone to wind erosion.

The air quality in a given region is measured by the concentration of criteria pollutants in the atmosphere. Under the CAA, the EPA developed numerical concentration-based standards, NAAQS, for criteria pollutants that have been determined to affect human health and the environment. The NAAQS represent the maximum allowable concentrations for ozone, which is measured as nitrogen oxides (NOx) and volatile organic compounds (VOCs); carbon monoxide (CO); nitrogen dioxide; sulfur dioxide (SO_2); respirable particulate matter (including particulate matter equal to or less than 10 microns in diameter (PM10) and particulate matter equal to or less than 2.5 microns in diameter (PM2.5]); and lead (40 Code of Federal Regulation Part 50).

The EPA classifies the air quality in a region according to whether the concentrations of criteria pollutants in ambient air exceed the NAAQS. Areas are designated as either “attainment,” “nonattainment,” “maintenance,” or “unclassified” for each of the six criteria pollutants. Attainment means that the air quality is better than the NAAQS; nonattainment indicates that criteria pollutant levels exceed NAAQS; maintenance indicates that an area was previously designated nonattainment but is now attainment; and an unclassified air quality designation by the EPA means that there is not enough information to appropriately classify an area, so the area is considered attainment.

The area is generally rural with relatively few major sources of air pollution emissions. Examples of sources of regulated air pollutants in the area include transportation sources (such as cars, buses, trucks, trains, ships and barges, and aircraft), urban sources (including wood smoke, emissions from commercial operations, and gas-powered residential equipment), reintrained dust (which is naturally occurring particulate matter that is resuspended into the atmosphere through natural processes such as wind), agricultural practices (including field burning, reintrainment of dust from practices such as plowing, and emissions from farm equipment), and wild fires. These types of sources occur, to varying degrees, throughout the area.

The air quality within the broad area of the potential affected environment is considered good by EPA standards and there are no areas that are not in attainment.

3.9.2 Regional Greenhouse Gas Conditions

GHGs are chemical compounds found in the earth's atmosphere that absorb and trap infrared radiation, or heat, re-radiated from the surface of the earth. The trapping and build-up of heat in the atmosphere increases the earth's temperature, warming the planet and creating a greenhouse-like effect (EIA 2009a). ***Anthropogenic*** activities (caused or produced by humans) are increasing atmospheric concentrations to levels that could increase the earth's temperature up to 7.2 F by the end of the twenty-first century (EPA 2010a).

The U.S. Global Climate Research Program (GCRP) summarizes the effects of global climate change to date in their report on *Global Climate Change Impacts in the United States* (GCRP 2009). The GCRP has found that, since the 1970s, average temperatures in the United States have risen, sea levels have risen, and precipitation patterns have changed. These findings are supported by the Intergovernmental Panel on Climate Change (IPCC) for the global climate (IPCC 2007).

The principle GHG emitted into the atmosphere through human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (EPA 2010b). Of these four gases, CO_2 is the major GHG emitted (EPA 2010b; Houghton 2010). For example, CO_2 emissions from the combustion of coal, oil, and gas constitute 81 percent of all U.S. GHG emissions (EIA 2009b). Carbon dioxide enters the atmosphere primarily through the burning of fossil fuels such as coal, natural gas and oil, and wood products; as a result of land use changes; and the manufacturing of cement, among other industrial sources. Prior to the industrial revolution, concentrations were roughly stable at 280 parts per million (ppm), but have increased 39 percent to 390 ppm in 2011, an increase which is attributed to human activities (IPCC 2013).

Of the remaining three principle GHGs, methane is emitted during the production and transport of fossil fuels, through intensive animal farming, and by the decay of organic waste in landfills. Methane concentrations have increased 148 percent above preindustrial levels (EPA 2010b). Nitrous oxide is emitted during agricultural and industrial activities, and during the combustion of fossil fuels and solid waste. Nitrous oxide atmospheric levels have increased 18 percent since the beginning of industrial activities (EPA 2010b). Fluorinated gases, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic compounds emitted through industrial processes and now are being used to replace ozone-depleting compounds such as chlorofluorocarbons in insulating foams, refrigeration, and air conditioning. Although they are emitted in small quantities, these gases have the ability to trap more heat than CO_2 and are considered high global-warming potential gases. Atmospheric concentrations of fluorinated gases have been increasing over the last two decades and are expected to continue to increase (EPA 2010b).

Global atmospheric GHG concentrations are a product of emissions and removal over time. Soils store carbon in the form of decomposing plant materials and constitute the largest carbon reservoir on land. Through the process of photosynthesis, atmospheric carbon is also captured and stored as biomass in vegetation, especially forests.

Stored carbon can be released back into the atmosphere when biomass is burned (ESA 2008). In addition, CO_2, N_2O, and CH_4 emissions increase in areas where soil disturbance occurs (Kessavalou et al. 1998). Models predict atmospheric concentrations of all GHG will increase over the next century, but the extent and rate of change is difficult to predict, especially on a global scale.

In 2000, Oregon's GHG emissions were 67.7 million metric tons of carbon dioxide equivalent (MMtCO_2e), which was equal to approximately one percent of U.S. GHG emissions (more than 7 billion metric tons CO_2e). This represented a 15 percent increase over Oregon's 1990 GHG emissions of 58.7 MMtCO_{2e}. According to its worst-case forecast, the Oregon Department of Energy estimates that GHG emissions from Oregon will be 61 percent higher by 2025 (Oregon Department of Energy 2004).

Of the GHG emissions from Oregon in 2000, 84 percent came from CO_2. The primary source of CO_2 pollution came from burning fossil fuels, such as coal at power plants serving the state, gasoline, diesel, and natural gas. There were also emissions from industrial processes, such as manufacture of cement and from combustion of fossil-fuel derived products in burning municipal and industrial wastes (Oregon Department of Energy 2004).

The Washington Department of Community, Trade, and Economic Development (WDCTED) and Ecology published the current Washington GHG inventory in December 2007 (Ecology and WDCTED 2007). Their data shows that, in 1990, industrial sources in Washington State emitted 88.4 MMtCO_2e. Between 1990 and 2000, emissions grew steadily to over 100 MMtCO_2e. Emissions then dropped significantly over the next 2 years, largely because of the permanent shutdown of much of Washington's aluminum manufacturing industry, before resuming a steady increase between 2003 and 2005 (Ecology and WDCTED 2008).

During the 1990s and 2000s, Washington's GHG emissions were dominated by burning fossil fuels such as gasoline and natural gas. The main source of emissions in Washington is the transportation sector, which produces almost half of the state's GHG emissions. The next largest sector was emissions from electricity consumption, followed by combustion emissions in the industrial and residential/commercial sectors (Ecology and WDCTED 2008).

GHG analyses indicate that in 2005, activities in Idaho accounted for approximately 37 MMtCO_2e, an amount equal to approximately 0.5 percent of total U.S. GHG emissions (based on 2004 U.S. emissions). Idaho's gross GHG emissions are rising faster than those of the nation as a whole (gross emissions exclude carbon sinks, such as forests). Idaho's gross GHG emissions increased 31 percent from 1990 to 2005, while national emissions rose by only 16 percent from 1990 to 2004 (Center for Climate Strategies 2008).

Transportation and agriculture are Idaho's principle GHG emissions sources. Together, these two sectors accounted for 51 percent of Idaho's gross GHG emissions in 2000. The use of fossil fuels — natural gas, oil products, and coal — in the residential, commercial, and industrial sectors constituted another 19 percent of total Idaho emissions. The combustion of fossil fuels for electricity generation (including emissions associated with the generation of electricity imported from other states) constituted only 13 percent of total Idaho emissions, which is a little less than the nation as a whole (Center for Climate Strategies 2008).

3.9.3 Current Immediate Need Action

There are no specific sources of regulated air pollutants within the area of effect of the current immediate need action. Equipment associated with the dredging operation and transport and placement of dredged materials would produce hydrocarbon, carbon monoxide, and diesel air emissions during operation.

Greenhouse gas conditions in the area of the current immediate need action are the same as those described above in Section 3.9.2.

3.10 Aesthetics

The LSRP are located in an arid region with surrounding open and agricultural landscapes and is predominantly rural in character except for the Tri-Cities area in Washington, and the Lewiston-Clarkston areas around Lower Granite Reservoir. The river passes through and is adjacent to the Blue Mountains and Columbia Basalt Plain physiographic provinces. The land surrounding the Snake River at its confluence with the Columbia is composed of low hills with steppe vegetation. Moving upstream, the valley walls become steeper, forming a canyon with sidewalls ranging from 200 to 2,000 feet high. The steep buttes and walls surrounding the river are the dominant features of this landscape. Throughout much of the area, roadways (e.g., U.S. Highway 12) and railroad facilities are adjacent to the reservoirs. Aesthetics of the Lower Snake River

The lower Snake River provides a water feature in an arid landscape with often dramatic, steep surrounding hillsides and canyons, making it an important aesthetic resource in the geographical area of the potential affected environment. Many of the recreational facilities developed along the lower Snake River take advantage of the scenic qualities of this landscape, as well as water-based recreation such as boating and fishing. In the urbanized areas, riverfront parkland has been developed and is heavily used.

The aesthetic values of the river and surrounding landscapes vary based on the viewers' perspectives and values. Highway travelers tend to view the resources as they are traveling on roadways, such as along U.S. Highway 12, which parallels the Snake River over several stretches of its alignment; as such, these travelers tend to view the resources at a distance, generally at high rates of speed. Recreational users tend to view the resources for longer periods of time because they are involved in recreational activities that are dependent on the river setting. Local residents tend to view the resources as they go about their daily business, as well as when they use the river and surrounding lands for recreational purposes (Corps 1992).

The levees in Lewiston-Clarkston provide a visual, as well as recreational resource, with landscaping, walking paths, and points that provide views of the river. The levees do obscure views of the river from various locations in Lewiston, Idaho. Throughout the geographical area of the potential affected environment, viewing patterns vary seasonally in a manner similar to recreational uses of the river and surrounding lands, with more activities during the warm and sunny periods in late spring, summer, and early fall.

3.10.1 Current Immediate Need Action

The Ice Harbor navigation lock approach is located at the downstream end of the LSRP where the surrounding topography is more open with low hills. The shoreline adjacent to the work area is an area that was highly disturbed and reshaped during construction of the dam. Because of the soil disturbance and the more arid climate, vegetation is sparse and largely composed of non-native grasses and forbs. There are some pockets of shrubs along both banks of the river. The site has an industrial atmosphere as it is adjacent to the dam.

The confluence area, including the ports, is located at the upstream end of the LSRP where the surrounding topography is a somewhat narrow canyon with steep-sloped canyon walls. The shoreline adjacent to the dredging and dredged material placement area is a mix of port/industrial use, levees, and riprap. A county road runs along the north shore. Vegetation on the steep slopes is grasses and forbs with shrubs in the draws.

SECTION 4.0 ENVIRONMENTAL EFFECTS OF ALTERNATIVES

The following sections describe the potential effects on the natural and human environment of the three plan alternatives carried forward for more detailed analysis. These sections present both the general effects of potential future actions (that is, actions to address both future forecast and future immediate needs) and the effects of the proposed current immediate need action to re-establish the congressionally authorized navigation channel dimensions. The discussion of the effects of the current immediate need action includes effects associated with the related Port berthing-area maintenance. Effects descriptions for each resource and alternative are organized by actions taken to maintain the authorized purposes of the LSRP (i.e., effects of measures implemented to address problem sedimentation accumulation relative to navigation, recreation, fish and wildlife conservation, and flow conveyance through the Lewiston levee system).

Alternative 1 represents no change from the current management of the LSRP and addresses sediment accumulation that interferes with the existing authorized purposes of the LSRP through operating the reservoirs for the navigation objective and adjusting operational procedures at the dams. Alternative 5 is a plan based primarily on dredging to address sediment accumulation that interferes with the existing authorized purposes of the LSRP. Alternative 7 presents a variety of measures– dredging and dredged material management, system management, and structural sediment management – to evaluate and potentially implement within the LSRP to address sediment accumulation that interferes with the existing authorized purposes. All three alternatives include ongoing coordination with land management agencies through the LSMG and assume that agencies and land owners responsible for land management in the basins (including federal and state agencies, tribes, and conservation districts) would continue to implement existing land management programs and practices (BMPs) related to erosion control (USRM) at current or increased levels of implementation as funding and technology allow.

Implementation of Alternative 1 would be the same for the current immediate need action to re-establish the navigation channel to its congressionally authorized dimensions and for future actions. For both future needs and the current immediate need, the Corps would monitor conditions in the LSRP and manage the reservoir levels (consistent with applicable biological opinion and other requirements) to provide a 14-foot water depth in the navigation channel and, to the extent possible, provide for other existing authorized purposes. The Corps can raise reservoir levels only to the maximum operating pool elevation for each reservoir, thereby limiting this alternative’s effectiveness.

Alternative 5 would address future needs through dredging and dredged material management measures. The Corps would monitor sediment in the LSRP, and either in anticipation of or in response to sediment accumulation that interferes with existing authorized purposes, the Corps would initiate planning, environmental compliance and implementation of dredging and dredged material management. The general effects of future implementation of dredging and dredged material management are described below by resource. Alternative 5 would also include navigation objective reservoir operations (Alternative 1) as a measure for maintaining existing authorized purposes of the LSRP. As noted in Section 1, environmental compliance for future actions would include NEPA review and documentation tiered off of this EIS. The current immediate need (re-establishing the congressionally authorized dimensions of the federal navigation channel) would be addressed by navigation objective reservoir operation in the interim and dredging and dredged material management.

Alternative 7 would be the same as Alternative 5 but also includes system management and structural sediment management measures. The Corps would monitor sediment in the LSRP, and either in anticipation of or in response to sediment accumulation that interferes with existing authorized purposes, and would initiate planning, environmental compliance, design and implementation of cost-effective and environmentally acceptable measures to address specific sedimentation problems. The general effects of future implementation of any of the measures are described below by resource. As noted in Section 1, environmental compliance for future actions would include NEPA review and documentation tiered off of this EIS. The current immediate need would be addressed by navigation-objective reservoir operation and dredging and dredged material management.

Table 4-1. Alternatives and Associated Measures

Measures	Alternative 1 - No Action Alternative: Continue Current Practice	Alternative 5 - Dredging-Based Sediment Management	Alternative 7- Comprehensive (Full System and Sediment Management Measures)
Dredging and Dredged Material Management			
Navigation Channel and Other Dredging		●	●
Dredging to Improve Flow Conveyance Capacity		●	●
Beneficial Use of Sediment		●	●
In-water Disposal of Sediment		●	●
Upland Disposal of Sediment		●	●
Structural Sediment Management			
Trapping Upstream Sediments (in reservoir)			●
Agitation to Resuspend Sediment			●
Bendway Weirs			●
Dikes and Dike Fields			●
System Management			
Reservoir Drawdown to Add Conveyance Capacity			●
Reservoir Drawdown to Flush Sediment			●
Navigation-Objective Reservoir Operation	●	●	●
Reconfigure Affected Facilities			●
Relocate Affected Facilities			●
Raise Lewiston Levee to Manage Flood Risk			●

Since Alternative 5 is inclusive of the navigation objective reservoir operation (Alternative 1) and Alternative 7 is inclusive of the measures in Alternative 5, the descriptions of the effects of each alternative presented below include by reference the effects of the common measures of the described for the preceding alternative(s). For example, description of the effects of Alternative 5 includes the effects of navigation objective reservoir operations from Alternative 1 by reference.

4.1 Aquatic Resources

The project alternatives described in this EIS would each have some potential effects on aquatic resources within the geographical area of the potential affected environment. Effects are categorized within the same groups of plankton and benthic communities, aquatic plants, and fish (including threatened and endangered species) as presented in Section 3.1. Within the LSRP, most of the research on aquatic resources has focused on Lower Granite Reservoir. Therefore, effect discussions will more frequently reference Lower Granite Reservoir, although in many cases the discussion is also applicable to the other reservoirs within the LSRP.

4.1.1 Alternative 1: No Action (Continue Current Practices)

4.1.1.1 Future Actions

Effects on Plankton and Benthic Community

Navigation*:* Navigation objective reservoir operation is the only measure that would be used to address navigation, and would have no measureable effect on plankton and the benthic community within the LSRP. The abundance, distribution, and diversity of benthic and planktonic organisms would not change from the current condition under this No Action Alternative. Plankton communities would not be negatively affected by maintaining reservoir levels near the higher elevations of their operating ranges. Under this alternative, the Corps would maintain the reservoir level above MOP, as needed, and even at the upper end of the operating range year-round to maintain the congressionally authorized 14-foot navigation channel depth.

Recreation*:* Under this alternative the Corps would not implement any measures to maintain recreation at the recreation areas. As sediment accumulated, boaters may stir up sediment with propellers (prop wash). This would increase turbidity locally and may have a minor, adverse effect on plankton and benthic organisms by slightly reducing light penetration in a limited area. If the Corps closes the boat ramps and/or recreation areas for safety reasons, this effect from prop wash would cease.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could include small amounts of excavation to remove the accumulated sediment, which could have a similar localized effect on plankton and benthic organisms as for recreation areas from turbidity.

Flow Conveyance*:* Because the Corps would not implement any measures to address flow conveyance under this alternative, there would be no effect to plankton or benthic communities.

Effects on Aquatic Plants

Navigation: Aquatic plants would not be affected by navigation objective reservoir operation. Reservoirs levels would be within authorized operating ranges and would not substantially change shallow-water aquatic plant habitat in the reservoirs.

Recreation*:* Under this alternative the Corps would not implement measures to maintain recreation areas. Turbidity from prop wash could adversely affect aquatic plants, if present in the vicinity of recreation areas, by reducing light penetration within a limited area and dislodging of plants could occur as boats pass near and or over them. Settling of fine sediments stirred up by prop wash could potentially cover aquatic plants. If the Corps closed recreation areas affected by sediment accumulation, the effects on aquatic plants from prop wash would cease.

Fish and Wildlife*:* fish and wildlife, maintenance of HMU irrigation intakes would have similar effects on aquatic plants, if present in the vicinity of intakes, as the effects on plankton and benthic communities described above.

Flow Conveyance*:* Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no effect on aquatic plants.

Effects on Fish (Including Threatened and Endangered Species)

Navigation*:* Navigation objective reservoir operation could result in minor adverse effects on listed salmonid species by affecting juvenile passage survival through reservoirs due to maintenance of reservoir levels above MOP. Raising the operating pool above MOP would have a greater effect in the areas near the dams than it would further upriver due to the normal change in elevation moving upstream.

Recreation*:* If sediment accumulated at recreation areas, increased prop wash from recreational boating would stir up sediment and increase turbidity. Any adverse effects on ESA-listed fish from increased turbidity would be localized in the area where sediments were disturbed by prop wash. If the Corps closed recreation areas affected by sediment accumulation, the effects on aquatic plants from prop wash would cease.

Fish and Wildlife: For fish and wildlife, maintenance of HMU irrigation intakes would cause localized turbidity, which could have minor adverse effects on fish. Like recreation areas, this effect would be localized and limited to the area surrounding the irrigation intake being maintained.

Flow Conveyance*:* Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no effect on fish, including threatened and endangered fish species.

4.1.1.2 Current Immediate Need Action

Under the No Action Alternative, the current immediate need to re-establish the congressionally authorized dimensions of the federal navigation channel would be addressed by navigation objective reservoir operation only. The effects on plankton and benthic communities, aquatic plants, and fish under this alternative would be the same as those of the future actions (Section 4.1.1.1).

The effects of the No Action Alternative in addressing the related Port berthing-area maintenance needs would be the same as those of the current immediate need action.

4.1.2 Alternative 5 (Dredging-Based Sediment Management)

4.1.2.1 Future Actions

The effects on aquatic resources of Alternative 5 would be from periodic dredging operations and dredged material management. In-water work associated with dredging would have temporary, localized effects on turbidity and increased suspended sediment, as well as noise and possible ***entrainment*** of fish. The navigation channel and other areas where dredging would take place would be excavated to their congressionally authorized dimensions. These changes would cause a temporary loss of benthic habitat and organisms at the dredging location.

In the areas where the material is deposited, for either in-water beneficial use of dredged material or in-water disposal, the riverbed elevation would be raised and cause temporary loss of benthic habitat and organisms at the dredged material placement sites. In-water placement of dredged material could potentially affect fishes, cause turbidity-related effects, and create noise disturbances. Some of these effects could be minimized by adhering to the winter in-water work window when many fish species are present at lower densities and primary productivity is lower. In-water placement of dredged material for beneficial use could create new, more productive, long-term shallow water habitat at the placement sites. Upland placement of dredged material for beneficial use or disposal would be unlikely to have direct effects on aquatic resources.

Navigation-objective reservoir operation implemented as part of this alternative would have the same effects on plankton and benthic community, aquatic plants, and fish (including threatened and endangered species) as those described for Alternative 1.

Effects on Plankton and Benthic Community

Navigation: For future actions to address navigation, plankton communities would not be affected by navigation objective reservoir operations (as described for Alternative 1 above).

Benthic and ***epibenthic*** organisms at a dredge site would likely suffer some level of mortality because of dredging. Recovery of the benthic invertebrates would occur within a few months Bennett et al. 1990). If dredged material is placed in-water for beneficial use, some benthic organisms may survive the transfer and placement of dredged material to a new location.

Plankton and benthic organisms immediately downstream of a dredging site would likely be adversely affected due to increases in local turbidity and redeposition of suspended sediment. Increased suspended sediment can affect feeding of benthic and ***pelagic*** (open river) filter feeding organisms (Parr et al. 1998), and the settling of the suspended particles can cause local burial, affect egg attachment, and modify benthic substrate. Adverse effects would be minor and localized. Some minor changes in the species composition and relative abundance of the benthic fauna are likely, because of combined effects of changes in substrate conditions as well as water currents from increasing the depth in the dredged area.

In-water placement of dredged material creation of shallow-water habitat can increase the abundance and availability of benthic macroinvertebrates. With the exception of oligochaete worms, the density of benthic organisms decreases with depth (Pool and Ledgerwood 1997). Currently, greater than 90 percent of the habitat in Lower Granite Reservoir is considered either mid-depth (20 to 60 feet) or deep water (greater than 60 feet) (Tiffan and Hatten 2012). Therefore, by raising the river bottom in some places to less than 20 feet deep through placement of dredged material, macroinvertebrate abundance and diversity could be enhanced at sites where habitat is created with dredged material.

Benthic species with planktonic larval stages or species that move into the water column from the substrate (e.g., *Corophium* species and chironomids) are expected to rapidly recolonize an in-water dredged material placement site within a few weeks. Less mobile species such as oligochaete worms would be expected to recolonize within a few months (Seybold and Bennett 2010; Bennett et al., 1990, 1993a, 1993b). Studies have determined that the dredged material placement site at Knoxway Bench (RM 116) has been quickly colonized by benthic macroinvertebrates, and the total density of invertebrates was consistently high during both fall and spring (Seybold and Bennett 2010). Thus, placement of dredged material for in-water habitat creation would have no lasting adverse effects on populations of benthic species. Other beneficial use of dredged material that involved in-water placement would be likely to have similar effects on plankton and benthic organisms, if it involved placement in similar locations and quantities. Beneficial use of dredged material that involves upland placement would be unlikely to have direct effects on plankton or benthic organisms.

For in-water disposal of dredged material, benthic invertebrates inhabiting the placement area would be displaced and/or overlain by sediment during the dredged material placement. Monitoring of previous dredged material placement locations in Lower Granite Reservoir showed that benthic invertebrates with planktonic larval stages or species that move into the water column from the substrate (e.g., *Corophium* sp and chironomids) are expected to rapidly recolonize an in-water dredged material placement site within a few weeks. Less mobile species such as oligochaete worms would be expected to recolonize within a few months (Seybold and Bennett 2010; Bennett et al., 1990, 1993a, 1993b). Effects of in-water dredged material disposal would be similar to those described above for in-water placement of dredged material to create habitat.

Recreation: For recreation, the Corps may dredge sediments that interfere with safe operation of recreation areas. Dredging and dredged material management would likely have similar effects to those described above for navigation-related dredging, but be considerably less in scope since the area and amount of sediment dredged and managed would be much less than for navigation.

Fish and Wildlife: For the purpose of fish and wildlife conservation (i.e., HMU irrigation intake maintenance), the Corps would implement the same measures, which would have the same effects as described above for Alternative 1.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on plankton or benthic communities as navigation maintenance dredging, though effects may be greater in scope due to the larger physical area being dredged and substantially greater quantities of sediment dredged and managed.

Effects on Aquatic Plants

Navigation: Aquatic macrophytes are large plants that typically grow in shallow water along the shorelines of lakes or in the slow-moving reaches of the lower Snake River reservoirs. Dredging for navigation would occur primarily in the deeper areas where these plants are not present. Therefore, Alternative 5 would have a minimal indirect impact on aquatic plants that inhabit shallow waters. Temporary and localized increases in turbidity and resettlement of suspended solids during dredging operations may have adverse effects on aquatic plants. A large quantity of suspended sediment can reduce light penetration, which in turn reduces primary production of both pelagic and benthic algae and rooted plants (macrophytes). Because the typical dredged material is primarily composed of sand, the suspended sediments would settle quickly and therefore are not likely to reduce light penetration for an amount of time that would have an effect on plants. Although dredging operations may create a detectable plume extending up to 1,000 feet downstream, the Corps would modify the dredging operation until turbidity levels become lower and within the acceptable range (Corps 2002a; Corps 2005; Appendix J).

Placement of dredged material within shallow water areas could adversely affect aquatic plants by burying them if they are present. The continuation of in-water dredged material placement, on the other hand, would enlarge shallow water areas that could be colonized by aquatic plants.

Any aquatic plants present at shallow water placement sites (for habitat creation) would be buried and die. Effects from this dredged material placement would be short term, minor, and localized with no long-lasting effects to the populations of benthic plants if present. These populations are capable of replacement and recolonization of lost abundance by a large source of adjacent and upriver drifting segments of populations. Most research and monitoring on large river systems has shown that disturbance to habitat is a natural process and can be beneficial (Corps 2002a).

Any aquatic plants present at dredged material disposal sites would be buried and die. Deep-water placement would have minimal effect on existing aquatic plants, as it is outside of the photic zone and aquatic plants would not likely be present.

Recreation: For recreation, the Corps may dredge sediments that interfere with safe operation of recreation areas or ramps. Dredging and dredged material management would likely have similar effects on aquatic plants as those described above for navigation-related dredging. Dredging for recreation purposes would likely be at shallower depths than navigation dredging, and therefore may have a higher likelihood of encountering aquatic plants. However, the area and amount of sediment dredged and managed for recreation would be much less than for navigation.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance) the Corps would implement the same measures and have the same effects as described above for Alternative 1, and could dredge to maintain irrigation intakes. Dredging for HMU irrigation intakes would likely be localized around the intake, would remove relatively small amounts of sediments, and would have minimal effects on aquatic plants.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on aquatic plants as navigation maintenance dredging, , though effects may be greater in scope due to the larger physical area being dredged and substantially greater quantities of sediment dredged and managed.

Effects on Fish (Including Threatened and Endangered Species)

Navigation: Dredging effects on fish are generally localized and include possible entrainment, increased turbidity, noise, and changes to habitat such as substrate and depth.

Most anticipated navigation dredging activities would use a barge-mounted clamshell bucket to excavate and remove sediment. Due to the characteristics of this equipment, it is generally accepted that clamshell buckets have a low potential to entrain fish in comparison to other dredging methods (Corps 2002a). Specifically, the clamshell bucket descends to the substrate in an open position. During the descent, the bucket cannot trap or contain a mobile organism because it is open on top and bottom. The force generated by the descent drives the jaws of the bucket into the substrate, which “bites” the sediment upon retrieval, thus filling the empty bucket with sediment. The bucket bottom then closes as it is retracted from the dredged area. Clamshell dredging operations would proceed slowly and would present reasonable opportunity for fish, including adult and juvenile salmonids, to escape from a dredge area prior to commencement of the actual dredging operation.

In addition to the type of equipment used for dredging, the time of year would also reduce the possibility of affecting ESA-listed fish. Juvenile or adult coho, spring and summer Chinook, and sockeye salmon are likely to be at the lowest densities during the winter in-water work period than other times of the year.

The winter in-water work period (December 15 through March 1) is the time of year when the fewest ESA-listed salmonids are found in the reservoir (Tiffan and Connor 2012). Migrating salmonids are pelagically oriented fish (i.e., present in the water column above the bottom) that do not typically occur in the benthic environment (i.e., in the sediment at the bottom of the reservoir). The subyearling Chinook that rear and overwinter in the lower Snake River and associated reservoirs also prefer shallow water habitat over deeper water habitats during the spring and summer (Corps 2010a, Tiffan and Connor 2012) and are generally pelagically oriented near the surface during the winter (Tiffan and Connor 2012). These characteristics greatly reduce the risk of entrainment of either juvenile or adult salmonids. Furthermore, the disturbance from dredging activities is likely to encourage fall Chinook salmon and steelhead to avoid the vicinity of the dredging operations altogether.

Dredging to maintain the authorized dimensions of the federal navigation channel has the potential to destroy salmon spawning areas through harming eggs and/or alevins. While there is potential for fall Chinook to spawn in the tailraces of the lower Snake River projects, no redds have been identified within the navigation lock approaches of any of the lower Snake River projects since surveys began in 1993. The Corps would perform a redd survey in these areas prior to any dredging activity and would modify dredging as appropriate (Appendix J). Therefore dredging activities in the lock approach areas would be unlikely to affect redds.

Dredging and in-water dredged material placement would not affect water temperature or dissolved oxygen because activity would typically take place in cold weather during the in-water work window. Dredging activities are temporary, and would cause short-term and localized impacts by increasing turbidity and suspended solids, which could adversely affect fish.

Although dredging operations may create a detectable plume extending up to 1,000 feet downstream, operations causing a 5-NTU increase over background (10 percent increase when background is over 50 NTUs) at a point 300 feet downstream would result in actions to reduce the plume. Given the relatively large size of the LSRP reservoirs, the turbidity plume caused by dredging would be localized around the area of dredging, and ample space remains for fish to move away from the turbidity plume. Based on the disparity between the turbidity increases anticipated as part of the dredging and dredged material placement operation and the levels reported to be harmful to fish, dredging and dredged material placement operations would not adversely affect salmon and steelhead as a result of increased turbidity. In addition, although turbidity may cause stress, Gregory and Northcote (1993) have shown that moderate levels of turbidity (35 to 150 NTU) accelerate foraging rates among juvenile Chinook salmon.

Although low-to-moderate turbidity levels can enhance survival by providing cover from predation (Gregory and Levings 1998), excessive levels of turbidity can reduce feeding efficiency and food availability, and damage gills (Bruton 1985; Gregory 1993). In the immediate vicinity of dredging or in-water dredged material placement, short-term turbidity could be high enough to interfere with predation success of vertebrate sight feeders, including juvenile salmonids. The disturbance would be limited to the duration of the project. Although the sight feeders may move out of the disturbed area during the proposed event, it is expected they would return on completion of the project. These interferences, if they occur, would be of limited duration, and would not coincide with any major migration of anadromous fish during the allowed winter in-water work period. Adequate area exists to allow sight feeders to move out of the turbid zone for feeding purposes.

Dredging activities would also generate underwater sound-pressure levels that could elicit responses in some fish (Hastings and Popper 2005). The intensity of the sound-pressure levels from dredging activities can be quite variable. However, sound-pressure levels are generally in the range of 112 to 160 dB. These sound intensities may influence organism behaviors or perceptions, but would be unlikely to cause physiological damage (Hanson et al. 2003).

The habitats directly affected by navigation dredging are generally deeper than the shallow habitats preferred by fall Chinook (depths less than 10 feet) and dredging effects would occur for a relatively short period of time. These sandy and silty portions of the riverbed would retain essentially their same characteristics after dredging. Because the area is used as a migratory corridor for ESA-listed anadromous salmon species, there is potential to modify designated critical habitat. However, dredging would not substantially change the cross-sectional areas of the river and, therefore, velocities would not change in areas used for salmon migration or degrade salmon migratory habitat. In addition, dredging would occur for a relatively short period of time during the period of lowest salmonid abundance (Tiffan and Connor 2012). The most substantial effect would be a short-term (1 year or less) reduction in available food items. Based on previous investigations disturbed substrates would be rapidly recolonized by macroinvertebrates (Mackay 1992). Additionally, most of the dredging would occur in mid-channel areas during the winter that are used much less extensively by juvenile salmon than shallower, near-shore areas (Bennett et al. 1997, Gottfried et al. 2011).

Adult steelhead and juvenile fall Chinook salmon are likely to be disturbed as a result of dredging operations, since it is expected that noise and activity will encourage fish to move to other areas. However, given the relatively small footprint of the operation at any given time, this disturbance is not expected to reach levels that would temporarily or permanently disrupt essential behaviors of fall Chinook or steelhead.

Subyearling fall Chinook salmon used the shallow-water rearing habitat (i.e., submerged bars less than 20 feet deep) created with in-water placement of dredged material that surrounds Centennial Island (Lower Granite Reservoir, near RM 120) (Seybold and Bennett 2010). Subsequent sampling has indicated that in some years, as many as 10 percent of the total sample of subyearling Chinook salmon from the Lower Granite Reservoir originated from the habitat created by in-water placement of dredged materials and that fall Chinook salmon were most commonly collected over lower gradient shorelines that have low velocities and sandy substrate (Seybold and Bennett 2010; Tiffan and Connor 2012; Tiffan and Hatten 2012).

A recent analysis of juvenile fall Chinook salmon use of shallow-water habitats in the lower Snake River reservoirs found that fall Chinook used these habitats, including the Corps' shallow-water dredged material placement site at Knoxway Bench (located on the lower Snake River between RM 116.5 and 117.5), which was created using dredged materials in 2006 (Naughton et al. 2009). The Knoxway Bench site has been quickly colonized by benthic macroinvertebrates, and the total density of invertebrates was consistently high during both fall and spring (Seybold and Bennett 2010). Creation of shallow-water habitat is expected to enhance fall Chinook rearing areas by providing shallow-water habitats with increased macroinvertebrate food sources. The placement of dredged material could have a negative effect on Pacific lamprey ammocoetes by burying them if they are present. However, in the long-term, habitat conditions in the area could be improved for lamprey.

Based on research since the 1990s, creation of shallow-water habitat has been shown to provide additional juvenile fall Chinook rearing habitat without increasing the amount of predation on juvenile fall Chinook. Pre-dam/pre-reservoir habitats used during fall Chinook outmigration would have been predominantly shallow-water habitats except for the larger deeper pools used by sturgeon. While filling the reservoirs has resulted in the creation of more mid-depth habitats and potentially resulted in more habitat for shoreline and non-native predators such as smallmouth bass, salmonid predators such as bass typically utilize adjacent cover (of which darker depths can be classified). Hence, the Corps proposes to place materials in a large enough footprint with no cover (open sand or small gravels) designed to retard hunting opportunity of predators such as smallmouth bass from that mid-depth to shallow water edge.

Substrate material and depth are important to the use of habitat created with dredged material. Traditionally, a depth of 20 feet was determined as the boundary between mid-elevation depth and shallower water, based on typical limits of the photic zone conducive for primary and secondary productivity of food web constituents. The 20-foot demarcation was also selected because the shallower zone represents preferred depths of open sandy bench habitat important for juvenile fall Chinook salmon rearing (Bennett et al. 1993a, 1993b, 1995b, 1997; Curet 1994; Connor et al. 1994; Rondorf and Miller 1994). Studies within the Lower Granite Reservoir captured subyearling Chinook salmon over low-gradient, low-velocity, sandy substrates in the shallow zone indicating their preference for this habitat (Bennett and Shrier, 1986; Bennett et al. 1988, 1990, 1991, 1993a, 1993b). In addition, subyearling Chinook salmon rearing along the shoreline of Lower Granite Reservoir during the spring exhibit a strong selection for substrata consisting of primarily sand and a moderate avoidance of cobble/sand and talus/sand (Curet 1994).

Tiffan and Connor noted that while a sizeable portion of juvenile fall Chinook salmon remained in the lower Snake River after the spring and summer migrations, their use of shallow water habitat during fall and winter 2010 was limited. Furthermore, radio-tagged fish located were pelagically oriented, and generally not found over shallow water or close to shore during winter months. This provides evidence for shallow water habitat use by natural subyearlings during spring and summer, and evidence against large-scale use of shallow water habitat by salmonids during fall and winter. It also provides a biological basis for creating shallow water habitat less than 6.5 feet deep when depositing dredged materials (Tiffan and Conner 2012).

Disposal of dredged material (that is, deep-water dumping of dredged material as opposed to beneficial use) would cause temporary localized increases in turbidity and suspended solids, as well as noise disturbance. These factors can affect fish in the immediate area, but their mobility would allow them to temporarily escape the disturbance and return later after the effects of the dredged material placement have dissipated. Both resident and anadromous fish could use the area upstream and downstream of the sites for refuge when dredging and placement activities would occur. The in-water dredged material placement activities would not be a continuous activity confined to a single location and fish would return to the activity areas shortly after completion of the project. Potential effects of the dredged material placement operation on downstream migrating salmonids would be expected to vary depending on the timing of the downstream migrations, the amount of time the migrants spend in the affected areas, and their use of the affected areas. Both adults and juveniles of other salmon species would most likely be present within the lower Snake River reservoirs at low densities during the in-water work window and therefore would not be affected by the temporary increases in turbidity, suspended solids, and noise from in-water disposal of dredged material.

Bull trout adults only intermittently inhabit areas of the lower mainstem of the Snake River where dredging would occur. These fish may enter the LSRP during migrations from the tributaries that they inhabit during the remainder of the year (Faler et al. 2008). These are pelagic adult fish that can actively avoid the dredging operations when noise and other disturbances associated with dredging operations occur. Spawning and juvenile rearing occurs in the upstream reaches of tributaries; therefore, dredging in the mainstem of the Snake River would not affect these life stages for bull trout.

The mainstem of the Snake River is part of the designated critical habitat for bull trout. Dredging operations may cause temporary avoidance of the area by bull trout, but would not permanently alter the ability of the river to provide adult rearing and migration habitat.

Dredging and associated dredge material placement can disturb foraging habitat for sturgeon. White sturgeon juveniles and adults would be temporarily displaced into potentially less desirable foraging habitat, which could adversely affect their health and viability. Additionally, there is potential for dredging to disturb some spawning areas which can occur within the navigation channel in areas below the tailrace of dams (Parsley and Kappenman 2000). However, the timing of the in-water work window in the mainstem (December - March) should prevent dredging effects to the sturgeon eggs since spawning occurs during mid May through mid July after the dredging operations would have ceased. White sturgeon spawning occurs in fast-flowing sections of the Snake River below dam tailraces (Parsley and Kappenman 2000) and at the upstream reach of Lower Granite Reservoir, so any dredged material placement in the deeper, slower-flowing reservoirs would not affect white sturgeon spawning habitat.

Pacific lamprey may potentially be present during navigation dredging operations. Although ammocoetes settle out downstream from spawning riffles, the distance downstream that ammocoetes would drift before settling out and burying into the substrate has not been determined. If drift potential includes a substantial distance and ammocoetes migrate slowly downstream with flow, rearing Pacific lamprey could potentially be present in some of the areas proposed for dredging. Because the ammocoetes settle out in backwater areas, most areas that would be dredged or where dredged material may be placed are not likely to be heavily populated. Ammocoetes metamorphose into juveniles and migrate out to the ocean during March through July of the year following their metamorphosis (Wydoski and Whitney 2003). Pacific lamprey lack a swim bladder and are believed to typically occupy the lower portion of the water column and tend to drift downstream with the current during migrations (Luzier et al. 2011; Wydoski and Whitney 2003). This behavior makes them susceptible to entrainment or burial by dredging activities. However, both the juveniles and adults are mobile and could actively avoid dredging activities and the winter in-water work window occurs outside the time frame when the majority of adult and juvenile migration occurs.

Recreation: Under Alternative 5, where sediment interferes with recreation, dredging and dredged material management would be used to address sediment accumulation. Dredging and dredged material management would have similar types of effects on fish as described above for navigation-related dredging and dredged material management, but would be considerably less in scope and magnitude. Dredging activities in backwater areas, such as recreation areas, could affect fish that may be present in these areas. For example, in the McNary Reservoir, Easterbrooks (1996) reported that during the winter, when dredging would occur, both resident and overwintering anadromous species have been identified as using the backwater areas. Most of the predatory resident fish component was composed of introduced species, and salmonids were composed of both yearling and subyearling Chinook (Easterbrooks 1996). For recreation areas, hydraulic dredging could potentially take place in the summer in backwater areas where water temperature is warmer than 73 degrees Fahrenheit, and therefore ESA-listed fish are not likely to be present. Effects of hydraulic dredging on fish would be similar to the effects of mechanical dredging described above.

Fish and Wildlife: Measures taken under this alternative to conserve fish and wildlife (i.e., maintenance of HMU irrigation intakes) would create localized turbidity, which could have minor adverse effects on fish as described for Alternative 1. The Corps may excavate areas around intakes, or may dredge areas around intakes. In either case, the effect would be limited to the area immediately around the intake and would have minor, temporary effects on fish.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on fish as navigation maintenance dredging, though effects may be greater in scope due to the larger physical area being dredged and substantially greater quantities of sediment dredged and managed.

4.1.2.2 Current Immediate Need Action

Effects on Plankton and Benthic Community

Under Alternative 5, the effects on the plankton and benthic community of the current immediate need action (dredging to restore the congressionally authorized dimensions of the federal navigation channel, beneficial use of dredged material, and navigation objective reservoir operation) and related maintenance at Port berthing areas would be the same as the effects described above under future actions.

Effects on Aquatic Plants

The effects on aquatic plants as a result of the current immediate need action and performing related maintenance at the Ports' berthing areas would be the same as the effects described above under future actions.

Effects on Fish (Including Threatened and Endangered Species)

Under Alternative 5, the effects on fish as a result of the current immediate need action would be the same as the effects described above under future actions.

The areas being proposed for dredging as part of the current immediate need action have relatively small footprints within the lower Snake River. As the proposed dredging activities would deepen areas from an approximate minimum depth of 7 feet to a maximum of 16 feet, the river in regard to sturgeon use would remain relatively similar and the period of disturbance would be relatively short. Areas where dredge material will be placed (i.e., Knoxway Bench, RM 116) would become shallower in localized areas upon completion of activities. This area is a relatively small area within the lower Snake River but is anticipated to provide valuable shallow water rearing habitat for subyearling fall Chinook (Tiffan and Connor 2012; Tiffan and Hatten 2012) while minimally affecting sturgeon habitat areas, including food source production areas.

Redd surveys would be conducted in the tailrace of Ice Harbor Dam, an area of potential fall Chinook spawning habitat, prior to initiation of the proposed action (see the monitoring plan, provided in Appendix J). No known spawning habitat is present in the Lower Granite pool portions of the current immediate need action.

The in-water activities at the proposed dredging sites and in-water dredged material placement sites would be monitored to ensure the operation complied with state water quality standards and would provide a relatively minimal risk to the aquatic environment and ESA-listed salmonids. The effect of turbidity on fish would be minimal because the location and footprint of the proposed dredging sites would allow both juvenile and adult salmonids to readily escape or avoid exposure to the elevated turbidity plume dissipating from the dredging or in-water placement.

The Corps has prepared a BA for the proposed current immediate need action that documents the effects on ESA-listed fish species. The effect determinations documented in the BA for the current immediate need action are: "may affect" and "would likely adversely affect" Snake River fall Chinook salmon, Snake River spring/summer Chinook salmon, and bull trout; and "may affect" but "not likely to adversely affect" Upper Columbia spring Chinook salmon, steelhead and Snake River sockeye salmon (Appendix K).

The location of the Ports in Clarkston and Lewiston are not protected backwater habitats, but are mainstem areas that continually collect both sand and silt. Dredging the federal navigation channel and berthing areas at the two Port facilities in the Snake River would have similar effects as those described above for navigation dredging but would be smaller in scope and magnitude.

Furthermore, recent sampling efforts did not positively locate any juvenile lamprey in the types of areas being proposed for dredging or disposal of materials (Arntzen et al. 2012).

4.1.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

All sediment and system management actions under this alternative would occur within the lower Snake River reservoirs. In comparison to Alternative 1 and Alternative 5, Alternative 7 provides a broader array of sediment management tools for the Corps to consider and potentially implement, including measures that involve in-water work, permanent in-water structures, and operational changes to the LSRP. The effects of dredging and dredged material management under Alternative 7 are the same as those discussed under Alternative 5.

4.1.3.1 Future Actions

The effects of dredging and dredged material management are described above in Section 4.1.1 and are not repeated in this section. Because actions associated with structural sediment management measures and some system management measures involve many of the same effects such as in-water work, the use of construction equipment, and localized substrate disturbance and increased turbidity, they will be discussed together in the following section.

Direct effects to aquatic resources from structural sediment management measures would largely result from in-water construction, potentially from increased turbidity and noise, if those actions are required for construction. The addition of structures within the river channel would alter flow and sediment transport patterns in the area influenced by the structures.

The construction process for adding in-stream structures (bendway weirs, dike fields, or in-reservoir sediment trapping systems) would adversely affect water quality by increasing in-stream turbidity during construction and for a short period following construction. Agitation to suspend sediment would also create in-stream turbidity during implementation.

For most structural sediment management measures, heavy construction equipment would be used during implementation. Accidental releases of diesel fuel, lubricants, hydraulic fluid, and other contaminants contained in heavy equipment could potentially result in acute negative impacts to fish, invertebrates, and aquatic habitat. In addition, long-term effects could also result if a spill was not properly remediated. All over-water construction vessels would be fueled at existing commercial fuel docks. Such facilities have existing spill prevention systems in place that would be adequate to avoid spills or immediately address any accidental spills that might occur. The only potential sources of contaminants at the construction sites would be the construction equipment itself (lubricating oils and fuel).

A variety of system management measures in addition to navigation objective reservoir operation, as described in Section 2, could be implemented within the LSRP. These measures include reservoir drawdown to flush sediments, reconfiguring or relocating affected facilities to avoid problems with sediment deposition, and raising levees to provide for added flow conveyance capacity.

The main effects of reservoir drawdown measures to the aquatic environment would be from changes in flow conditions, water levels, and sediment dispersion patterns. Reconfiguring or relocating facilities could involve some in-water construction, such as at water intake structures, mooring facilities, and docks. In those instances, effects to the aquatic environment would be similar to those described for the in-water construction activities of the structural sediment management actions, and would include noise, local turbidity, and potential chemical spills from equipment.

Effects on Plankton and Benthic Community

Navigation: Construction of bendway weirs or dikes for navigation would adversely affect benthic organisms that inhabited the site prior to the beginning of construction. After construction, as sediment accumulates between the weirs, recolonization is likely to occur as discussed with dredging and dredged material placement operations. However, changes in the hydrology and sediment accretion could preclude the site from returning to its preconstruction benthic community. This could be beneficial in cases where the preconstruction conditions held poorly populated benthic communities. The accumulation of new sediment could allow the colonization of these areas and therefore benefit primary productivity and the food web. The structures themselves would provide a new and different substrate that would support a different benthic community.

Construction of bendway weirs or dikes for navigation would have little discernible effect on plankton in the reservoirs. Localized effects could include temporary displacement from the construction sites and potential reduced feeding ability from increased suspended sediment from construction and in water disposal.

During construction activities, benthic invertebrates within the construction zones would either be displaced or suffer mortality. Mobile organisms such as crayfish could escape construction activities, while immobile organisms living in the substrate would be killed. Their loss would be of a short-term nature because the area of impact would be repopulated rapidly by organisms such as mayfly larvae, caddis flies, and midge larvae that drift with the stream current and readily recolonize disturbed areas.

The construction of the dikes themselves would have less impact on the benthic community than the scouring of the river channel that would occur after the dikes are in place. These effects would be localized in portions of the river channel scoured as a result of the dikes where benthic organisms reside. Changes in flow patterns for both bendway weirs and dikes could redistribute planktonic organisms to other areas, but little effect on abundance would occur. For non-mobile organisms such as benthic invertebrates and plants, the process would result in their dispersal with the agitated sediment, and deposition downstream. If the sediment contained organic materials in an anaerobic state, resuspension would increase the ***biological oxygen demand*** and depress dissolved oxygen (Johnson 1976).

Trapping upstream sediments would require excavation (dredging) of an in-stream sediment basin where sediments could be trapped and stored. A sediment trap would need to be periodically dredged to remove accumulated sediments. Initial excavation and periodic dredging (and associated dredged material management) would have similar effects on plankton and benthic organisms as described for navigation dredging.

Plankton and benthic communities would not be affected by land-based reconfiguring or relocating navigation-related facilities, but in-water construction associated with reconfiguring or relocating facilities would have turbidity and other effects associated with construction and described above for dikes. Closure of affected facilities would be unlikely to affect plankton or benthic organisms unless closure involved in-water activities for demolition of facilities, in which case activities would have turbidity and other effects associated with construction as described above. Effects from reconfiguring, relocating or closing affected facilities would be localized in the area where in-water activities were undertaken.

Plankton and benthic communities could be affected by reservoir drawdown used to flush sediments out of the federal navigation channel. Increasing flows to flush and transport sediment downstream and out of Lower Granite Reservoir would carry some of the plankton community out of the reservoir as well, but populations would likely be replaced by incoming flows from upstream which could contain a different plankton community.

Recreation: Under this alternative, the Corps could implement dredging and dredged material disposal to address sediment that interferes with recreation. In addition, the Corps could consider agitation to resuspend sediment as a potential measure for maintaining the existing authorized purpose of recreation. Effects of these measures on plankton and benthic organisms would be similar to those described above for dredging, but would likely be substantially less in scope due to the smaller areas affected (recreation) and quantities of sediments. In addition, reconfiguring, relocating, or closing affected facilities could be considered under this alternative for recreation. Effects of these system management measures would be similar to those described above for navigation, but would likely be less in scope due to the smaller facilities affected.

Fish and Wildlife: For fish and wildlife, Corps would consider agitation to resuspend and the reconfiguration, relocation, and closure of affected facilities to address sediment that interferes with HMU irrigation intakes. Agitation to resuspend sediment would have similar effects on plankton and benthic organisms as described for recreation above, but would likely be very minor due to the small area affected (i.e., the area surrounding an irrigation intake). Relocation and reconfiguring affected irrigation intakes would have minor effects during activities to relocate or reconfigure the intakes. Closure of affected facilities would not involve in-water work, and therefore would not affect plankton or benthic organisms.

Flow Conveyance: For flow conveyance, the Corp would consider trapping upstream sediment, drawing down the reservoir(s) to flush sediment, and raising the Lewiston levee to manage flood risk. Trapping upstream sediment and reservoir drawdown to flush sediment would have the same effects as described for navigation above. Raising the Lewiston levee would involve work next to Lower Granite Reservoir, but would not include in-water work and would not affect plankton or benthic communities.

Effects on Aquatic Plants

Navigation: For the sediment management measure to address navigation aquatic plants within the construction site would be lost due to excavation or installation of the in-water structures (weirs, dikes, traps, or relocated/modified facilities). Once construction was completed, the bottom habitat and substrate composition would be changed and, in the case of weirs or dikes, the accretion of fine sediments around the dikes could preclude or enhance recolonization by aquatic plants.

Trapping upstream sediment would cause loss of aquatic plants if they were present within the sediment trapping area, initially during excavation and later during periodic dredging of the trap. Excavation, dredging, and dredged material management associated with development and maintenance of the trap would increase turbidity during those activities, which could have adverse effects on aquatic plants in surrounding areas.

System management actions to maintain navigation would have differing effects on aquatic plants. During modified flow regimes to flush sediments, submerged aquatic vegetation could be adversely affected by transported sediments scoured from the navigation channel burying plants. During construction activities associated with reconfiguring or relocating facilities, localized areas may experience submerged aquatic vegetation losses, but would not affect overall population assemblages.

Recreation: For this alternative, the Corps could implement dredging and dredged material disposal to address sediment that interferes with recreation areas. Effects of these measures on aquatic plants would be similar to those described above for navigation, but would likely be substantially less in scope due to the smaller areas affected (recreation areas) and quantities of sediments. In addition, the Corps could consider agitation to resuspend as a potential structural sediment management measure for maintaining the authorized purpose of navigation. This measure would create turbidity, and agitated sediments would be transported away from the agitation site, potentially settling on aquatic plants in another location and adversely affecting them. In addition, reconfiguring, relocating, or closing affected facilities could be considered under this alternative for recreation. Effects of these system management measures would be similar to those described above for navigation, but would likely be less in scope due to smaller facilities affected.

Fish and Wildlife: For fish and wildlife, Corps would consider agitation to resuspend sediment and the reconfiguration, relocation, and closure of affected facilities to address sediment that interferes with HMU irrigation intakes. Agitation to resuspend sediment would have similar effects on aquatic plants as described for recreation above, but would likely be very minor due to the small area affected (i.e., area surrounding an irrigation intake). Relocation and reconfiguring affected irrigation intakes would have minor effects during activities to relocate or reconfigure the intakes. Closure of affected facilities would not involve in-water work, and therefore would not affect aquatic plants.

Flow Conveyance**:** For flow conveyance, the Corp would consider trapping upstream sediment, modifying flow regime reservoir drawdown to flush sediment, and raising the Lewiston levee to manage flood risk. Trapping upstream sediment and reservoir drawdown to flush sediment would have the same effects as described for navigation above. Raising the Lewiston levee would involve work next to Lower Granite Reservoir, but would not include in-water work and would not affect aquatic plants.

Effects on Fish (Including Threatened and Endangered Species)

Navigation**:** Construction of bendway weirs or dike fields for navigation would have effects on fish that inhabit the area during the construction of the structures. Construction during the winter in-water work window would minimize the number of species and individuals affected by construction activities. However, as described in Section 3.1, steelhead and fall Chinook may be present throughout much of the year and could be in the areas proposed for in-water work during the construction periods.

These structures would generally be constructed out of riprap. Effects on salmonids would be minimized by conducting work during the approved in-water work period when many fish species are present at lower densities. Noise and vibration would adversely affect resident fish. Adverse effects of pile driving, if used, may be mitigated through various construction practices such as measures that include bubble curtains, pile hammer cushions, and coffer dams. If pile driving is involved with implementation of a measure, the Corps will assess and develop measures to reduce the noise and vibration effects on fish.

The changes in channel morphology concentrate a more diverse bottom structure and hydraulic response within the weir fields than what was present in the unaltered bend. This increase in diversity in the environment has attracted greater numbers of fish and greater diversity in a study on the Mississippi River (Wilson 1997). Deep holes and sand bars are generated in the course of operation of the weir fields, which provides a diverse environment for various aquatic species. This can also have the effect of increasing habitat for ambush predator species such as smallmouth bass, especially if the weirs are constructed of material such as riprap.

In-water structures would alter the flow characteristics of the river channel, which may affect critical habitat for the ESA-listed salmon species that use the lower Snake River as a migratory corridor. Addition of structures within the river channel would alter localized flow patterns, depths, and sediment, and disrupt or move local benthic communities. These changes would be within the vicinity of the constructed structures and may alter some of the specific routes within the river for migrating adult and juvenile salmon but would not impede their migrations.

These measures would not affect bull trout which rear and spawn far upstream in the tributaries. Adults are only occasionally present in the mainstem and reservoirs and they could actively avoid the localized construction effects such as noise and turbidity. Because bull trout primarily inhabit the cooler waters upstream in tributaries, the temporary effects to the food web in the construction areas would have a negligible effect on food resources for bull trout.

Construction of weirs or dikes would potentially reduce the amount of mid-water bench habitat used by white sturgeon. Loss of habitat in the localized area of disturbance could cause some white sturgeon to be displaced into potentially less desirable foraging habitat. As described earlier in Section 4.1.1 with regard to dredging, this effect would be temporary. Avoidance of the construction areas by sturgeon due to the disruptive activities would allow sturgeon to limit or eliminate their exposure to the effects of noise and increased turbidity.

Adult upstream migration of Pacific lamprey occurs in September and October; juvenile downstream migration occurs in May and June. Because the timing of these movements would not overlap with the winter in-water work window, no direct effects on Pacific lamprey are anticipated. During the Corps' 2011 survey for lamprey presence at the Snake/Clearwater confluence where sediment accumulation is interfering with commercial navigation, no individuals were observed. The Corps acknowledges that ammocetes may be present in the areas where weirs or dikes would be constructed, and if present, could be harmed or killed during construction activities.

Reservoir drawdown to flush sediment in the Lower Granite Reservoir is likely to adversely affect listed salmonid species due to increased turbidity, loss or alteration of shallow-water rearing habitat, and modified juvenile passage survivals through the routes at Lower Granite. These impacts would be lessened to some degree if the measure was implemented during the winter in-water work window.

The measure of reservoir drawdown to flush sediment to aid navigation would result in suspension of sand and silt in the water column and deposition further downstream, resulting in increased turbidity within the reservoir. This may result in exceeding natural background levels, potentially affecting ESA-listed fish species. For salmonids, turbidity elicits a number of behavioral and physiological responses (i.e., gill flaring, coughing, avoidance, and increase in blood sugar levels), which indicate some level of stress (Bisson and Bilby 1982; Berg and Northcote 1985; Servizi and Martens 1992). The magnitude of these stress responses is generally higher when turbidity is increased and particle size decreased (Bisson and Bilby 1982; Gregory and Northcote 1993). Although turbidity may cause stress, studies have shown that moderate levels of turbidity (35-150 NTU) accelerate foraging rates among juvenile Chinook salmon, likely because of reduced vulnerability to predators (camouflaging effect) (Gregory and Northcote 1993). In lamprey the increased turbidity has been associated with a trigger to begin juvenile outmigration and, depending on the timing, may result in premature arrival to the ocean. When particles causing turbidity settle from the water column, they contribute to sedimentation. Depending on the local hydraulics and sediment transport and constituents, some sediment might settle in areas that are prone to movement and flushing, while other deposits may be more permanent. Reservoir drawdown to flush sediment for navigation would likely only be considered for Lower Granite Reservoir; there is no documented salmonid spawning in Lower Granite Reservoir, so this measure would not affect salmon spawning in the reservoir or in the tailrace area of Lower Granite Dam.

Snake River ESUs of Chinook, sockeye, and steelhead juveniles out-migrate in the spring. Through the drawdown action it is possible that flow velocities could be increased during outmigration periods and may slightly improve the functioning of the migration corridor and mainstem juvenile rearing habitat during those months. As drawdown would be used for navigation in Lower Granite Reservoir, this effect would occur there.

The actions to reconfigure or relocate affected navigation facilities would include the use of mechanized construction equipment and in-water work. Construction during the winter in-water work window would minimize the number of species and individuals temporarily displaced by the dewatering of the construction site. However, as described in Section 3.1, steelhead may be present throughout much of the year and could be in the areas proposed for in-water work during the construction periods. Overwintering juvenile fall Chinook could be present during construction, as well as both juvenile and adult steelhead. Worksite BMPs would be used as a minimization practice, consisting of several measures meant to decrease fish exposure to the effects of construction activities. Despite this, it is likely a small number of juvenile salmonids could be injured or killed during construction of relocated or reconfigured facilities. Closure of navigation facilities would not affect fish, unless closure involved in-water work, in which case effects would be similar to those described above for reconfiguring or relocating facilities.

Recreation: Under this alternative, the Corps could implement dredging and dredged material disposal to address sediment that interferes with recreation. In addition, the Corps could consider agitation to resuspend sediment as a potential structural sediment management measure for maintaining the existing authorized purpose of recreation. Effects of agitation on fish include temporary increased turbidity, displacement of fish from the location where agitation is occurring, and disturbance from noise during the operation. These impacts would be temporary, and mobile organisms could escape and return to the area when turbidity levels return to pre-agitation levels. In addition, reconfiguring, relocating, or closing affected recreation facilities could be considered under this alternative. Effects of these system management measures would be similar to those described above for navigation, but would likely be less in scope due to the smaller facilities affected.

Fish and Wildlife: For fish and wildlife, agitation to resuspend sediment and the reconfiguration, relocation, and closure of affected facilities to address sediment that interferes with HMU irrigation intakes. Agitation to resuspend would have similar effects on fish as described for recreation above, but would likely be very minor due to the small area affected (i.e., area surrounding an irrigation intake). Relocation and reconfiguring affected irrigation intakes would have minor effects during activities to relocate or reconfigure the intakes. Closure of affected facilities would not involve in-water work and therefore would not affect fish.

Flow Conveyance**:** For flow conveyance, the Corp would consider trapping upstream sediment, reservoir drawdown to flush sediment, and raising the Lewiston levee to manage flood risk. Trapping upstream sediment and reservoir drawdown to flush sediment would have the same effects as described for navigation above. Raising the Lewiston levee would involve work next to Lower Granite Reservoir, but would not include in-water work and would not affect fish.

4.1.3.2 Current Immediate Need Action

Effects on Plankton and Benthic Community

Under Alternative 7, the effects on the plankton and benthic community of the proposed current immediate action (dredging to re-establish the congressionally authorized dimensions of the federal navigation channel) and related maintenance at the Ports' berthing areas would be the same as the effects described above under current immediate need action for Alternative 5.

Effects on Aquatic Plants

Under this alternative, the effects on aquatic plants as a result of the current immediate need action and related maintenance at the Ports' berthing areas would be the same as the effects described above under current immediate need action for Alternative 5.

Effects on Fish (Including Threatened and Endangered Species)

Under this alternative, the effects on fish, including threatened and endangered species, as a result of the current immediate need action and related maintenance at the Ports' berthing areas would the same as the effects described above under current immediate need action for Alternative 5.

4.2 Terrestrial Resources

4.2.1 Alternative 1: No Action (Continue Current Practice)

4.2.1.1 Future Action

Navigation: Navigation objective reservoir operation would be used to address navigation and would result in a continuation of normal operation of the pools. This includes changing pool elevations 3-5 feet depending on time of year. Raising and lowering the pools annually leads to a riparian strip that is heavily disturbed and dominated by invasive plant species such as false indigo, reed canary grass and poison hemlock. The effect to native riparian vegetation is expected to be high competition from invasive species that are suited to thrive in disturbed areas.

Most wetlands affected by the raising and lowering of the pools for navigation would be considered perennial because of the seasonal inundation and desiccation due to fluctuating pool levels. The effects to these wetlands would be the same as what has happened for the last 40 years of reservoir operation. When the water level is lowered annually, invasive plant species become more dominant in these areas and out-compete native vegetation.

Effects of navigation objective reservoir operations to maintain navigation on terrestrial wildlife would remain the same as under normal pool operation. Wildlife that uses riparian areas during a portion of their lives have adapted to the rise and fall of river levels. There would be no increase in effects to vegetation, wetlands, or terrestrial wildlife due to navigation maintenance under the No Action alternative.

Recreation: Under this alternative, the Corps would not implement any measures to maintain recreation at recreation areas. As sediment accumulates, boaters may stir up sediment with prop wash, which would increase turbidity in the vicinity of recreation areas. Increased turbidity would be minor and would not have indirect effects on vegetation, wetlands or terrestrial wildlife.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could include small excavation to remove accumulated sediment, with minor localized increases in turbidity. This minor increase in turbidity would not have indirect effects on vegetation, wetlands or terrestrial wildlife.

Flow Conveyance: Because the Corps would not implement any measures to address flow conveyance under this alternative, there would be no effects on vegetation, wetlands, or terrestrial wildlife.

4.2.1.2 Current Immediate Need Action

Under this No Action Alternative, navigation objective reservoir operation would be implemented to address the current immediate need action to re-establish the federal navigation channel. Therefore, the effects on vegetation, wetlands, and wildlife would be the same as those described for future actions.

The measure to address related work to maintain Port berthing areas would also be navigation objective reservoir operation, which would have the same effect on vegetation, wetlands, and terrestrial wildlife as those for maintenance of the federal navigation channel.

4.2.2 Alternative 5: Dredging-Based Sediment Management

4.2.2.1 Future Actions

Navigation: Under this alternative, navigation would be addressed primarily by dredging and dredged material management. Dredging would result in intermittent and temporary disturbance or displacement of wildlife species from the operation of construction equipment. These activities are not expected to prevent wildlife from obtaining food or otherwise using the areas adjacent to the dredging. Riparian forest and shrub habitat for raptors and other birds would not be affected. Waterfowl, birds, aquatic furbearers, and other wildlife could be temporarily disturbed or displaced by activities; however, they would likely use areas upstream and downstream of the sites where dredging activities occur.

Most activities associated with dredging would be performed in deeper water away from any terrestrial habitat, so no effects to terrestrial habitat are expected. It is assumed that existing entry and exit points and staging areas for work would be used and would not result in effects to existing riparian habitat and wetlands.

The beneficial use of sediment, if used for enhancement or creation of aquatic and wildlife habitat, could positively affect certain types of wetlands and riparian habitat. The dredged material would provide an ideal source of substrate material for near-shore habitat and wetlands restoration, which could potentially improve the size, function, and quality of nearby wetlands. If in-water placement of dredged material was employed as a beneficial use of dredged material, activities to place and shape the material would have similar effects on wildlife as dredging. Placement of dredged material would generally be closer to shore than dredging and may have a noticeable effect on wildlife that uses riparian or near-shore shallow-water areas within the LSRP. Other beneficial uses of dredged sediments include a variety of potential upland and in-water placements; the effects of any beneficial use of dredged sediments on terrestrial resources would depend on the setting, the quantity of dredged material, and other factors. For future beneficial use of dredged material, the Corps (and any local sponsor) would conduct an appropriate NEPA review and comply with applicable laws and regulations.

Upland disposal of sediment would be a temporary activity and would not be continuous. Generally, areas identified for upland disposal would include sites that are heavily disturbed and provide little to no habitat value. Effects would be minor, short-term, and localized, as adjacent areas would still be available for foraging, feeding, and perching. Wildlife would return to the areas shortly after completion of the dredging and placement of sediment. Terrestrial wildlife should not realize long-term impacts by the upland disposal since no valuable habitat would be impacted. The dredged material disposal sites could have a long-term benefit because the newly disposed sediment becomes naturally seeded and provides additional habitat.

In-water disposal of sediments would occur primarily in deep water and mid-depth areas of the Snake River where terrestrial species are not present. As a result, this measure would have no impact on terrestrial resources.

As discussed in Section 3.2 (Terrestrial Resources), federally listed or other protected wildlife species have the potential to be present near the dredged or beneficial-use sites under this alternative. However, given the proposed dredging and beneficial use of sediment activities that would occur within the river, the measures are not expected to cause any appreciable impact to ESA-listed or other protected terrestrial wildlife species or plants. Alternative 5 could cause temporary displacement of individuals on the water; however, species are expected to leave the area of impact as there are multiple alternate places for species to relocate.

There is potential for effects to listed species from upland disposal of sediment. However, it is expected that disposal sites would be already heavily disturbed areas and effects should be minimal. Further analysis would be needed for site-specific projects to determine effects as disposal sites are identified.

Selection and further development of any measure would be subject to project-specific tiered environmental review and requirements, including the ESA.

Recreation: Under this alternative, the Corps would use dredging and dredged material management as needed to maintain recreation areas. The effects of dredging and dredged material management for maintenance of recreation areas would be similar to those described above for navigation maintenance, but would be minor or negligible because the scope of dredging at recreation sites would be substantially less than for navigation.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. This could include small amounts of excavation to remove accumulated sediment. Excavation activities may temporarily disturb wildlife in near-shore areas, but would be of a short duration and effects would be minor or negligible.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on terrestrial resources as navigation maintenance dredging.

4.2.2.2 Current Immediate Need Action

The effects of the current immediate need action (dredging to re-establish the congressionally authorized dimensions of the federal navigation channel) and related maintenance at the Ports' berthing areas on terrestrial vegetation, wetlands and wildlife would be the same as effects described above under future actions.

Selection and further development of any measure would be subject to project-specific tiered environmental review and requirements, including the ESA.

4.2.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.2.3.1 Future Actions

Navigation: The effects of navigation dredging and dredged material management under Alternative 7 are the same as those discussed under Alternative 5.

Construction activities associated with bendway weirs, dikes/dike fields and the relocation, reconfiguration, or closure of facilities implemented to maintain navigation may require some construction on the near shore and in upland areas (in the case of relocating, configuring or closing facilities. These activities could result in minor to moderate short-term direct effects to wildlife by the potential removal of their habitat. Construction of these facilities also has the potential to fill or clear shoreline wetlands, resulting in a long-term loss of some wetland areas if construction could not avoid them.

However, because the majority of the actions would occur in the water, no long-term effects on terrestrial resources are expected due to the small areas of upland involved. The short-term disturbance of wildlife and loss of habitat type and function caused by construction activities would be avoided to the extent feasible and would be limited in scope. These changes would be short term (where fast-growing vegetation is affected) or long term in areas of woody vegetation, resulting in minor adverse direct effects to upland resources. No short- or long-term direct effects are expected as a result of sediment trapping to upland wildlife habitat types, because these measures would occur in the water where terrestrial resources are not present. Any upland placement of sediment from this measure would have similar effects to those described for Alternative 5.

The reservoir drawdown component of this alternative would have a temporary effect on terrestrial wildlife. A drawdown would typically last a month. Terrestrial wildlife species that rely on the aquatic/terrestrial interface would incur effects during the drawdown. Terrestrial species in search of water would find it difficult to reach the water's edge as deposited sediment would be exposed and would prove difficult to traverse. Terrestrial vegetation and wetland habitat would not experience severe effects because of the short duration of the drawdown and potential winter time-frame of this measure.

As discussed in Section 3.2 (Terrestrial Resources), listed, federally protected wildlife species are found in counties adjacent to the lower Snake River; however, none occur in areas that would be affected by Alternative 7 measures. Selection and further development of any measure would be subject to project-specific tiered environmental review and requirements, including the ESA.

Recreation: To address sediment accumulation at recreation areas under Alternative 7, the Corps could consider agitation to resuspend sediment or the relocation, reconfiguration, or closure of affected facilities. The effects of these measures would have similar effects on terrestrial resources as those described for navigation above, but would likely to be less in scale since the scope of both sediment accumulation and the affected recreation facilities would be considerably less than for navigation.

Fish and Wildlife: For fish and wildlife, agitation to resuspend and the reconfiguration, relocation, and closure of affected facilities would be considered by the Corps to address sediment that interferes with HMU irrigation intakes. These measures would be unlikely to affect terrestrial resources since activities would be in-water and limited to a relatively small area around the irrigation intake.

Flow Conveyance: Construction activities would have minor, short-term effects within and immediately around the location of a levee raise. The Lewiston levees are in an urban area, so disturbance would affect developed, landscaped areas of the levees and would have little or no effect on wildlife, plants, or wetlands.

4.2.3.2 Current Immediate Need Action

The effects on vegetation and terrestrial wildlife species as a result of dredging to re-establish the federal navigation channel and related maintenance at the Ports' berthing areas would be the same as effects described above under Alternative 5.

4.3 Recreation

4.3.1 Alternative 1: No Action (Continue Current Practices)

4.3.1.1 Future Actions

Navigation: Navigation-objective reservoir operation would have minor, indirect benefits to recreation (see below).

Recreation: Navigation objective reservoir operation may provide some benefits to recreational boating by alleviating the difficult or hazardous access to recreation areas that may experience interference with boating activities due to sediment deposition. While the recreation sites were designed to operate within the full range of pool elevations, some recreation areas/boat ramps experience sedimentation problems that limit boat usage or are at least an inconvenience at MOP. Swim beaches and recreation areas/ramps would generally benefit from operation at pool levels at the higher end of a reservoir's operating range, until the maximum pool level is reached. Maintaining the navigation objective would have little or no effect on land-based recreation or water-based recreation not associated with problem recreation areas.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep irrigation intakes functioning. This could include small amounts of excavation to remove accumulated sediment, which would not affect recreation in the LSRP.

Flow Conveyance: Because the Corps would not implement any measures to address flow conveyance under this alternative, there would be no effect on recreation.

4.3.1.2 Current Immediate Need Action

The current immediate need to re-establish the dimensions of the federal navigation channel involves only the authorized project purpose of navigation. Under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. Therefore, the effects on recreation would be the same as those described for future actions.

No changes to recreational visitation rates are expected.

4.3.2 Alternative 5: Dredging-Based Sediment Management

4.3.2.1 Future Actions

Navigation: Recreational users of park and recreation facilities along the lower Snake River may be disturbed by navigation dredging activities and the presence and use of large mechanical equipment. Dredging activities would have minor, short-term, adverse effects on aquatic recreation, such as fishing and boating, in the vicinity of the dredging locations and dredged material placement sites (for either beneficial use or disposal). Minor temporary effects (e.g., noise, aesthetics) on land-based recreation would result from dredging in the lower Snake River adjacent to recreation areas. Navigation dredging would likely occur during the approved winter in-water work period (December 15 through March 1) when recreation use is generally low, which would also minimize any effects on recreation.

Sediment management measures are not expected to result in changes to recreational visitation rates. In-water placement of dredged material to create fish habitat would have minor, short-term effects on any recreational activities that may be occurring in the vicinity of the dredged material placement during the placement. In-water disposal of dredged material would have similar effects on recreation as in-water beneficial use. Upland placement of dredged sediment, for either beneficial use or disposal, may affect recreational sites or activities if they are in the vicinity of the placement.

Recreation: Dredging to address sediment that interferes with recreation areas would affect boating or other recreational activities at the recreation area and surrounding area during dredging. Dredging could occur during the winter or summer in-water work windows. Summer dredging would be more likely to affect recreation activities since recreational use is generally higher in the summer. Dredged material management (all types) would have similar effects as described for navigation dredging, but would likely be less in scale because dredging recreation areas would generate considerably less dredged material than navigation dredging. Restoration of the design dimensions of facilities would have a positive effect on river recreation.

Fish and Wildlife: Under this alternative, dredging to maintain HMU irrigation intakes would be minor and in the immediate area of the intake and would therefore have little or no effect on recreation.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on recreation as navigation maintenance dredging.

4.3.2.2 Current Immediate Need Action

Under Alternative 5, the effects to recreational resources as a result of dredging to re-establish the federal navigation channel, as well as related work to maintain the Ports' berthing areas, would be the same as effects described above under future actions. Specific effects are described below.

The proposed maintenance dredging at Ice Harbor Dam and the Snake and Clearwater rivers confluence, the related Port berthing-area maintenance, and the disposal at RM 116 are expected to have some effects (e.g., noise, aesthetics) on recreational users of the river in the locations where the dredging and disposal would take place. However, because this work would be done during the winter months, the effects on recreation areas would be minor due to the low levels of recreational activities that occur during those months. The Corps plans to publicize the dates of the proposed dredging operations to alert anglers and boaters. The proposed action does not include dredging any recreation sites, recreation areas, or boat launches; therefore these areas would see continued access problems due to sediment accumulation.

One type of recreational activity, steelhead fishing, could be affected by the proposed dredging actions. Steelhead fishing is a popular recreational activity in the confluence area. The steelhead season in this area extends from June through March in Washington and from September 15 to April 15 in Idaho. There is some concern that the turbidity plume caused by the dredging may discourage steelhead from moving upriver or may discourage fishermen from trying to catch steelhead. However, the number of steelhead passing over Lower Granite usually decreases by the third week of November. In recent years, the steelhead season has been winding down by the first of January. Because dredging would not start until December 15, the peak of the steelhead season should have passed prior to the start of dredging. Also, the allowable increase in turbidity close to the dredge operation would be low relative to the natural variations in background turbidity. Therefore, the dredging operation should have a minor negative impact on recreational steelhead fishing.

The dredging-based sediment management measures are not expected to result in changes to recreational patterns or visitation rates.

4.3.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.3.3.1 Future Actions

Navigation: Direct effects on recreation from structural sediment management measures to maintain navigation under Alternative 7 in the lower Snake River would include the same activities and effects associated with dredging and dredged material management as described under Alternative 5 above. Temporary, adverse direct effects on recreation from the construction of bendway weirs, dike fields, or reconfiguring and relocating affected facilities (such as water intake structures, commercial navigation facilities, or recreational boating facilities), would include potential effects on users' experiences near the construction areas. For example, if bendway weirs or dike fields were constructed in an area of the river near an existing recreation area (land- or river-based), recreation activities would be disturbed, and perhaps eliminated temporarily, during construction. Long-term, adverse direct effects would include potential navigation hazards to recreational watercraft posed by weirs and dike fields, and potential long-term disruption of fishing locations.

Short-term adverse effects on recreation would result from activities associated with reservoir drawdown to flush sediment. This measure would result in substantial changes in water levels and flow conditions, likely interrupting water-based recreation during the flushing event (likely several weeks in duration). However, drawdown would likely occur in late winter or early spring, when river recreation would be at fairly low levels, minimizing the effect on recreation. No long-term direct effects on recreation would result from reservoir drawdown to flush sediment as water levels would be returned to within normal operating ranges.

Trapping upstream sediments by excavating an area within the reservoir would have temporary but recurring direct effects (e.g., noise, aesthetics) on users and activities if any recreational facilities are near the point of excavation.

Reconfiguring, relocating, or closing affected navigation facilities in the lower Snake River would result would have a short-term effect on any recreational activities in the vicinity of the affected facility if construction activities were involved in implementing any of these measures.

Alternative 7 would not have indirect effects on land-based recreation. Measures that direct sediment away from locations where it could affect recreational use (such as the entrance to a recreation area), would have a beneficial long-term effect on water-based recreation. Adaptive management through sediment and system management measures are not expected to result in changes to recreational patterns or visitation rates.

Recreation*:* Agitation to resuspend sediments that interfere with recreation areas would have a temporary adverse effect recreational use of the facilities where and when the agitation is implemented. Short-term, adverse direct effects on recreation from agitation to resuspend sediment would include effects on river recreation in the immediate area of implementation due to noise, presence of equipment, and increased turbidity. It would have a beneficial effect on recreation by restoring the design dimensions of the facility. Reconfiguring or relocating affected recreational facilities in the lower Snake River would result in long-term, beneficial effects on the affected facilities and recreation use by allowing use that is unaffected by sediment deposition. Relocation or reconfiguring facilities could temporarily disrupt recreation if those measures involved construction. Closure of affected recreation facilities would have a long-term adverse effect on recreation by eliminating that facility and increasing use at other, available facilities (which could become overcrowded).

Fish and Wildlife: Agitation to resuspend, relocation, reconfiguration, or closure of facilities to maintain HMU irrigation intakes—would be minor and in the immediate area of the intakes, and would therefore have little or no effect on recreation.

Flow Conveyance: If levee raises were proposed in portions of the Lewiston levee system used for recreation, construction would have a temporary adverse effect on recreation activities that occur in the vicinity. Visitation to the recreation facilities that include the Lewiston Levees would be reduced and recreational activities (primarily trails) would be interrupted during construction. Recreational use would be restored following construction, and there would be no long-term or indirect effects on recreation. Trapping upstream sediment would have the same effects on recreation as described above for navigation.

4.3.3.2 Current Immediate Need Action

Under Alternative 7, the effects of dredging to re-establish the federal navigation channel and performing the related Ports' berthing-area maintenance would be the same as effects described above under current immediate need action for Alternative 5.

4.4 Cultural Resources

4.4.1 Alternative 1: No Action (Continue Current Practices)

4.4.1.1 Future Actions

Navigation: Maintaining pool levels at the higher end of the reservoirs' operating ranges to maintain the navigation objective may cause shoreline archaeological sites or portions of sites to be inundated for longer periods of time than when not maintaining higher pool levels. This can provide some protection for sites; however, the more likely outcome is that longer exposure to high water levels could lead to increased erosion and loss of portions of archaeological sites. Long-term effects can include erosion and loss of portions of a site and/or contributing elements of archaeological districts. Materials exposed through erosion lose their scientific context, and are also exposed to potential looters. Under this no action alternative, changes in water levels would not be substantial, but do have the potential to adversely affect archaeological sites when higher water levels are maintained. Historic buildings, including the dams, would not be affected by maintaining pool levels at the navigation objective.

Recreation: Under this alternative, the Corps would not implement measures to maintain recreation at recreation areas. Sediment accumulation around recreation sites would continue and the Corps may close recreation areas or marinas as a result of sediment accumulation. Not maintaining and potentially closing recreation areas would not affect cultural resources.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. These activities would not affect cultural resources.

Flow Conveyance: Because the Corps would not implement any measures to address flow conveyance under this alternative, no cultural resources would be affected.

4.4.1.2 Current Immediate Need Action

Under this alternative, the Corps would implement the same navigation objective reservoir operation as described for future actions to address the current immediate need to re-establish the federal navigation channel. Therefore, the effects on cultural resources would be the same as for future actions described above.

4.4.2 Alternative 5: Dredging-Based Sediment Management

4.4.2.1 Future Actions

Navigation: Early archaeological surveys conducted under the auspices of the Smithsonian Institution's River Basin Survey Program, as part of pre-inundation salvage efforts, and as result of ongoing management of archaeological resources by the Corps, have resulted in the identification of numerous archaeological sites within the LSRP. Sites include those that are on lands adjacent to the rivers, as well as a number of sites that were subsequently inundated after construction of the LSRP. Dredging and disposal activities carried out near shorelines, confluences, alluvial fans, islands or channel bars, and in the area of recorded archaeological sites have the potential for ground disturbance that can bury, damage or destroy archaeological sites.

Dredging and the disposal of dredged material also have the potential to disturb sites of religious and cultural significance to Indian tribes, including those that may have been inundated when the reservoirs associated with the LSRP were filled. One other aspect of dredging that has the potential to affect historic properties is the disturbance of secondary deposits of archaeological material that may occur within sediments identified for dredging including, potentially, human remains. Although the secondary deposition of the archaeological material likely means it retains no archaeological value, it may have traditional religious and cultural significance, especially in the case of human remains. For this reason, in-water disposal of dredged material is preferred as it ensures that the material remains in the river, in a secondary depositional environment. However, in shallow areas where dredged material may be placed for beneficial use, material placement and contouring also have the potential to disturb or bury inundated sites. Depending on where work takes place, construction activities may introduce disturbances to historic properties of religious and cultural significance to Indian tribes. Upland disposal of dredged material may entail some beneficial protection if the material is used to armor archaeological sites already being affected by erosion; however, the chemical effect of burying sites is not well understood. Reuse of fill in conjunction with habitat enhancement may have beneficial effects for historic properties of religious and cultural significance to Indian tribes. However, the construction of site access (e.g., roads), if required, would potentially increase access and traffic in the vicinity of the placement site, leading to an increased risk for damage to archaeological sites and adverse effects to historic properties of religious and cultural significance to Indian tribes.

The use of mechanized equipment for upland placement of dredged material for beneficial use or disposal has the potential for ground disturbance that could adversely affect archaeological sites or cause damage to subsurface artifact site integrity. Concerns for construction activities include activities in associated staging and lay-down areas, and any retaining structures built to hold dredged material. Reuse of dredged material in conjunction with habitat enhancement may have beneficial effects for historic properties of religious and cultural significance to Indian tribes, but could also result in the inadvertent burial of cultural resources.

Selection and further development of any future actions would be subject to project-specific tiered environmental review and requirements, including consultation with the appropriate tribal governments in accordance with Section 106 of the NHPA and its implementing regulation 36 CFR Part 800.

Recreation: For this alternative, dredging and dredged material management associated with recreation areas affected by sedimentation would have similar effects on cultural resources as those described for navigation maintenance. The potential to effect cultural resources would be less since the scale of dredging and the amount of dredged material management would be considerably less for recreation-related actions than for navigation maintenance.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. Any dredging would be limited to the affected intakes immediate surroundings. These activities would not affect cultural resources.

Flow Conveyance: Dredging to improve flow conveyance would have similar effects on cultural resources as navigation maintenance dredging, though effects may be greater in scope due to larger quantities of sediment dredged and managed..

4.4.2.2 Current Immediate Need Action

Potential effects to cultural resources as a result of dredging to re-establish the congressionally authorized dimensions of the federal navigation channel would be the same as effects described above under future actions. Specific effects of this current immediate need action are described below.

Dredging would be done in both Washington and Idaho. On the Washington side, some dredging would be done in close proximity to archaeological sites, but should not directly impact any of them because all identified locations have been previously dredged to the same depths planned for the near-term maintenance dredging actions (Table 1-3). In addition, the selected dredging method would not go below recently accumulated sediments into previously undisturbed riverbed material.

In Idaho, the proposed dredging location has a portion of an archaeological site included within the project area but, again, it is not anticipated that dredging activity would impact the archaeological site because the area has been previously dredged several times to the same depths proposed for the near-term maintenance dredging actions (Table 1-3). In addition, the selected dredging method would not go below accumulated sediments into previously undisturbed riverbed material.

In-water placement of dredged material has the potential to bury inundated archaeological sites. Disposal of the material at approximately RM 116 is also consistent with previous disposal actions. Although the in-water disposal of the dredged material from the for the current immediate need action would extend to the west of the previously used areas, it would remain east of known, inundated archaeological sites. In-water disposal would also not affect any values associated with sites of religious and cultural significance to Indian tribes known for the vicinity.

The current immediate need action is not anticipated to have adverse effects to any archaeological material located within a secondary context, as that material would be relocated into a similar environment within the Lower Granite Reservoir. Similarly the current immediate need action is not anticipated to have any effects to historic properties of religious and cultural significance to Indian tribes.

4.4.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.4.3.1 Future Actions

***Navigation**:* Any navigation dredging and dredged material management performed under Alternative 7 would have the same effects on cultural resources as those activities performed under Alternative 5.

The construction of bendway weirs and dikes/dike fields and the reconfiguration and relocation of affected navigation facilities would involve in-water, and some upland, construction that could adversely affect archaeological sites. Use of mechanized equipment has the potential for ground disturbance that can displace or destroy surface sites; in addition, heavy equipment can compact the soil, causing damage to subsurface site integrity. Construction also would create ground disturbance, a threat to archaeological sites. Placement of fill has the potential to bury archaeological sites. This may entail some beneficial protection; however, the chemical effect of burying sites is not well understood. Removal of riverbed or shoreline material, if required, has the potential to expose sites if removal reaches below the level of the fill, subjecting the site to potential vandalism and to wind and wave action that leads to erosion.

These measures may adversely affect values associated with sites of religious and cultural significance to Indian tribes.

Changes in water level and flow velocity from drawdown have the potential to harm archaeological resources through scouring of point bars, changes in the timing and duration of site exposure, and increased erosion in sites on shorelines, islands, and bars. Depending on the level of changes in water level and flow velocity, there is a potential for some sites that are currently inundated to become exposed. While this may provide an opportunity for investigation, it also risks casual discovery and potential looting or vandalizing of the site. If water levels are sufficient to continually or seasonally expose new portions of lands, traffic may be attracted to the area, further risking the integrity of sites.

Selection and further development of any measure would be subject to project-specific tiered environmental review and requirements, including consultation with the appropriate tribal governments in accordance with Section 106 of the NHPA and its implementing regulation 36 CFR Part 800.

Recreation: Under this alternative, measures implemented for recreation areas affected by sedimentation would have similar effects on cultural resources as those described above for navigation maintenance. However, the potential to affect cultural resources would be less since the scale of dredging and the amount of dredged material management would be considerably less for recreation-related actions than for navigation maintenance. Agitation to resuspend sediment has the potential to move fine sediments that are capping inundated sites, compromising spatial integrity, and removing artifacts. Removal of fine sediments over time has the potential for long-term effects by moving artifacts from their original location and removing underlying fine sediments, allowing artifacts to lag unto the surface below, and even to create false sites by moving lighter artifacts and grouping them artificially.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. Measure implementation would be limited to the affected intakes' immediate surroundings. These activities would not affect cultural resources.

Flow Conveyance: Levee raise would be confined to the top of portions of the existing levee system in the vicinity of the Snake and Clearwater Rivers' confluence. The levee system is not presently eligible for listing in the National Register of Historic Places and is a disturbed site, so raising the levee would not affect historic properties or archaeological sites. Construction areas would be surveyed prior to any potential levee raise and the Corps would evaluate whether historic properties are present and potentially affected in compliance with the requirements of the NHPA.

4.4.3.2 Current Immediate Need Action

Under this alternative, the effects to cultural resources as a result of dredging to re-establish the federal navigation channel and related work to maintain the Ports' berthing areas would be the same as effects described above under the current immediate need action for Alternative 5.

4.5 Socioeconomics

4.5.1 Alternative 1: No Action (Continue Current Practices)

4.5.1.1 Future Actions

Navigation*:* Navigation objective reservoir operation lessens the effect of sediment accumulation on commercial navigation by, to the extent possible, maintaining the authorized dimension of the federal navigation channel By maintaining pool levels to provide 14 feet of water in the navigation channel, commercial navigation would be unimpeded. However, navigation objective reservoir operation would be effective for only a limited time; sediment will continue to accumulate and ultimately would impede navigation because pool levels cannot be raised beyond maximum operating pool.

Sediment accumulation interferes with commercial navigation and creates the potential for navigation hazards and property damage when the depth of the federal navigation channel and Port access and berthing areas becomes less than the authorized dimensions. The grounding of vessels on sediment shoals can cause damage to vessels, which can lead to sinking or capsizing due to holes or rips in hulls, and puts crews and passengers at risk. On commercial barges, grounding also can result in leakage or loss of cargo into the river. Navigation objective reservoir operation would provide a temporary solution to sedimentation that impedes commercial navigation. However, since pool levels can only be raised to a maximum operating pool elevation, the capacity to raise pool levels would ultimately be used up and commercial navigation would be impeded, having an adverse effect on commercial navigation, as well as cruise ship operations.

Measures taken under this alternative would not affect railroad or highways in the short term. However, when commercial navigation is impeded, commodities would likely shift to other modes (truck, train), resulting in increased demand for freight rail service and heavy truck traffic on regional roadways, having an adverse effect on roads and railroads. Freight rail would be affected by demand for additional transportation capacity, which may be limited; increased truck traffic on regional roadways could increase road maintenance and congestion.

Navigation objective reservoir operation would help maintain economic activity in the region and would not change employment, income, or other socio-economic conditions in the area. When the effectiveness of navigation objective reservoir operation decreases and commercial navigation is affected, regional employment and income could be adversely affected.

Recreation*:* Under this alternative, the Corps would not implement measures to maintain recreation at recreation areas, and may close recreation areas or marinas if sediment accumulation causes safety problems. The use of recreation areas and marinas would decrease if sediment impeded access to channels or ramps. Boaters would need to use other facilities, which would shift local economic benefits from recreation away from affected facilities and to available ones.

***Fish and Wildlife**:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. Maintaining current conditions at HMUs would have no socio-economic effects.

***Flow Conveyance**:* Because the Corps would not implement measures to address flow conveyance under this alternative, flood risk in the areas behind the Lewiston levee system would increase as sediment accumulated in the upper reaches of Lower Granite Reservoir. This No Action Alternative may have a long-term adverse socioeconomic effect on the Lewiston area due to this increase in flood risk and the associated risk of economic flood damages.

4.5.1.2 Current Immediate Need Action

The current immediate need action to re-establish the congressionally authorized dimensions of the federal navigation channel involves only the authorized project purpose of navigation. Under Alternative 1 the Corps would maintain the federal navigation channel by continuing to operate Lower Granite Reservoir at the higher end of its operating range and by making operational adjustments at Ice Harbor Dam.

Sediment has currently accumulated in the navigation channel and Port berthing areas such that water depth at MOP is below the authorized 14 feet in several locations, and as shallow as seven to nine feet in some locations. It is not currently possible to provide the 14-foot depth congressionally authorized navigation channel at maximum pool level. Ports have reported that barges have grounded and tour boats have had to find alternative locations for passengers to embark. Continuing navigation objective reservoir operation would not provide the authorized federal navigation channel dimensions because the upper limits of the reservoirs' operating ranges have already been reached. The No Action Alternative would result in a continuing decrease in the capacity of the navigation channels and port access and berthing areas to accommodate commercial barge traffic and would therefore have the same socioeconomic effects as for the future actions described above.

4.5.2 Alternative 5: Dredging-Based Sediment Management

4.5.2.1 Future Actions

***Navigation**:* Measures under Alternative 5 to maintain navigation would have minor, short-term, beneficial direct effects on income and employment through construction activities associated with dredging and dredged material management. Alternative 5 would have no long-term direct effects to population, employment, and income. Dredging would re-establish the navigation channel dimensions and therefore no adverse effects would result to transportation and related sectors. Raising pool levels as an interim measure would maintain current navigation operations (and associated economic activities); therefore, no adverse effects would result to the transportation and related sectors. Additionally, no direct socioeconomic or other effects would be disproportionately borne by high minority or high low-income populations; therefore, no environmental justice issues would result from this alternative.

Beneficial use of dredged material for fish habitat creation or ecosystem restoration projects would have indirect benefits, including potential recreation benefits (fishing). Recreation activities lead to increased economic consumption on travel expenditures for fuel, food, and lodging, which could be incurred while visiting a recreational site. The net economic effect would be positive. Beneficial use of dredged material for other environmental restoration or enhancements (either in-water or upland) could have similar indirect beneficial economic effects. Beneficial use of dredged material for development purposes could have economic benefits if used for activities like port development or road fill.

Alternative 5 would have a long-term beneficial impact on river navigation by providing adequate depths in the navigation channels and access channels to ports, moorages, and public recreation areas. The short-term impact of dredging could include minor disruption of barge, cruise, or recreational traffic as dredge equipment works in the navigation channel or at ports and moorages. Disruptions at port facilities would potentially also affect highway and railroad connections to the ports. In-water placement of dredged material (for beneficial use or in-water disposal) would not affect river navigation.

Alternative 5 would maintain the authorized purposes of the LSRP, including commercial navigation. Farms and businesses that ship products by barge on the lower Snake River would continue to have access to markets and transportation options provided by the inland navigation system, which would be a positive economic effect.

***Recreation**:* Under this alternative, the Corps would dredge and manage dredged material to address sediment that interferes with recreation. Maintaining recreational uses would support economic activities associated with recreation in the LSRP.

***Fish and Wildlife**:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance and dredging and dredged material management to keep intakes functioning. Maintaining current conditions at HMUs would have little or no socioeconomic effects.

***Flow Conveyance**:* Dredging to improve flow conveyance would have similar socio-economic effects as navigation maintenance dredging, though effects may be greater in scope due to the larger physical area being dredged and substantially greater quantities of sediment dredged and managed.

4.5.2.2 Current Immediate Need Action

Under Alternative 5, the effects to socioeconomic resources as a result of dredging to re-establish the congressionally authorized federal navigation channel dimensions would be the same as effects described above under future actions. This work would address the areas where industrial users have had the most difficulty navigating, and would enable commercial navigators to once again operate tugs and barges at full capacity. These factors would result in a positive economic effect on the navigation and related industries in the region.

4.5.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.5.3.1 Future Actions

Navigation*:* Similar to dredging and dredged material management, structural and system sediment management measures for navigation included in Alternative 7 would have minor, short-term, beneficial direct effects on income and employment through construction activities associated with the measure's implementation. Alternative 7 would have no long-term effects on population, employment and income. Because Alternative 7 includes actions to maintain current navigation objective operations (and associated economic activities) there would be no adverse effects on transportation and related sectors. This alternative would have a long-term beneficial direct effect on river navigation by maintaining adequate depths in the navigation channels and access channels to ports, moorages, and public recreation areas. Additionally, no direct socioeconomic or other effects would be disproportionately borne by high minority or high low-income populations; therefore, no environmental justice issues would result from this alternative.

System management measures that involve construction (bendway weirs, dikes/dike fields, or the relocation, reconfiguration or closure of affected facilities) could have short-term direct effects on socioeconomics. Construction of dikes or weirs could have temporary effects on commercial navigation during construction if they are close to the navigation channel or facilities. Relocation or reconfiguring affected facilities would temporarily interrupt economic activity of that facility, although construction activity associated with the relocation or reconfiguration would create a temporary local economic benefit.

Reservoir drawdown to flush sediments from Lower Granite Reservoir would require substantial changes in reservoir operations that would temporarily preclude most barge navigation in the reservoir while drawdown was occurring. This would be a temporary adverse impact on commercial and recreational navigation. Normal operating water levels would be restored following the implementation of the drawdown or flushing measure, which would allow navigation to resume. Some shipments would likely shift to other modes (rail, truck), which could adversely affect the capacity of the rail or highway system; however, these measures could have a long-term beneficial effect on navigation by re-establishing the navigation channel. Changes to the ways in which barge tows are operated could affect the costs of barge shipping and commodities, as well as recreational vessels operating in the vicinity of the tows.

Because there would be time to plan for a drawdown and the expected timing would not correspond with the grain harvest season, the effect on shippers would be minimal due to the short duration of the drawdown. There may be some loss of grain sales if enough grain cannot be shipped out of the reservoir, but the use of downstream storage facilities and shipping of grain prior to drawdown would minimize economic effects. Other commodities would need to be stockpiled ahead of time. Trucks or rail could be used to transport these commodities for short-term supply. This would temporarily increase costs to those who usually use the river system for the transportation of commodities, but the increases should be small.

The loss of head and the ability to use Lower Granite to produce power would mean loss of power sales for the region during the drawdown. These costs would be borne by BPA (i.e., ratepayers).

A drawdown would have an effect on the cruise ship industry. If the drawdown is implemented at a time when the cruise ships plan to use the river it would halt their trips to the Lewiston/Clarkston area during that time. This would cause economic loss for the cruise industry and the local supporting industries in the affected area. After this drawdown activity, cruise ships may be able to access docking facilities depending on the effectiveness of the flushing event.

Drawdown could have adverse effects on infrastructure adjacent to and crossing Lower Granite Reservoir. During the 1992 drawdown test, several structural problems at ports and private facilities were observed (Corps 1993[drawdown report]). Sediment and system management measures noted above would generally have a long-term indirect positive effect on regional economies by providing for continuing commercial navigation and movement of commodities, and providing options for commodity shippers. The result would be positive long-term benefits to the communities protected by the levees.

Recreation: Under this alternative, the Corps would consider dredging and dredged material management, agitation to resuspend sediment, and reconfiguring, relocating, or closing facilities to address sediment that interferes with recreation. Maintaining recreational uses would support economic activities associated with recreation in the LSRP.

Fish and Wildlife*:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps could implement dredging, agitation to resuspend sediment, and reconfiguring, relocating, or closing facilities to address sediment that interferes with HMU irrigation intakes functioning. Maintaining current conditions at intakes using these measures would have little or no socioeconomic effects.

Flow Conveyance*:* Levee raise would provide a minor temporary increase in local employment and economic activities associated with construction. The levee raise would maintain acceptable levels of flood protection in Lewiston and provide long-term management of flood risk consistent with Corps policies and guidelines, thus maintaining an acceptable level of flood protection for a portion of downtown Lewiston. Levee raise would have a socioeconomic effect on businesses and land owners under consideration within the downtown economic redevelopment plan for the City of Lewiston. The effects of dredging would be the same as those under Alternative 5.

4.5.3.2 Current Immediate Need Action

Under Alternative 7, the socioeconomic effects of dredging to re-establish the federal navigation channel and of related Port berthing-area maintenance would be the same as effects described above under current immediate need action for Alternative 5.

4.6 Water Quality and Sediment Quality

4.6.1 Alternative 1: No Action (Continue Current Practices)

4.6.1.1 Future Actions

Navigation: Implementation of the navigation objective reservoir operation measure would not require construction or noticeably affect sediments in the target areas. Maintaining pool levels at the higher end of reservoir operating ranges is unlikely to affect temperatures and thermal stratification in the reservoirs, or otherwise affect water or sediment quality.

Recreation: Under this alternative, the Corps would not implement measures to maintain recreation at recreation areas. As sediment accumulates, boaters may stir up sediment with prop wash, increasing turbidity in the vicinity of boat activities that result in stirring up sediments, which would have a minor localized adverse effect on water quality. If the Corps closes boat ramps or basins for safety reasons, water quality effects from prop wash would cease.

***Fish and Wildlife**:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could include small amounts of excavation to remove sediment accumulated around the intakes, resulting in localized increases in turbidity. Water quality effects from increased turbidity would be localized and minor.

***Flow Conveyance**:* Because the Corps would not implement any measures to address flow conveyance under this alternative, there would be no effects on water or sediment quality for this authorized purpose.

4.6.1.2 Current Immediate Need Action

The current immediate need to re-establish the dimensions of the federal navigation channel involves only the authorized project purpose of navigation. To address the current immediate need action under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. The effects on water and sediment quality of measures undertaken to address the current immediate need would be the same as those described for future actions.

4.6.2 Alternative 5: Dredging-Based Sediment Management

4.6.2.1 Future Actions

Navigation: This alternative could have an intermittent, negative effect on water quality in both the Snake and Clearwater Rivers, primarily due to mobilizing sediments that could increase turbidity levels during dredging and dredged material management that uses in-water placement of sediment (beneficial use or in-water disposal). At dredging sites, water quality impacts would occur for a short distance downstream while the dredge is operating. At in-water placement sites, minor adverse effects would occur while dredged material is placed and up to a few hours afterwards. At dredging and placement locations, only a small portion of the river would be affected.

Dredging is not anticipated to affect water temperatures. However, water temperatures at in-river placement sites may slightly increase from current conditions in the summer. Water overlying the shallow habitat would likely exceed 68^{o}F during summer days, but may also cool off more at night relative to the open-water. Predicting the thermal effects of these opposing actions in the long term is hampered by uncertainty related to issues of vegetation that could become established nearby and create shading, global warming, and runoff volume. However, considering the small incremental change in volume of shallow water, the greater cooling of shallow water at night, the effects of wind and wave action on mixing near shore, and advection of water through these areas, the overall changes to the thermal budget of the reservoir are not anticipated to be significant.

Dredging and in-water placement activities would be temporary and would cause minor, localized effects by increasing turbidity and suspended solids. Background turbidities in the lower Snake River generally do not exceed 10 NTUs. As early as the 1940s, Van Oosten (1945) concluded from a literature survey that average turbidities as high as 200 NTUs are harmless to fish. Newcombe and Jensen (1996) provide a more robust risk analysis of the effects of turbidity upon salmonids, and show that prolonged exposure to turbidity levels greater than 100 NTU can affect long-term feeding success.

Dredging in areas with finer sediments, such as the Ports of Lewiston and Clarkston, is likely to have the greatest effect on water quality. For any future dredging action the Corps would complete sediment sampling consistent with the Sediment Evaluation Framework (SEF) and other applicable guidelines and plans to determine the suitable dredged material management measure.

The use of mechanized equipment in the river would increase the potential for a spill or release of hazardous materials such as oil, grease, fuels, or hydraulic fluids into the aquatic environment. Certain chemicals may have serious toxic effects on water quality and aquatic organisms. Avoidance and minimization measures would be implemented to prevent spills and releases. Spills would be controlled by measures outlined in the SPCC Plan.

The Corps would prepare a monitoring plan, if needed, for dredging and disposal activities to be undertaken as part of future actions.

Recreation: For this alternative, dredging and dredged material management associated with recreation areas affected by sedimentation would have similar effects on water quality as those described for navigation maintenance. The potential to effect cultural resources would be less since the scale of dredging and the amount of dredged material management would be considerably less for recreation-related actions than for navigation maintenance.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. Any dredging would be limited to the affected intakes immediate surroundings. These activities would have minor localized adverse effects on water quality due to increased turbidity in the area surrounding the maintenance activity.

Flow Conveyance: Dredging to improve flow conveyance would be a much larger dredging operation in both area and quantity than the navigation channel dredging. As a result, the temporal and spatial effects on water quality would likely be greater due to the additional area disturbed and time spent dredging.

4.6.2.2 Current Immediate Need Action

The immediate effects of dredging to re-establish the federal navigation channel on water quality would be the same as those described above under future actions.

Based on the results from the 2013 sampling (Section 3.6), the sediments proposed for the current immediate need action dredging met the chemical, physical, and biological criteria for open and unconfined in-water placement.

Dredging the federal navigation channel downstream of Ice Harbor Dam would have minimal effects on water quality. The material to be removed from this area would be river cobble 2 to 6 inches in diameter with few fines, and possibly some larger rock up to 18 inches in diameter. Other areas where dredging is proposed are predominantly sand, and dredging those sediments would also only have minor effects on water quality.

Increased localized turbidity would occur with associated dredging and disposal. Turbidity was measured at three locations relative to the dredging zone during the 2005/2006 channel maintenance project: 300 feet upstream at the background station, 300 feet downstream at the compliance boundary, and 600 feet downstream at a remote station. The boundary and remote stations each consisted of one float with two sensors, one located 1 m below the surface and one situated 1 m above the sediment. The compliance stations consisted of two floats anchored about 100 feet apart. Each of those floats had two probes placed 1 m below the surface and 1 m above the sediment. Changes to turbidity were determined by comparing average hourly data from the compliance and remote stations to background data. Dredging was stopped if exceedances above the applicable state standards occurred for four consecutive hours. There were no instances when turbidity exceeded the Idaho water quality standards when dredging occurred in the Clearwater River (collectively identified as the Port of Lewiston) during the 2005/2006 dredging activity. Dredging in the Snake River (collectively referred to as Port of Clarkston) did create some turbidity plumes that resulted in exceedances. When the data from the compliance boundary was pooled, the Washington State standard was surpassed 1.2 percent of the time using the 4-hour criteria. The percentage was the same at the remote station. Hourly differences exceeded 15 NTU less than 1 percent of the time at both downstream monitoring stations. It should also be noted that 7.1 and 11.5 percent of the combined hourly differences at the compliance boundary and remote location, respectively, were less than the background levels.

The placement of turbidity monitoring stations at the 2005/2006 in-water disposal location was similar to the locations proposed for the current immediate need action, with a few exceptions. A background station was located 300 feet upstream of the disposal zone and two compliance floats were placed 300 feet downstream. Instead of a downstream remote station, a lateral station was located about 300 feet from the disposal zone in the direction of the thalweg. Four consecutive hours of data were again used to evaluate conformity with state standards. The pooled data from the compliance boundary floats showed that turbidity levels did not exceed the 5 NTU criteria 99.4 percent of the time, and that hourly turbidity measurements were lower at the compliance boundary than at the background station 27.7 percent of the time. The hourly composite turbidity was greater than 15 NTU 0.4 percent of the time. The results from the lateral station showed higher turbidity levels. However, the 4-hour criterion was still achieved 97.7 percent of the time when the surface and deeper data were pooled. Forty-three percent of the hourly turbidity data were less at the lateral station than at the background location, and 2.3 percent of the hourly values were greater than 15 NTU.

The other proposed area to be dredged is downstream of the Ice Harbor navigation lock approach. As a result of the relatively high velocities in that area, none of the historic sediment sampling that has occurred in that reach has identified any fines. Therefore, downstream turbidity levels are anticipated to be minimal when the rock and cobble are disturbed.

Based on the results from the recent round of sampling in 2011 and 2013 (Section 3.6), the sediments that would be dredged met the chemical and physical criteria for open and unconfined in-water placement and are suitable for in-water placement. The suitability determination provided by the DMMO indicates that there would be no adverse biochemical effects to listed fish species, pelagic zooplankton, or benthic macro invertebrates from the proposed action (Appendix I). Dredging would not affect the quality of sediments in the Lower Snake River.

Disposal of the dredged material at the beneficial-use site at RM 116 to create shallow-water fish habitat also would be expected to cause turbidity plumes. The plumes, primarily from the reshaping of placed sediment, would be of short duration, as the evacuation by a barge is a singular event as opposed to the continuous operation of the dredge, and material is generally coarse and not subject to much resuspension and transport. Previous disposal actions have shown that the material tends to stay in a clump as it drops from the barge to the riverbed, further minimizing the size of the plume (Corps 2005).

The Corps has prepared a monitoring plan for dredging and disposal activities that would be undertaken as part of the proposed current immediate need action (Appendix L). A Section 404(b)(1) Evaluation was prepared for the current immediate need action and is included in Appendix L.

4.6.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.6.3.1 Future Actions

Navigation: Effects to water quality and sediment quality would be the same as those described for dredging and dredged material management as described under Alternative 5. Therefore, all of the direct effects of the measures evaluated for Alternative 5 apply to this alternative. Effects on water quality and sediment quality from maintaining pool levels at the navigation objective under Alternative 7 would be the same as those described under Alternative 1.

Mechanized construction equipment and in-water work would be required to construct bendway weirs, dikes, sediment traps, and the reconfiguration or relocation of existing navigation facilities. In-water work has the potential to increase turbidity and TSS. These effects would be localized and temporary, and could be reduced with the implementation of protective measures. Ground disturbance outside of the active channel, such as removal of vegetation, soil disturbance, and compression and exposure of bare ground, could also increase the erosion risk in the vicinity of the river. Facility relocation would likely involve more substantial earthwork due to larger construction efforts. Soil loss from erosion could adversely affect surface water quality by increasing suspended solids and turbidity in receiving waters. Erosion control measures would be implemented to minimize these risks.

The use of mechanized equipment in the vicinity of the river would increase the potential for a spill or release of hazardous materials such as oil, grease, fuels, or hydraulic fluids into the aquatic environment. Avoidance and minimization measures would be implemented to prevent spills and releases. Spills would be controlled by measures outlined in the SPCC Plan.

Bendway weirs operate by redirecting flow around river bends to prevent bank erosion on the outside bend and deepening of the channel. The weirs can be directed to flow toward the opposite, inside bend causing scouring in order to straighten and widen the channel. Bank scour from bendway weirs may cause sediments to become suspended during some flows and increase local turbidity. These effects would occur until the scouring reaches equilibrium.

Sediment traps work by collecting sediment and preventing downstream movement of trapped sediments. Some compounds, particularly nutrients, bind to suspended particles in the water column; settling of these particles could also reduce forms of phosphorus and nitrogen in the system. As the traps reach capacity, the sediments collected would need to be removed and deposited as a beneficial use, or in an upland or in-water location. Effects of these deposition measures on water quality are described under Alternative 5.

In-water disposal would affect water quality similarly to in-water beneficial use, as discussed under Alternative 5. Upland placement would not directly affect water quality, but could have minor indirect effects from the discharge of effluent from dewatering of dredged sediments placed in an upland disposal area. Given the general quality of sediments in the Lower Snake River, adverse effects from dewatering dredged sediments would not be anticipated.

Reservoir drawdown to flush settled sediments would not require construction. Drawdowns would occur for a relatively short duration during high spring flows when water temperatures are typically cooler; therefore, it is unlikely that water temperature or DO concentrations in the reservoir would be affected. Reservoir drawdown would result in increased turbidity because increased flows would resuspend sediments in the reservoir being drawn down. Flushed coarser sediments would have a less severe and smaller areal extent of effects on turbidity than finer sediments. Increased flows would transport sediments from certain areas of the river, increasing turbidity throughout the area influenced by the drawdown. During the 1992 drawdown test of Lower Granite Reservoir turbidity increases were the greatest at the upstream end of the reservoir where riverine conditions were restored. This is also the part of the river where the transition from free-flowing conditions to a slower moving reservoir environment and sediment deposition occurs when the reservoir is at the normal operating elevation (Corps 1993). Daily turbidity increased from 2 to 22 NTU between Highway 12 at RM 139.5 and Red Wolf Bridge at RM 137.5, with an average increase of 14 NTU. The subsequent decrease between Red Wolf Bridge to the Lower Granite Dam forebay at RM 108 ranged from 3 to 26 NTU, averaging 12 NTU. These turbidity effects would occur for a relatively short period of time following the drawdown, but before the reservoir levels are restored to the normal operating ranges.

Recreation: To address sediment accumulation at recreation areas under Alternative 7, the Corps could consider agitation to resuspend sediment or the relocation, reconfiguration, or closure of affected facilities. The effects of these measures would have similar effects on water quality as those described for navigation above, but would likely to be less in scale since the scope of both sediment accumulation and the affected recreation facilities would be considerably less than for navigation. The agitation to resuspend measure involves periodic agitation of deposited sediment to suspend these particles into the water column, which are then conveyed downriver with flows. Agitation would likely result in localized more extensive turbidity plume than the one associated with dredging, and would be a function of location, duration of agitation, and other factors. Other effects of agitation on water quality would be similar to those related to dredging, as discussed under Alternative 5.

Fish and Wildlife: For fish and wildlife, agitation to resuspend sediment and the reconfiguration, relocation, or closure of affected facilities to address sediment that interferes with HMU irrigation intakes. These measures would have minor, short-term effects on water quality because they would be limited to a relatively small area around the irrigation intake.

Flow Conveyance: A levee raise would be done adjacent to Lower Granite Reservoir along the existing leveed reach in the vicinity of the Snake and Clearwater' confluence. Soil loss from erosion during construction could adversely affect surface water quality by increasing suspended solids and turbidity in receiving waters. Erosion control measures would be implemented to minimize these risks. Raising levees would not measurably increase impervious surfaces or change land uses, so it would not have a long-term effect on water quality. Levee raise would not affect sediment quality. Reservoir drawdown to flush sediment and trapping upstream sediments would have the same effects on water quality as described for above for navigation.

4.6.3.2 Current Immediate Need Action

Under this alternative, the effects to water quality as a result of dredging the federal navigation channel to restore congressionally authorized dimensions would be the same as the effects described above under current immediate need action for Alternative 5. Related dredging to maintain the Ports' berthing areas would also have the same effects on water and sediment quality as those described under current immediate need action for Alternative 5.

4.7 Hydrology and Sediment

4.7.1 Alternative 1: No Action (Continue Current Practices)

4.7.1.1 Future Action

Navigation*:* Navigation objective reservoir operation would not measurably affect sedimentation in the LSRP. Pool levels would be maintained at the higher end of reservoir operating ranges to aid in navigation and other uses of the river. This measure would not directly affect the volume of sediment transported or accumulating in the LSRP. Alternative 1 would have no indirect effects on sediment and hydrology. Sediment would continue to enter into the LSRP system and would likely accumulate in the reservoirs, including areas where sediment would interfere with authorized purposes.

Recreation*:* Under this alternative, the Corps would not implement measures to maintain recreation at recreation areas. Prop wash would stir up minimal amounts of sediment. Alternative 1 would have no noticeable effect on hydrology or sediment transport and deposition in the LSRP.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. This could involve small amounts of excavation to remove sediments. This would have no effect on hydrology or sediment in the LSRP.

Flow Conveyance: Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no effect on hydrology and sediment in the LSRP.

4.7.1.2 Current Immediate Need Action

The current immediate need to re-establish the authorized dimensions of the federal navigation channel and Port berthing areas involves only the authorized project purpose of navigation. Under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. Therefore, the effects of actions to address the current immediate need would be the same as those for the future actions.

4.7.2 Alternative 5: Dredging-Based Sediment Management

4.7.2.1 Future Actions

Navigation: Under this alternative, the Corps would conduct dredging to remove accumulated sediments that interfere with navigation. Changes in the volume or frequency of dredging (increases or decreases) are possible in response to changes in sediment loading to the reservoirs due to climate change, changes in the frequency of wildfire, land use changes, or other causes.

Dredging would temporarily change the channel cross section in the dredged area. Water depth would be increased and channel width possibly would be increased (as needed) in certain areas, although any increases would not result in the total width being greater than the congressionally authorized width. Over time, dredged areas may continue to fill in and may need to be dredged again. Historic data on past dredging provides the best available information on the frequency and volume of required future dredging under Alternative 5.

Beneficial use of dredged sediments for in-water habitat creation would result in a small, localized change in the location of the sediment in the reservoirs, but no change in the total volume of sediment. In-water disposal of dredged sediment would have the same effect. Beneficial use of dredged sediments outside of the reservoir (e.g., upland placement for beneficial use) or upland disposal would result in a very small change in the total volume of sediment in the reservoir. Beneficial use of dredged sediments would have no effect on the accumulation of sediment that interferes with the authorized purposes of the LSRP.

Alternative 5 would have no indirect effects on sediment and hydrology. Sediment would continue to enter into the LSRP system and would likely accumulate in the reservoirs, including areas where sediment would interfere with authorized purposes. Dredging and dredged material management would need to be performed periodically to address sediment accumulation. Raising pool levels would not indirectly affect sediment transport or accumulation in the LSRP.

Recreation: Under this alternative, the Corps would dredge and manage dredged material to maintain recreation areas. Effects would be similar, but reduced in scale, to those discussed above for navigation, and would have no noticeable effect on hydrology or sediment transport and deposition in the LSRP.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance, and could dredge to keep intakes functioning. This could involve small amounts of excavation or dredging to remove sediments. This would have no effect on hydrology or sediment in the LSRP.

Flow Conveyance: Navigation dredging in the upper reaches of Lower Granite Reservoir would have an ancillary benefit of improving flow conveyance through the Lewiston levee system, but would not of itself completely address flood risk. Dredging to improve flow conveyance would be a much larger dredging operation in both area and quantity than the navigation channel dredging. As a result, the temporal and spatial effects hydraulics and sediment would likely be greater than those for navigation dredging due to the additional area disturbed and time spent dredging.

4.7.2.2 Current Immediate Need Action

The current immediate need action under Alternative 5 would involve dredging the sediment in the federal navigation channel that is currently interfering with the authorized purposes of the LSRP and re-establishing the channel’s authorized dimensions. The general effects on hydrology and sediment as a result of the current immediate need action would be the same as the effects described above under future implementation.

4.7.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.7.3.1 Future Actions

Navigation: Structural sediment management measures would include the construction of in-reservoir facilities intended to enhance the movement of sediment through problem areas and into deep water areas or areas where deposition would not interfere with authorized purposes, and would also involve reservoir water level management operations to similarly enhance the movement of sediment out of problem areas. These measures would change the velocity of flow through certain areas within the reservoir in which they are applied, either long term (for the constructed facilities), or temporarily, in the case of the water level changes. The sediment that is resuspended by the transport enhancement measures would produce a localized increase in turbidity and suspended sediment.

The Corps studied reservoir sediment transport and hydraulics (Corps 2011b). The studies indicate that in-water structures, such as weirs and dike fields, can be effective in moving coarse sediment out of the confluence area and farther downstream into the Lower Granite Reservoir. This would result in a beneficial long-term effect as it would reduce sediment accumulating in areas where it would interfere with authorized purposes of the LSRP, and reduce the volume of required dredging in the Snake River and Clearwater River in the upper end of Lower Granite Reservoir. In-water structures would reduce the cross-sectional area of the channel, which may initially result in an increase in flood flow water levels (a direct adverse effect). Over time, as sediment in the channel erodes, this effect on flood flow water levels decreases. The 50-year-long simulations by the Corps indicate that the relative increase in water surface elevation at the confluence area is less than half a foot for the standard project flood.

In-water work associated with the installation of structures such as weirs and dikes could have temporary, localized effects on turbidity and increased suspended sediment. The structures would have long-term, positive effects by increasing the movement of sediment and thereby reducing sediment accumulation in problem areas. The structures would be designed so that sediment moved out of problem areas would settle out in non-problem areas. The total amount of sediment in the reservoirs would not change, just the amount accumulating in problem areas.

Sediment traps would trap sediments upstream of where sediment deposition would otherwise interfere with authorized purposes of the LSRP, including navigation. Sediment traps would temporarily trap sediment that would otherwise be periodically dredged and moved elsewhere. Therefore, sediment traps would have similar effects on sediments as dredging and dredged material management.

The results from the simulation of seasonal drawdown indicate that drawdown of the reservoir during high flow periods would move a significant amount of sediment out of the confluence area (a direct benefit), but that the material tends to be redeposited near Silcott Island (in the vicinity of RM 130). Dredging may be required in this area to maintain the authorized dimension of the navigation channel, if sediment is redeposited in the navigation channel. Drawdown during the low flow period tends to move much less material and thus has a minor beneficial effect. The Corps concludes that reservoir drawdown may have to be greater than the 1992 test drawdown to transport sediment further into Lower Granite Reservoir and produce a measureable reduction in flood water surface elevations at the confluence. Results also suggest that drawdowns would have to occur frequently in order to be an effective sediment management technique.

Reservoir drawdown to increase the movement of sediment out of problem areas could have temporary, localized effects on turbidity and increased suspended sediment. In addition, the resulting flushing of sediment could cause short-term, localized erosion and/or bank destabilization. Sediment would be temporarily resuspended in the water column, rather than being concentrated in problem areas, thereby having a long-term, positive effect on sediment accumulation. Reservoir drawdown would also result in a long-term, positive effect on sediment quantity in certain problem areas. The system management measures would be expected to reduce the need to dredge in certain specific areas, although measures would need to be reimplemented on a regular basis as sediment refills the problem areas. Also, the results of Corps modeling studies indicate that reservoir drawdown in the Lower Granite Reservoir would reduce problem sediment in the navigation channel near the confluence, but would not move sediment far enough downstream into the reservoir to provide flood risk benefits. Prior studies have shown that materials need to be transported and deposited downstream of River Mile 120 to avoid adverse long-term effects on flood risk within the areas protected by the Lewiston levee system. This is why prior in-river disposal sites have been located much farther downstream within Lower Granite Reservoir. In-water work associated with reconfiguration or relocation of affected facilities could have temporary, localized effects on turbidity and increased suspended sediment. Assuming the modified operations function as anticipated, they could have long-term positive effects by reducing the impact of sediment accumulation on authorized purposes.

Raising the Lewiston levee would have a long-term benefit for flood risk management in the City of Lewiston, Idaho. Any future levee raise would be implemented to achieve flood risk protection levels consistent with Corps policies and guidelines. This would provide a consistent level of flood risk protection for the areas of downtown Lewiston currently protected from inundation by the levees.

Uncontrolled redistribution of sediment associated with flushing and drawdown measures designed to move sediment from problem areas could result in indirect, adverse effects by creating problem sediment accumulation areas in other locations, for which further action, such as dredging, may be required. Sediment transport associated with in-water structures as well as flushing or drawdown would be modeled in greater detail as part of any proposal to implement such measures pursuant to the PSMP.

Uncontrolled redistribution of sediment associated with measures designed to move sediment from problem areas could result in indirect, negative effects by creating different problem areas in other locations located downstream, which would necessitate working in deeper water conditions to correct. It is assumed that projects would be designed to avoid or minimize this unintended effect.

Recreation: Under this alternative, the Corps would consider agitation to resuspend sediment, and reconfiguring, relocating, or closing facilities to maintain recreation areas. Effects would be similar, but reduced in scale, to those discussed above for navigation, and would have no noticeable effect on hydrology or sediment transport and deposition in the LSRP.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance, and could relocate or reconfigure intakes to keep them functioning. These measures would involve small amounts of sediments and would have no effect on hydrology or sediment in the LSRP.

Flow Conveyance: Under Alternative 7, the Corps could raise the Lewiston levee to manage flood risk. If flood risk were predicted to increase above acceptable levels, raising the levee would effectively reduce flood risk in areas behind the levees. Raising levees would not change the input or movement of sediment in Lower Granite Reservoir.

4.7.3.2 Current Immediate Need Action

Under Alternative 7, the effects to hydrology and sediment as a result of implementing the current immediate need action (dredging to re-establish the federal navigation channel) would be the same as the effects described above under current immediate need action for Alternative 5.

4.8 Hazardous, Toxic, and Radioactive Waste

4.8.1 Alternative 1: No Action (Continue Current Practices)

4.8.1.1 Future Actions

Navigation: The No Action Alternative would not have an effect on HTRW because there is no HTRW within the Lower Snake River navigation channel.

Recreation: Under this No Action Alternative, the Corps would not implement any measures to maintain recreation areas. Prop wash may stir up sediment, but based on sediment testing in the federal navigation channel, it is unlikely that HTRW would be associated with sediments stirred up near recreation areas. Therefore, the No Action Alternative would have no effect on HTRW in recreation areas.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could included small amounts of excavation to remove accumulated sediment, which would have similar effects as those for prop wash described for recreation above. The No Action Alternative would have no HTRW effects with respect to this authorized LSRP purpose.

Flow Conveyance: Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no effect associated with HTRW.

4.8.1.2 Current Immediate Need Action

The current immediate need action to re-establish the dimensions of the federal navigation channel involves only the existing authorized project purpose of navigation. Under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. Therefore, the effects of actions to address the current immediate need would be the same as those for the future actions.

4.8.2 Alternative 5: Dredging-Based Sediment Management

4.8.2.1 Future Actions

Navigation: Dredging the navigational channel and dredged material management could result in the release of hazardous materials, such as fuels and lubricants, from areas where such materials are stored or from the use of mechanical equipment, either into the water or on shore. However, the potential risk of release of fuels or other materials from equipment or storage is considered minor and temporary because it is assumed that releases would be controlled by implementation of BMPs required under construction stormwater pollution prevention plans. Any releases would be mitigated through standard remediation activities under existing regulations.

The Corps would complete a site assessment of any area proposed for upland disposal as part of planning for any site-specific action. If contamination were encountered during construction, there would be a risk of exposing the workers to that contamination. If HTRW were encountered, materials sampling and analysis would be required to determine the proper management and placement of such materials to prevent the spread of contamination to soils and surface water at other locations. Construction delays and increased construction cost may result if HTRW is encountered during construction.

If any HTRW were discovered during implementation of proposed dredging-related measures under this alternative, appropriate actions would be taken based on regulations in effect at that time. These actions could involve leaving those hazardous substances undisturbed or removing them from the site and disposing of them at an approved landfill, thus reflecting a positive indirect effect. Uncontrolled releases would be minimal and mitigated according to applicable regulations and therefore would not cause an indirect effect.

Recreation: Under this alternative, the Corps would dredge and manage dredged material to maintain recreation areas. Alternative 1 would have similar HTRW effects as described above for navigation, but lesser in scale because of the smaller areas and quantities of sediment involved in dredging to maintain recreation.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep intakes functioning. While maintenance would involve mechanical equipment near water, the work would be so minor that it would have no effect with respect to HTRW.

Flow Conveyance Dredging to improve flow conveyance would be a much larger dredging operation in both area and quantity than the navigation channel dredging. Flow conveyance dredging would pose a larger, but still minor risk of release of fuel or other materials during dredging. The Corps would take the same steps as described above for navigation dredging to test for HTRW during dredging and disposal activities.

4.8.2.2 Current Immediate Need Action

There would be no HTRW effects from the current immediate need action, nor from the related maintenance at Port berthing areas. There is no HTRW in areas of the proposed areas to be dredged or at the potential disposal sites.

4.8.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.8.3.1 Future Actions

Navigation: For any construction activities, the Corps would conduct a site assessment as needed prior to final planning and implementation. Construction associated with structural sediment management measures such as bendway weirs, dikes and dike fields, and structures to agitate water would include the use of mechanical equipment and the storage of hazardous materials. The use of mechanical equipment could result in the release of hazardous materials, such as fuels and lubricants, into the water or on shore. However, the potential risk of release of fuels or other materials from mechanical equipment or storage is considered minor and temporary because it is assumed that releases would be controlled by existing regulations and prevented by implementation of best management practices required under construction stormwater pollution prevention plans. Any releases would be mitigated through standard remediation activities under existing regulations.

The reconfiguration or relocation of navigation facilities could generate HTRW through two possible mechanisms: demolition of all or portions of a facility, and construction of new facilities or expansion of existing facilities. The impacts of construction activities (including the increased risk of release of HTRW from mechanized equipment and storage) discussed above in structural sediment management measures would be applicable to system management measures involving construction activities (reconfiguring affected facilities, relocating affected facilities, and upstream sediment traps). The Corps or other responsible entity would conduct site assessment as needed prior to completion of planning for a reconfiguration or relocation of an affected facility.

Demolition activities associated with reconfiguring or relocating facilities could include the removal of lead-based paint and asbestos containing materials. Demolition may result in releases of these constituents to the air in the vicinity of the demolition, to soils onsite, and potential subsequent release to surface water and sediments. There would be a risk of exposure to the demolition workers from these hazardous materials. However, demolition work associated with lead and asbestos is assumed to be implemented using best management practices under existing regulations. Materials sampling and analysis prior to demolition would be required to determine the proper management and placement of such materials to prevent the spread of contamination to air, soils, or surface water. Delays and increased demolition cost may result if HTRW is encountered. The relative risk of release of HTRW from demolition is considered minor and temporary, with potential impacts only during demolition and relocation activities.

Trapping upstream sediments would be expected to have similar effects as dredging and dredged material management described above.

Other system management measures, including reservoir drawdown to flush sediment to add conveyance capacity, are not anticipated to affect HTRW as the two locations with elevated levels of contaminants in the sediments are located high enough on the shoreline that the sediment would not be mobilized during a flushing or drawdown action. If any HTRW were discovered during implementation of proposed measures under this alternative, those hazardous substances would either be left undisturbed or would be removed from the site and disposed of at an approved landfill, and any uncontrolled releases would be minimal and mitigated according to applicable regulations.

Recreation: The measures under this alternative to maintain recreation areas (agitation to resuspend sediment and the reconfiguration, relocation, or closure of affected facilities) would have similar effects as those described above for navigation. Agitation to resuspend sediments would involve mechanical equipment and would mobilize sediments and therefore would have similar HTRW effects as dredging.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would consider agitation to resuspend, or relocation or reconfiguration of affected intakes to keep them functioning. While these measures would involve mechanical equipment near water, the work would be so minor that it would have no effect with respect to HTRW.

Flow Conveyance: Levee raise construction activities would use fuels and other materials that, if released into the environment, could contaminate soil or ground water in the area of the release, or surface water in Lower Granite Reservoir. The Corps would require construction BMPs to prevent and control any accidental release of fuels or other materials during construction. Therefore, a levee raise would likely have no effects with regarding to hazardous, toxic or radioactive waste.

4.8.3.2 Current Immediate Need Action

Under Alternative 7, the effects to HTRW as a result of the addressing the current immediate need action and the related maintenance of Port berthing areas would be the same as the effects described above under current immediate need action for Alternative 5.

4.9 Air Quality

4.9.1 Alternative 1: No Action (Continue Current Practices)

4.9.1.1 Future Actions

Navigation: Under this alternative, air quality would be expected to remain similar to existing conditions. However, if there is some shifting of transportation from barge to truck or rail as sediment deposition interferes with commercial navigation, there may be some increased emissions into the air shed from the increased truck or train traffic. In the short term, this would be expected to have a minimal effect on air quality.

Recreation: Under this alternative, the Corps would not implement measures to maintain recreation areas. This may result in shifts in use of boat ramps and marinas if recreation areas are closed or undesirable due to sedimentation. This could result in negligible shifts in sources of emissions from boat motors, which would cause little to no effect on air quality.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could include small amounts of excavation to remove accumulated sediment, which would have negligible air quality effects from running equipment to excavate sediments.

***Flow Conveyance**:* Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no effect on air quality.

4.9.1.2 Current Immediate Need Action

The current immediate need action—re-establishing the congressionally authorized dimensions of the federal navigation channel—involves only the existing authorized project purpose of navigation. Under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. Therefore, the effects on air quality would be the same as those described for future actions.

4.9.2 Alternative 5: Dredging-Based Sediment Management

4.9.2.1 Future Actions

Navigation: Temporary air quality effects under Alternative 5 would result from emissions from equipment used for navigation channel dredging and dredged material placement activities.

Air pollutant emissions associated with in-water placement of dredged material (for beneficial use or disposal) would result from the use of tug boats and sediment transport barges, mechanized construction equipment (such as cranes, backhoes, and other earth moving equipment) to place dredged material. Upland disposal would create air emission from activities to construct containment berms where necessary for placement of dredged material. Emissions would also result from the use of nonelectric pumps, from mechanized construction equipment needed for the construction of any access roads and boat ramps, and from fugitive dust emissions during sediment transport and placement. Upland beneficial use of dredged material would involve similar activities and emissions.

The amount of fugitive dust emissions from construction activities and movement of dredged material would depend on meteorological conditions (particularly wind speeds), soil types and moisture content, and the surface area of soils or sediments exposed.

Under Alternative 5, emissions of GHGs would result from the use of internal combustion engines in dredges, tug boats, barges, and other types of construction equipment associated with navigation channel dredging activities. Emissions would be temporary, as well as minor, likely falling well short of the annual emissions thresholds in EPA's GHG reporting rule. Activities included under Alternative 5 would not be subject to state or local GHG regulations.

Construction activities related to navigation channel dredging may also result in the release of stored carbon into the atmosphere. In addition, studies have shown that some GHG emissions can increase in areas where soil disturbance occurs (Kessavalou 1998).

Dredging of the navigation channel, the transport and placement of dredged material, and associated construction activities may have minor temporary adverse effects on air quality at locations in the immediate vicinity of dredge sites. Existing air quality in the lower Snake River subbasin is currently in compliance with the NAAQS's criteria for pollutants. As a result, dredging, transport, placement, and construction activities are not likely to cause exceedance of the NAAQS.

No long-term air quality effects would result from the measures included under Alternative 5.

Recreation: Under this alternative, the Corps would dredge and manage dredged materials to maintain recreation areas. Dredging and dredged material management would have similar effects as described above for navigation, but would be smaller in scale.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning and dredge around affected intakes. The scope of these activities is minor and would have negligible air quality effects from running equipment to excavate sediments.

Flow Conveyance*:* Dredging to improve flow conveyance would be a larger dredging operation than the navigation channel dredging. Flow conveyance dredging would have similar, but greater, effects on air quality as navigation dredging.

4.9.2.2 Current Immediate Need Action

Activities associated with the current immediate need action would have little effect on air quality. The dredging activities would not likely generate windblown particulate matter (fugitive dust). The dredged soils would be wet, even after transport to the disposal site, and not subject to wind entrainment. Therefore, no air quality impacts are expected in the LSRP area from the dredging and dredged material placement. Additionally, equipment used for dredging, material transport, and placement would include mechanical dredging equipment and tug boats for pulling/pushing barges. These are generally powered by diesel engines that emit low quantities of hydrocarbon and carbon monoxide emissions. Localized diesel emissions would increase during dredging, transport, and disposal, but should have a de minimis impact on ambient air quality.

4.9.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.9.3.1 Future Actions

Navigation: Direct air quality effects from dredging-based sediment management measures under Alternative 7 in the lower Snake River subbasin would result from emissions associated with navigation channel dredging and dredged material management and would be the same as those described under Alternative 5.

Direct, temporary air quality effects would result from activities associated with the construction of bendway weirs and dikes (or dike fields), the reconfiguration or relocation of affected navigation facilities, and sediment trapping. Construction of these structural and system sediment management measures would require the use of typical construction equipment with internal combustion engines. The air quality effects would occur during construction activities. Based on the existing air quality designations for the lower Snake River subbasin, temporary construction activities associated building bendway weirs and dikes are not likely to cause exceedance of the NAAQS.

Operational air pollutant emissions would result from the use of mechanical equipment used for the dredging associated with sediment trapping. Mechanical dredge emissions would be similar to those described for navigation channel dredging under Alternative 5. Conveyor belt emissions would likely be similar to those from construction equipment described above. Long-term emissions would be intermittent, minor, and not likely to cause exceedance of the NAAQS.

No long-term direct air quality effects would result from Alternative 7 measures for maintaining navigation.

Climate change effects for system management measures under Alternative 7 would be the same as those described for Alternative 5, above.

Recreation: Under this alternative, the Corps would consider agitation to resuspend sediment and the relocation, reconfiguration, or closure of affected facilities to maintain recreation areas. Agitation to resuspend sediment and reconfiguration of affected facilities would have similar effects as described above for navigation, but would likely be smaller in scale. Relocation or closure may result in shifts in use of boat ramps and marinas if recreation areas are closed or undesirable due to sedimentation, which may result in negligible shifts in sources of emissions from boat motors.

***Fish and Wildlife**:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning and would consider agitation to resuspend sediment and the relocation or reconfiguration of affected intakes. The scope of these activities is minor and would have negligible air quality effects from running equipment to excavate sediments.

Flow Conveyance: Construction activities associated with a levee raise would involve mechanical equipment and would have similar emissions effects as other construction activities as measure described for navigation above.

4.9.3.2 Current Immediate Need Action

The effects to air quality as a result of the current immediate need action under Alternative 7 and related maintenance at the Port's berthing areas would be the same as the effects described above under immediate action for Alternative 5.

4.10 Aesthetics

4.10.1 Alternative 1: No Action (Continue Current Practices)

4.10.1.1 Future Actions

Navigation: Navigation objective reservoir operation would likely have only an imperceptible effect on the appearance of water levels in most of the Snake River and would not change aesthetic resources or viewing patterns of highway travelers, recreational river users, or local residents. Operating reservoirs at the higher end of their operating ranges would have a greater relative effect and the change in water level may be perceptible near the dams, which could result in a slight improvement in aesthetic resources by covering cut banks and barren shoreline areas that may be exposed during the annual spring minimum operating pool operation. This would result in a temporary, minor beneficial effect to all viewers.

Recreation: Under this alternative, the Corps would not implement measures to maintain recreation areas. This may impede use of these facilities due to sediment build-up and result in shifts in use of boat ramps and marinas if recreation areas are closed or undesirable due to sedimentation. If boat ramps or recreation areas are closed due to sediment issues, this alternative would likely have a localized adverse impact on aesthetics of the recreation facility due to closure and lack of use.

Fish and Wildlife*:* For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. This could include small amounts of excavation to remove accumulated sediment, which would have negligible aesthetic effects.

Flow Conveyance*:* Because the Corps would not implement measures to address flow conveyance under this alternative, there would be no aesthetic effects resulting from this alternative for this authorized purpose.

4.10.1.2 Current Immediate Need Action

The current immediate need action to re-establish the dimensions of the federal navigation channel involves only the existing authorized project purpose of navigation. Under Alternative 1, the Corps would implement the same navigation objective reservoir operation as described above for future actions. Therefore, the effects on aesthetics would be the same as those described for future actions.

4.10.2 Alternative 5: Dredging-Based Sediment Management

Navigation: Alternative 5 would have a temporary, direct effect on aesthetic resources in the areas where navigation channel and other dredging and beneficial use of sediment would take place. Dredging and disposal activities would be visible to drivers on adjacent highways and roads, boaters on the Snake River, recreation area users along the shorelines, and local residents.

Some members of the public may find the activities displeasing and in contrast to the rural nature of the Snake River canyon while others may find the activities to be of interest or at least consistent with other industrial uses of the reservoirs.

The measures associated with Alternative 5 would be short-term events and effects to aesthetic resources would only occur during the duration of dredging activities. Thus, measures associated with Alternative 5 measures to facilitate navigation would have only a minor, temporary adverse direct effect on the visual quality of the LSRP area. Alternative 5 is not anticipated to change viewing patterns for aesthetic resources in the lower Snake River subbasin.

The use of mechanized equipment to dewater dredged material and transport material from barges to an upland placement site could be visible by recreation river users, highway travelers adjacent to the site, and individuals on the shoreline near the site. Viewers could experience a negative effect locally from these activities; however, this effect would occur only temporarily and would be visible only in the areas where dredged material would be placed. Thus, it would constitute a minor adverse direct impact to aesthetic resources.

There would be no long-term effects to aesthetic resources associated with the navigation channel dredging and other dredging or dredged material management. Once a measure's implementation is complete, all equipment would be removed from the river and the aesthetic conditions would return to the existing conditions. None of the measures that are part of Alternative 5 would have lasting visual effects.

Recreation: Under this alternative, the Corps would dredge and manage dredged materials to maintain recreation areas. Dredging and dredged material management would have similar visual effects as described above for navigation, but would be smaller in scale.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning and dredge around affected intakes. The scope of these activities is minor and would have negligible visual effects from running equipment to excavate sediments.

Flow Conveyance: Dredging to improve flow conveyance would be a much larger dredging operation in both area and quantity than the navigation channel dredging, and would have similar but greater aesthetic effects as navigation dredging.

4.10.2.1 Current Immediate Need Action

The dredging in the federal navigation channel necessary to address the current immediate need action is anticipated to have a temporary, direct impact on aesthetics in the area where dredging and disposal operations are taking place. Dredging activities would be visible to drivers on U.S. Highway 12 and also to recreational boaters on the Snake River. Disposal activities would be visible to boaters and to drivers on SR 193 (Wawawai River Road), although the disposal area would be on the opposite side of the river from the road. This effect would result from the presence of dredging equipment in the river and the turbidity plume from dredging and disposal at the beneficial-use site at RM 116. This impact would occur during the duration of the dredging operation and would have a minor effect on the visual quality of the surrounding area. This alternative is not expected to change viewing patterns for the aesthetic resources in the potential affected environment.

4.10.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

4.10.3.1 Future Actions

Navigation: Construction-related activities associated with Alternative 7 measures to maintain navigation (bendway weir, dikes/dike fields, reconstruction or relocation of affected facilities, trapping upstream sediment, and agitation to suspend sediment), would include heavy equipment operation, material stockpiles, and worker presence. Construction of any of these measures would represent a noticeable change from existing conditions and would be visible by highway travelers, recreational users on the river and along trails, and local residents throughout construction. These viewers may experience a negative effect locally from construction activities, depending on the selected location of the placement of the measures; however, this effect would occur for only a temporary period of time and constitute a minor adverse direct impact to aesthetic resources.

Temporary effects associated with dredging and dredged material management would be the same as those described above under Alternative 5. Sediment trapping upstream would involve construction activities (dredging and dredged material management during construction and periodically to remove sediment). These activities would have similar visual effects to those for dredging and dredged material management described for Alternative 5.

The measures for bendway weirs and dikes/dike fields would place permanent in-water structures in the Snake River near its confluence with the Clearwater River. Part or all of the bendway weirs or dikes could be designed to be either below or above the typical operating levels of reservoir(s). If these structures are designed to be above the water, they would be visible to recreational river users, local residents, and highway travelers. Bendway weirs or dikes potentially constructed around the confluence of the Snake and Clearwater Rivers could be visible to travelers on U.S. Highway 12, which is designated as the Lewis and Clark Scenic Byway. This measure could introduce additional built features into the landscape, and therefore may have a minor, long-term adverse effect on aesthetic resources in the Snake River subbasin. There would be no long-term effects to aesthetic resources associated with the following measures: agitation to suspend sediment, dredging, beneficial use of sediment, in-water disposal, or upland disposal. These measures are considered to be one-time events and would have no long-lasting effects to viewers or viewing patterns.

During reservoir drawdown to flush sediment, large areas of river bottom would be temporarily exposed along the entire length of the Lower Granite Reservoir. This would expose a shoreline that is devoid of vegetation and gray-colored, and may be visually displeasing to highway travelers (SR 193 and U.S. Highway 12), recreational river users, and residents in the Clarkston/Lewiston area. This measure also creates the potential for material along the shore to slump, slough, and crack, which could also be considered displeasing to these viewers. However, some members of the public may find the drawdown to be of interest as the shoreline is not exposed to this degree during normal pool operations. The effects of this measure would constitute a temporary major adverse direct impact to aesthetic resources.

Long-term effects associated with the measure to reconfigure affected facilities would constitute a minor change to the local environment. The Corps assumes that reconfiguring of facilities would comply with applicable local development requirements, and would be generally consistent with existing development and its associated visual quality. Therefore, reconfiguring affected facilities would not result in an adverse effect to aesthetic resources.

Long-term effects associated with the measure to relocate affected facilities would constitute a moderate change to the local environment by adding a new or larger existing built feature to the landscape. The relocated facility would be visible to highway travelers, recreational users of the river, and local residents. As with reconfigured facilities, the Corps assumes that relocated facilities would comply with applicable local development requirements and be generally consistent with existing development in the surrounding area. The change in viewing patterns would constitute a moderate adverse direct impact to aesthetic resources.

There would be no long-term effects to aesthetic resources associated with reservoir drawdown to flush sediment. This measure would be a temporary condition of higher flows in Lower Granite Reservoir and would have no long-lasting effects to viewers or viewing patterns.

Recreation*:* Under this alternative, the Corps would consider agitation to resuspend and reconfiguring, relocating or closing affected facilities to maintain recreation at recreation areas. These measures would have similar visual effects as described above for navigation, but may be smaller in scale. Agitation to resuspend sediment would have no temporary affect on the viewing patterns of recreational river users, highway travelers, or local residents because the placement of a boat or small work barge (with propeller or jet features) for a short period of time would be similar to other boats and barges present on the Snake River and in the boat basins. The addition of a boat or barge performing agitation would not change viewing patterns, as most activity would occur below the water surface and would not be visible.

Fish and Wildlife: For fish and wildlife (i.e., HMU irrigation intake maintenance), the Corps would perform routine maintenance to keep the intakes functioning. The Corps would also consider agitation to resuspend sediment and the relocation or reconfiguration of affected facilities. The scope of these activities is minor and would have negligible visual effects.

Flow Conveyance*:* Any levee raise would likely be small (a three-foot or less increase in the levee height), and sites would be restored following construction, so the long-term effect on the appearance of the levee would likely be minimal. Raising the levee would have the long-term adverse effect of reducing the visibility of Lower Granite Reservoir from parts of Lewiston; however, because the levee raise would be less than three feet in most locations, the effect on visibility of the reservoir would be minor.

4.10.3.2 Current Immediate Need Action

The effects to aesthetic resources as a result of the current immediate need action under Alternative 7, and of related maintenance at the Ports' berthing areas, would be the same as the effects described above under current immediate need action for Alternative 5.

4.11 Cumulative Effects

The CEQ regulations implementing NEPA require agencies to consider the cumulative effects of their actions though the NEPA process. Cumulative effects are defined as effects "on the environment which result from incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time" (40 CFR § 1508.7).

The primary goal of a cumulative effects analysis is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and reasonably foreseeable future actions.

4.11.1 Resources Considered

The Corps used the technical analysis conducted for this EIS and considered public and agency input (Appendix G) to identify and focus on cumulative effects that are "truly meaningful" in terms of local, regional, or national significance (CEQ 1997). While the EIS addresses the effects of alternatives on the range of resources representative of the human and natural environment, not all of those resources need to be included in the cumulative effects analysis – just those that are relevant to the decision to be made on the proposed action. The Corps has identified the following resources that are notable for their importance to the region and potential for substantial cumulative effects. Those resources are:

- Threatened and endangered fish;
- Water and sediment quality;
- Hydrology and sediment; and
- Socioeconomics.

The Corps determined that the resources identified for cumulative effects analysis are of local, regional, or national significance. Environmental concerns regarding threatened and endangered fish are on a national level, as well as local and regional levels. The concerns about threatened and endangered fish (especially salmon) are based not only on the economic aspects of commercial and recreational fishing, but also on the important role that these fish have for the Pacific Northwest and in the culture of Native American groups. Also, concerns have been expressed about water quality, especially as it relates to the effects on human health and on threatened and endangered fish species. There is also a local and regional interest in sediment because it affects water quality, commercial navigation, flood risk management, and recreation. There is also a strong local and regional interest in socioeconomics effects associated with maintaining the navigation channel.

Resources are discussed in terms of their cumulative effect boundary (spatial and temporal), the historic condition and impacts to the resources, present condition and impacts to the resources, reasonably foreseeable future actions that may affect the resources, and the effects to the resource by the various sediment management alternatives when added to other past, present, and future actions.

This section evaluates the cumulative effects of actions that could potentially affect the same environmental resources as those discussed earlier in this EIS. The scope of this analysis extends beyond the LSRP to other areas that sustain the resources of concern. A resource may be differentially impacted in both time and space. The significance of those impacts depends on the characteristics of the resource, the magnitude and scale of the project’s impacts, and the environmental setting (EPA 1999).

The resources assessed have experienced various impacts since the mid-1800s. Actions such as river modification for navigation, fish harvest, mining, development of cities, construction and operation of dams and associated levee systems, flood control projects, agricultural development including irrigation, road building, grazing, and logging have all contributed to the current state of the resources in the area. These actions have negatively and positively affected the resources.

4.11.2 Geographic and Temporal Scope of Cumulative Effects Analysis

Guidance for setting appropriate boundaries for a cumulative effect analysis is available from CEQ (1997) and EPA (1999). Generally, the scope of cumulative effects analysis should be broader than the scope of analysis used in assessing direct or indirect effects. “Geographic boundaries and time periods used in cumulative impact analysis should be based on all resources of concern and all of the actions that may contribute, along with the project effects, to cumulative impacts” (EPA 1999). The analysis should delineate appropriate geographic areas including natural ecological boundaries, whenever possible, and should evaluate the time period of the project’s effects. The analysis should also include all potentially significant effects on the resources of concern (EPA 1999).

The term “cumulative effects area” is used in this section to describe the geographic area analyzed for cumulative effects for each resource. The geographic area of the cumulative effects analysis can be broader than the LSRP, which was the area defined for the assessment of direct and indirect environmental effects of the plan alternatives, and is determined by the characteristics of each resource (CEQ 1997). The geographic scope of the cumulative effects analysis includes the LSRP and its sediment-contributing watershed (see Section 1.6). For threatened and endangered fish species, the cumulative effects area is expanded beyond the LSRP and the sediment-contributing watershed to include the Columbia River from the confluence with the Snake River to the Pacific Ocean. For socioeconomics, the cumulative effects area is the Columbia-Snake River Inland Waterway and the western states using the waterway.

A temporal or time boundary is the duration that impacts from the proposed project or other actions affecting the resources would last. The boundary can vary per resource. Predicting the effects of future actions can be difficult and highly speculative. In the 2005 Lower Snake River Navigation Dredging EIS (Corps 2005), the Corps identified a general time frame of 30 years based on the 30-year history of the Lower Granite project and reservoir at that time and the ability to use the observed conditions within that period to predict future conditions. Based on that methodology (and given the time since that analysis), for this EIS the Corps used 40 years as the time frame for cumulative analysis of water and sediment quality, hydrology and sediment, threatened and endangered fish, and socioeconomics.

The temporal scope of the analysis includes past actions that have substantially altered the environmental conditions in the cumulative effects area, including the wide-scale settlement and development of the area by Euro-Americans beginning in the 1800s, federal ownership and management of large portions of the area, and substantial alteration of land and water resources for multiple purposes.

Discussed below are the past, present, and reasonably foreseeable future actions that were considered for the cumulative effects analysis, the effects of those actions on the resources assessed, and a summary of the cumulative effects of the plan alternatives. Table 4-2 summarizes the geographic and temporal boundaries used in this cumulative effects analysis.

Table 4-2. Geographic and Temporal Boundaries of Cumulative Effects Area

Resource	Geographic Boundary	Temporal Boundary
Water Quality and Sediment Quality	LSRP and sediment contributing watershed	40 years
Hydrology and Sediment	LSRP and sediment contributing watershed	
Threatened and Endangered Fish	LSRP, sediment contributing watershed, and Columbia River to Pacific Ocean	
Socio-economics	Columbia – Snake River Inland Waterway (including LSRP) and western states using the waterway	

4.11.2.1 Water Quality and Sediment Quality

The geographic boundary for the cumulative effects analysis for water quality and sediment quality includes actions taking place in the Snake River watershed downstream to the Columbia River. Snake River tributary headwaters were identified as the upstream boundary because actions in the tributaries can have impacts that are transferred downstream to the project area. Areas upstream of Dworshak Dam and the Hells Canyon dam complex were not considered because these dams essentially block most of the downstream sediment transport. The downstream boundary was selected as the area where an effect to the resource from any of the identified alternatives would affect the authorized purposes of the LSRP. The timeframe of 40 years was identified based on the history of the Lower Granite project, the most recently completed of the LSRP.

4.11.2.2 Hydrology and Sediment

The geographic and temporal boundary for hydrology and sediment is the same as that for the water quality and sediment quality resource. The sources and means of transport from Snake River tributaries to the LSRP are the same as the boundaries described for water quality and sediment quality. The Corps and other agencies have completed detailed analyses of sediment contribution and transport in the Snake River basin. Lower Granite Reservoir is the location where a large amount of sediment transported from upstream sources deposits, so the 40-year time frame was selected for hydrology and sediment as it represents the period for which sediment in Lower Granite Reservoir has been monitored and managed.

4.11.2.3 Threatened and Endangered Fish Species

The geographic boundary for the cumulative effect analysis for threatened and endangered fish includes the Snake River watershed and the Columbia River from the confluence with the Snake River to the Pacific Ocean. The cumulative effects analysis for the PSMP considers effects of both the proposed current immediate need action and reasonably foreseeable future actions. Given the range of measures considered that could constitute future actions, the uncertainty regarding the location, timing and scope of those measures, and the fact that tiered NEPA analysis and environmental compliance would address the cumulative effects of future actions taken, the Corps also applied the 40-year time frame used for other resources in this cumulative effects analysis.

4.11.2.4 Socioeconomics

The geographic boundary for the socioeconomics cumulative effects analysis was the LSRP its watershed, but also included the Columbia-Snake Inland Waterway because the LSRP navigation channel is an important link in that waterway and much of the cargo transported on the LSRP also travels on the Columbia River. The cumulative effects area also includes the region that uses the Columbia-Snake Inland Waterway to ship commodities it produces and receives materials it uses. The time frame of 40 years was used for the same reasons as cited above for the other resources considered.

4.11.3 Past, Present, and Reasonably Foreseeable Future Actions and Implications for Resources

The following sections present summaries of past, present, and reasonably foreseeable future actions considered in this cumulative effects analysis, and the effects of those actions on the resources considered. Section 3 of this EIS describes in detail current conditions of resources that have resulted from past and present actions.

4.11.3.1 Past Actions

Settlement and Development by Euro-Americans

Euro-American influence in the cumulative effects area began in the late 1700s (Corps 2005). By the mid 1800s, new settlements were being established and the cumulative effects area was being increasingly populated by Euro-American settlers migrating from the eastern United States. Prior to the arrival of new settlers, human-caused changes to the land and rivers were generally limited in comparison to methods employed following settlement by Euro-Americans (Corps 2005). By the late 1800s, commercial harvest of salmon and steelhead in the Columbia-Snake River basin began to quickly deplete fish populations.

Concurrent with increased fishing, dramatic changes in the landscape were taking place. Farming, grazing, mining, and timber harvest were practiced throughout the cumulative effects area. These land use changes, in turn, spurred development of a transportation network throughout the region. Railroads and road networks developed through the 19th and 20th centuries. Beginning in the 1800s rivers throughout the cumulative effects area were modified for navigation, as well as for mining and shoreline grazing, and later for power, irrigation, and water storage. Improvements in transportation systems spurred further development of agriculture, timber, livestock, and mining in the region. Railroads shipped materials produced in the cumulative effects area, as well as those produced from outside the area bound for markets and ports in larger cities such as Portland, Seattle, and Tacoma. With increased development, the scope of human-caused impacts on natural and cultural resources increased (Corps 2005).

Public Land Management

Federal land comprises more than 60 percent of the sediment-contributing watershed of the LSRP, and additional public lands are present in the Columbia River basin. National Forests in the cumulative effects area were established in the early 20th century and created large areas managed for multiple uses. During the mid-20th century, timber management became an emphasis for the Forest Service management of National Forests. Timber production generally increased in the 1970s. The Multiple-Use Sustained-Yield Act, passed by the U.S. Congress in 1960, gave recreation, fish, wildlife, water, wilderness, and grazing enhanced management status, along with timber management (USFS 2011). The Wilderness Act of 1964 provided additional protection for designated areas within National Forests and other federal land. Management of National Forests, as well as other federally managed lands, has defined the use of large portions of the cumulative effects area that are public lands. National Forest and public land management has had notable and varied effects on natural resources in the cumulative effects area. Wilderness designation, for instance, has preserved large portions of the cumulative effects area in a relatively natural state, which benefits wildlife, aquatic resources, and other natural resources. Timber harvest, grazing, mining, road building, and other activities on public land have had socioeconomic benefits in the region, but have also historically had adverse effects on wildlife, water quality, and fish.

Dams and Waterway Modifications

Development in the cumulative effects area has included building numerous dams on streams and rivers throughout the Columbia River basin. Early dams were built for irrigation, logging and mining (Corps 2005). Beginning in the early 1900s, larger dams were constructed on the Snake River and major tributaries for water storage, irrigation, and power-generation purposes. The Federal Reclamation Act of 1902 provided the impetus for construction of larger dams on the Snake River system.

From the 1930s through the 1970s, the federal government and others constructed dams on the Snake River system for multiple purposes that included hydropower, navigation, recreation, water storage, and irrigation. Federal dams in the cumulative effects area are part of the Federal Columbia River Power System. Dam building on the Snake River system has resulted today in 17 dams on the mainstem of the Snake River and more than 20 dams on tributaries, though most are outside the cumulative effects area (Corps 2005). Of those dams, four are on the mainstem Snake River within the cumulative effects area (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite). All four were designed and constructed by the Corps and are dams that impound sufficient water for navigation, and also generate power based on available flow in the river. Each dam has fish passage facilities. In addition to these four dams, other dams have been constructed throughout the Columbia River basin, including the McNary, John Day, The Dalles, and Bonneville dams on the mainstem Columbia between the Snake River and the Pacific Ocean, all operated by the Corps.

Dams on the Columbia-Snake River system have contributed to declines in anadromous fish runs. Since the 1950s, the combined consequences of dams, increased ocean fishing, changing ocean conditions, and lessened quality and availability of aquatic habitats have adversely affected Columbia-Snake River aquatic resources and, in particular, anadromous fish. Since the 1970s, the catch of salmonids has declined, with hatchery-raised species making up more than 80 percent of commercially caught salmon in the Columbia-Snake system (CCRH 2011). Fish hatcheries began operation in the Columbia River basin in 1877 and have offset some salmon and steelhead declines. Nonetheless, reduced salmonid populations resulted in the listings of multiple Snake and Columbia River species under the ESA (see Section 3.1).

The development of dams has also created substantial economic benefits to the cumulative effects area and the surrounding region. Dams on the lower Snake River and middle and lower Columbia River create an inland commercial navigation system that stretches 465 miles from the Pacific Ocean to Lewiston, Idaho, and is an integral part of a transportation network that moves products to and from the area. They also provide hydropower and limited storage for irrigation.

As documented in Section 1, since the development of dams on the Lower Snake River, the Corps has periodically dredged portions of the river to maintain authorized purposes (primarily navigation and flow conveyance) of the river system. The last navigation maintenance dredging took place in fall of 2012 at the Ice Harbor Dam lock approach.

4.11.3.2 Effects of Past Actions on Resources

Water Quality and Sediment Quality

Water quality conditions of the Snake River prior to modern-day settlement of the region in the mid-1800s are generally unknown; however, it is likely that conditions for most of the year were more suitable to most of the native fish and wildlife than the existing conditions. Some of the chemical constituents identified in the river today would have been absent. Naturally occurring compounds, such as metals and ammonia, were present in the water, but the concentrations of some elements may have been lower. Negative impacts to water quality have been caused by sources such as industrial and municipal waste, mining, logging, and other actions.

Historically, the water temperature of the Snake River likely varied more than it does today. High temperatures during the hottest part of summer may have been higher than current conditions, but the high temperatures probably did not last as long and additional cooling may have occurred during the night. The diverse temperatures between backwater areas and deep pools likely provided suitable habitat for a wider range of native fish and wildlife species than the existing conditions. Water temperatures have been affected by the clearing of streamside vegetation (an action that removes shade), channel straightening and widening for flood control, removal of irrigation water, urban development, and dams. The total dissolved gas (TDG) levels probably exceeded 100-percent saturation below natural waterfalls. However, elevated TDG levels would have quickly returned to saturation if the river were shallow and turbulent downstream. Today, spilling water over large dams is the main cause of high TDG levels.

Historic turbidity conditions likely exceeded today's regulatory thresholds during high flow events, but were likely lower than existing conditions in tributary streams. A report in the early 1900s stated, "…the water of Snake River at Burbank is usually turbid and should be clarified before being used for drinking or manufacturing" (Van Winkle 1914a). In the Snake River, average turbidity levels may have been higher than the present average turbidity condition because much of the fine sediment that contributes to turbidity levels now settles out in the reservoirs. Agriculture, overgrazing of livestock, road building, logging, flood control, mining, and other sources contributed to the increased erosion that increased turbidity levels in tributary streams. Environmental regulations like the CWA have addressed several factors that have historically affected water quality, like discharges from point sources like municipal and industrial wastewater discharges and, to some degree, non-point sources of pollution.

Many of the same factors that have historically affected water quality have also affected sediment quality. Agriculture, industrial waste, and urban development create conditions that can add contaminants to sediments that enter the Snake River and its tributaries.

Hydrology and Sediment

Hydrologic cycles were historically driven by climatic and topographic conditions and drove sediment transport through the Snake River system. Historically, sediment flowed into the project area from as far upstream as the headwaters and could have been transported as far as the Pacific Ocean. The amount of sediment entering stream systems prior to development was largely based on weather conditions, but was likely lower than it is today. However, comparing the earliest sediment transport data available (Van Winkle, 1914a, 1914b) to data gathered during the 1970s by the USGS suggests that the differences noted between those time periods probably are not significant and could be within the natural variability of the data. This sediment transport comparison was made from the perspective of comparing sediment load per square mile of effective upstream drainage area. Since major upstream projects such as Hells Canyon and Dworshak dams trap most of their inflowing sediment load, the drainage areas upstream of them were excluded when making these comparisons of the 1970s data with the early 1900s data.

Historically, sediment naturally built up in some areas of rivers and streams and played a role in changing their alignment. Based on historic modifications to the Snake River and its tributaries, sediment transport has been restricted to the extent that fine materials (silt and sand) settle out of the water column in the reservoirs instead of being flushed downstream (causing sedimentation) (NOAA Fisheries 1996). Agriculture, road building, logging, flood control, mining, and other sources contributed to the increased amount of sediment that entered tributary streams.

Threatened and Endangered Fish

Section 3 of this EIS describes current conditions of threatened and endangered fish that have resulted from past actions. Salmon and steelhead runs adapted to habitat conditions over thousands of years. In many areas of the Columbia and Snake River basins, these conditions have been significantly changed, or no longer exist. All native salmonid species in the Snake River basin have decreased from historical levels as a consequence of hydropower development, harvest management, hatchery development, and habitat degradation and. Before the mid-1870s, annual runs of salmon and steelhead returning to the Columbia River were roughly estimated to be greater than 8 million fish (Chapman 1986). Since 1938, when Bonneville Dam was constructed, the estimate of minimum total salmon and steelhead returning to the river has ranged from 0.2 to 3.2 million fish (University of Washington 2005). A variety of ocean conditions including currents, pollution, temperatures changes, and nutrient base also affect salmon survival.

Fish harvest has affected anadromous fish in the Columbia River basin for over 150 years. In 1875, the United States Commission of Fish and Fisheries began researching why Columbia River salmon catches were declining (U.S. Commission of Fish and Fisheries 1878). Their report indicated that 10 to 20 million pounds of canned salmon were taken from the Columbia River annually. While surveying areas for artificial fish propagation, they point out that, "…it should be remembered that the immense canning operations carried on along the Columbia River have entirely revolutionized matters, as far as the abundance of salmon eggs is concerned. Twenty years ago (1856), before the business of canning salmon on the Columbia River was inaugurated, salmon literally swarmed up all the small creeks and little tributaries of the main river in such immense quantities that several million eggs could, without doubt, have easily been collected from the spawning fish at the head of comparatively insignificant streams; but that day has gone by, probably forever."

Historically, runs of spring/summer Chinook salmon were found throughout the accessible and suitable reaches of the Snake River and its tributaries. On the Snake River, they spawned as far upstream as Auger Falls (RM 607) in Idaho, some 930 miles from the mouth of the Columbia River. Fall Chinook were also widely distributed in the mainstem of the Snake River, as far upstream as Shoshone Falls, Idaho (RM 615) and the lower reaches of its tributaries. Snake River sockeye salmon were found in five lakes in the Stanley basin, Big Payette Lake on the North Fork of the Payette River in Idaho, and Wallowa Lake in the Grande Ronde River basin. Steelhead were also widely distributed in most accessible and suitable habitats.

Dams have inundated large amounts of spawning and rearing habitat. These dams eliminated the primary production areas of many fish runs, and they have contributed to the reduced distribution and abundance of salmon in the system. The Snake River has been reduced, for the most part, to a single channel; floodplains have been reduced in size; off-channel habitat features have been lost or disconnected from the main channel; and the amount of large woody debris in the river (large snags and log structures critical to juvenile survival) has been reduced.

Most of the remaining habitats are affected by flow fluctuations associated with reservoir management. Approximately 80 percent of historical fall Chinook salmon spawning habitat was lost with the construction of dams on the mainstem Snake River. The spawning grounds between Huntington, Oregon (RM 328) and Auger Falls in Idaho (RM 607) were historically the most important for this species. Historically, only limited spawning activity occurred downstream of RM 273 (Matthews and Waples 1991), which is about 1 mile below Oxbow Dam. Development of irrigation and hydropower projects on the mainstem Snake River in the past century have inundated or blocked access to most of this area. Construction of Swan Falls Dam (RM 458) in 1901 eliminated access to 152 miles (about 25 percent) of total potential habitat, leaving 458 miles of mainstem habitat. Construction of the Hells Canyon Complex (1958-1967) cut off anadromous fish access to 211 miles (or 46 percent) of the remaining historical fall Chinook habitat upstream of RM 247. Additional fall Chinook habitat was modified as a result of the construction of the four lower mainstem Snake River dams.

Fall Chinook salmon currently have access to approximately 100 miles of mainstem Snake River habitat, which is roughly 16 percent of the 610 miles of historic habitat available prior to completion of Swan Falls Dam. Even before mainstem dams were built, habitat was lost or severely damaged in small tributaries by construction and operation of irrigation dams and diversions, inundation of spawning areas by impoundments, and siltation and pollution from sewage, farming, logging, and mining (Fulton 1968). Artificial propagation of Chinook salmon in the Columbia River basin began as early as 1877 (Pratt et al. 2001) with expansion by the states around 1912-1917 when fish liberation (survival through release) became more successful. Artificial propagation began with egg collection efforts at stations on the Snake River near Ontario, Oregon. In the 1900s, large hatchery programs were implemented throughout the Columbia and Snake River basins as mitigation for loss of habitat and to enhance anadromous fish runs. These programs have been in maximum production operation for many decades. In recent years, however, the use of hatcheries has been extensively questioned in terms of fish quantity versus fish quality (i.e., genetics). Issues include hatchery practices and high hatchery-fish harvest rates that may be detrimental to wild runs; potential loss of desirable wild fish genetic characteristics through interbreeding with hatchery fish in the wild; competition between hatchery and wild fish for habitat and food; and predation by hatchery fish on wild fish. Many of these issues are subjects of ongoing research, but may contribute to the overall decrease in wild fish populations (NOAA Fisheries 2004).

Listing of several salmonids under the Endangered Species Act has created a framework and goals for recovery of fish populations.

Socioeconomics

The Snake and Columbia Rivers have been used to transport people and commodities for centuries. The use of the river system for transportation increased with the use of riverboats prior to the building of dams on the system. As the inland Northwest developed, the volume of agricultural products increased the demand for more efficient ways of transporting the products to market and delivering goods upstream to new settlements. In addition to roadway construction, many rail lines were developed to provide transportation. Since much of the land surrounding the Snake River is very hilly, mainlines were built along the banks of the Snake River from Pasco, Washington, to Lewiston, Idaho. Spur lines and roads fed the grain terminals built along the main lines.

When the eight lock and dam projects were completed on the mainstem of the Columbia and lower Snake Rivers, an inland waterway was created, which made it more economical to transport many commodities by barge, and an entire infrastructure developed around the dimensions of the locks on the river. The waterway led to the development of a river-based transportation industry in the region. As barge shipments increased, many of the old rail lines were abandoned or removed.

4.11.3.3 Present Actions

Many past actions described above continue through the present. The scope and location of land uses that affect the environment have changed over time, with resulting shifts in how the environment is affected. For example, wilderness designations in large portions of the Salmon and Clearwater subbasins have reduced the extent of uses such as logging, roads, mining, and grazing in those areas, and have allowed the wildfire processes to shift toward more natural cycles. Section 3 of this EIS describes current conditions of resources that have resulted from past and present actions.

Multiple resource management plans provide guidelines for land management on public lands. As noted in the previous section, management practices that reduce erosion and sedimentation have been, and continue to be, implemented on public lands and have reduced loads of sediment to streams in the cumulative effects area. Similarly, current levels of implementation of agricultural conservation practices on private lands contribute to reducing erosion and sediment loads from cropland.

Current actions by the Corps and other agencies that manage dams on the Snake and Columbia rivers include the operation and maintenance of existing facilities. Corps operation of the dams and reservoirs must comply with the terms and conditions of the 2010 FCRPS BiOp (NMFS 2010). In addition, numerous plans and programs exist throughout the cumulative effects area and surrounding region that aim to improve water quality, habitat, and ecosystem functions to benefit the recovery of endangered fish. These include, but are not limited to:

- Tribal programs and partnerships in watershed planning and ecosystem restoration efforts.
- State watershed plans and programs, including the Oregon Plan for Salmon and Watersheds, the Washington Watershed Planning Act and Shoreline Management Act, and recovery efforts by state fish and wildlife/game departments.
- The Lower Snake River Fish and Wildlife Compensation Program (Corps 1977).
- Interagency efforts such as the Northwest Power and Conservation Council's (NWPCC's) Columbia River Basin Fish and Wildlife Program (NWPCC 2009).
- Actions by local governments and nongovernmental agencies to improve water quality and habitat.

The effects of recovery efforts on threatened and endangered fish species is illustrated by the existing conditions of these resources described in Section 3.1. Recovery efforts have helped restore local ecosystems and have had benefits to water quality and habitat in portions of the cumulative effects area. The present actions described above contribute to the environmental conditions for the resources described in Section 4.11.3.4 below, and do not change any of the condition or trends described.

4.11.3.4 Effects of Present Actions on Resources

Water Quality and Sediment Quality

Current water quality conditions range from good to exceptional. The lower Snake River is classified as Class A (Excellent) by Ecology (Chapter 173-201A WAC). The lower Snake River is water-quality-limited for temperature and TDG. This limitation reflects both historic and current activities. (Corps 2005)

Ongoing operation of water resource development projects modifies natural hydrologic and water temperature regimes throughout the Columbia River basin. Heat exchange characteristics in the lower Snake River are influenced by water residence times and river channel geometry and thus would be impacted by an increase in operating pool level. Dworshak Dam, on the North Fork of the Clearwater River, is routinely operated to manage flows and water temperatures (provide cooling water) in Lower Granite Reservoir between July through mid-September when peak water temperatures occur in the Snake River.

Present actions include activities that result in sediment loading to the lower Snake River, as well as actions that can resuspend sediment in the lower Snake River and its tributaries. Typically, the turbidity levels within the project area range from <1 to 40 NTUs. Turbidity levels can be much higher during high flow events.

Water quality can be adversely affected by spills from existing land uses and activities around the LSRP, such as from port and industrial operations, commercial navigation, and recreation boating.

Sediment quality can be affected by present activities that include agriculture, urban land uses, and industrial activities. Effects of present activities on sediment quality can add to past actions' effects on sediment quality.

Hydrology and Sediment

As noted above, construction of the Snake River dams has had an effect on sediment transport downriver. Ongoing operation of the Snake River dams still traps sediment, even though they are run-of-the-river projects. Flow regulation by storage projects upstream of the LSRP also has reduced the amount of sediment that would have been transported during high flows. Storage projects, such as Dworshak Dam, will trap more sediment than run-of- river projects such as the lower Snake River projects. In addition, some of the fine-grained sediments do not settle out behind the dams and are carried downstream. Recent sediment transport studies have indicated that sediment management efforts in agricultural areas have reduced the loading of finer sediments to the LSRP (Appendix N).

Threatened and Endangered Fish Species

Present activities in the cumulative effects area would largely continue the effects to threatened and endangered fish that have resulted from past actions. Continued operation of dams and other water resource development projects, along with other present actions, would perpetuate the effects on populations and habitat of listed species in the LSRP.

Socioeconomics

Commercial navigation provides an economic driver in the Lewiston/Clarkston area. Much of the region around the Snake River is dominated by the agriculture industry and the major commodities shipped on the Snake River are agricultural products. Secondary economic effects include income supported by the navigation industry and income generated to meet the demand for goods and services.

Currently, based on the information available, there are continuing economic impacts to the Lewiston and Clarkston area due to the current state of the navigation system. Existing shoaling in Lower Granite Reservoir has reduced the depth of the federal navigation channel to less than the congressionally authorized dimensions. Grounding of barges has been reported by barge operators and ports. Similarly, the cruise industry is experiencing problems in the Lewiston/Clarkston area where docking locations are being limited by the existing water depths.

In order to support the development demands, an infrastructure system has been developed and is presently being maintained and expanded to a limited extent. This infrastructure system includes roads and bridges, levees, power distribution systems, communication systems, wastewater treatment facilities, and municipal and industrial water supply. Infrastructure is expected to continue to expand as the human population of the area continues to grow.

As part of the regional infrastructure, multiple modes are used to ship agricultural commodities. Railroads provide a mode of commodity transport within the Columbia basin. Grain is typically delivered by truck to elevators, where it is loaded on rail cars for export. Historically, rail transportation accounted for about half of the total annual shipments of wheat and barley at Columbia River export houses for the period from 1981 through 1997. Direct truck transportation of grain accounted for a relatively small portion (about 2 percent) of grain shipments (Corps 2005). Barges account for remainder of grain shipments.

4.11.3.5 Reasonably Foreseeable Future Actions

Cumulative effects analyses must consider the effects of “reasonably foreseeable future actions regardless of what agency…or person undertakes such…action” (40 CFR §1508.7). Future actions that are speculative are not considered reasonably foreseeable (EPA 1999). Documented planned and permitted or funded actions by local, state or federal government agencies, private entities, or individuals are considered “reasonably foreseeable.” Similarly, the Corps considerers the continuation of existing programs, without major changes in policy, law, regulations, or funding, reasonably foreseeable.

Based on the CEQ guidance (CEQ 1997) and pubic and agency comments, the Corps has identified several reasonably foreseeable future actions, including the continuation of existing actions, within the geographic and temporal scope of this cumulative effects analysis. These actions, when considered together with the past and present actions summarized in the preceding sections, may have cumulative effects on the resources analyzed. The Corps anticipates that the cumulative effects analyses of actions proposed pursuant to this EIS will conduct cumulative effects analysis at a project-specific level of detail through a tiered NEPA process.

The Corps reviewed adopted plans and policies and contacted agencies and individuals with knowledge of potential future actions to identify the reasonably foreseeable future actions. An overview of reasonably foreseeable future actions is presented Table 4-3 below.

Table 4-3. Reasonably Foreseeable Future Actions

Reasonably Foreseeable Future Action (Responsible Party)	Location within Cumulative Effects Area
LSRP Operations - continuing (Corps) • Continued operation of dams and reservoirs (consistent with FCRPS biological opinion) • Monitoring of sediment transport	Lower Snake River
Non-Corps Dredging - by ports and others • Periodic maintenance dredging by ports or managers of recreation facilities	Lower Snake River
Hydropower Operations (Corps, Reclamation, Idaho Power, BPA) • Continued operations of hydropower dams	Columbia and Snake River system
Public Land Management – continuing (USFS, BLM) • Implementation of resource management plans • Multi-use management • Timber harvest and associated activities at or near current levels • Continued road decommissioning at current levels • Continued fire management and suppression	Public lands throughout the cumulative effects watershed study area
Urban Land Uses maintain and redevelop existing urban areas • Minimal expansion of urban land uses, consistent with adopted plans. • Planned industrial facilities. • Port development, including industrial and shipping-related development. •	Throughout the cumulative effects watershed study area, focused on main transportation routes and urban centers.
Transportation Infrastructure • Maintenance of existing transportation infrastructure. • Development of McCoy rail grain terminal facility in Rosalia, WA (opened in 2014)	Snake and Columbia Rivers; Integrated Transportation System in the Northwest
Agricultural Land Management (private landowners and conservation districts) • Continued agricultural conservation practices at or near current levels.	Throughout the cumulative effects watershed study area, focused on lower Snake River subbasin

Table 4-3. Reasonably Foreseeable Future Actions

Reasonably Foreseeable Future Action (Responsible Party)	Location within Cumulative Effects Area
Fisheries Management and Recovery Plans (and associated activities) for ESA-Listed Fish (NMFS, USFWS, tribes, state departments of fish and wildlife/game) • Terms and conditions of 2008/2010 BiOp • Springfield hatchery (began operation in 2013) on the Salmon River. • Planned habitat restoration, fish passage improvements to benefit listed fish	Columbia and Snake River systems

Substantial modification of existing publicly funded programs noted in Table 4-3 does not appear reasonably foreseeable. As such, the Corps has assumed the continuation of the programs and associated actions at or near their current levels into the future. Legislative actions may affect current programs; however, making assumptions about specific legislative changes in this analysis would be speculative and not appropriate for the cumulative effects analysis.

Continuation of existing programs at current levels would essentially affect no change to the environmental conditions and trends identified for environmental resources in Section 3 and in Section 4.11.3.4.

In addition to the continuation of existing programs being reasonably foreseeable, the Corps also identified plans and projects (including some projects that went into operation after the Draft EIS was completed) that are reasonably foreseeable. In July 2014, the Corps coordinated with local governments, ports, and other parties with knowledge of planned actions that could be considered reasonably foreseeable. This coordination identified several actions that were not considered in the Draft EIS' cumulative effects analysis. Some actions identified through were already in development or even operation, but are described here since their environmental effects would, for the most part, contribute to the past and present actions' cumulative effects described in the preceding sections.

Reasonably foreseeable actions identified in the area around the LSRP include:

- Dredging the barge slip and entrance channel for the Cargill grain terminal at the Port of Walla Walla on the Snake River downstream of Ice Harbor Dam (proposed for winter 2014/2015).
- Dredging the City of Asotin recreation area (potentially within 3 to 5 years).
- Columbia Grain's proposed expansion of its short-term grain storage system at the Port of Garfield facility. Ground pile expansion would add capacity for additional short-term storage of 1 million bushels of grain.

- City of Lewiston Waterfront Future Plan, a long-term plan for the redevelopment of waterfront areas of Lewiston, Idaho.
- The development and operation of the McCoy Unit Train Grain Terminal near Rosalia, Washington (between Clarkston and Spokane).
- Columbia Pulp's proposed development of a straw pulp production plant near Lyons Ferry, Washington.

4.11.3.6 Effects of Reasonably Foreseeable Future Actions on Resources

Water Quality and Sediment Quality

Reasonably foreseeable future operation of the LSRP and water resource projects, including hydropower, would be likely to have the same effects on water quality as described for present actions above. Dworshak Dam, on the North Fork of the Clearwater River, is routinely operated to manage flows and water temperatures (provide cooling water) in Lower Granite Reservoir between July through mid-September when peak water temperatures occur in the Snake River. Without maintaining the federal navigation channel at its congressionally authorized dimensions, commercial and recreational vessels would stir up sediment where it accumulates in the navigation channel and around recreational areas, causing localized temporary increases in turbidity. Shoaling in the navigation channel would increase the risk of groundings by commercial vessels, which could result in the release of chemicals or petroleum into the LSRP. Spills related to groundings would have adverse effects on water quality. Reasonably foreseeable actions to dredge port and recreation facilities are minor in scale and would be done in accordance with applicable permits, including CWA Section 401 water quality certification, and as such would not noticeably change water quality conditions or change the water quality effects of past and present actions.

Reasonably foreseeable future management of public and agricultural lands would be likely to result in a continuation of existing water quality conditions in the cumulative effects area. Reasonably foreseeable future urban development and population growth could include the expansion of urban areas and increased stormwater and municipal and industrial wastewater discharges. These future actions could have localized effects on temperature, nutrients, and other water quality parameters. The scope of reasonably foreseeable future development and population growth is not of a scale that would substantially change the area and type of past and present development over 40 years; therefore, no substantial changes to water quality would be expected. In addition, compliance with National Pollutant Discharge Elimination System (NPDES) requirements and other environmental regulations would minimize water quality effects of future land use changes and population growth.

Plans for redevelopment of the Lewiston, Idaho waterfront area would provide a framework that would focus business and civic activities around the riverfront areas. The plan's goals include enhancing community focus on the riverfront and making use of the aesthetic and recreational benefits of the rivers. Redevelopment that occurred in accordance with the plan would be unlikely to adversely affect water quality since redevelopment would meet current water quality requirements.

Development and operation of the proposed straw pulp production plant near Lyons Ferry, Washington would create a new large industrial facility close to the Snake River. Plant operations are estimated to use 600,000 gallons (Alexander 2014) of water per day, which would result in treated effluent discharges, which could affect water quality in the Snake River. Assuming compliance with NPDES discharge permits, operation of the plant would be unlikely to substantially contribute to the cumulative water quality and sediment quality effects of past and present actions.

Sediment quality can be affected by reasonably foreseeable future activities that include agriculture, urban land uses, and industrial activities described above. However, similar to water quality, it is unlikely that reasonably foreseeable future actions would have a noticeable effect on sediment quality in the cumulative effects area.

Hydrology and Sediment

Reasonably foreseeable future actions would be unlikely to result in changes in hydrological conditions or sediment transport in the cumulative effects area. Management of public lands consistent with currently adopted plans and policies would generally represent a continuation of present practices, and effects on erosion, transport, and deposition of sediment from public land in the Snake River watershed would not be likely to change from the conditions described for present actions and in Section 3.7. Sediment loads from agriculture may decrease as BMPs continue to reduce erosion. This could result in a minor overall reduction in fine sediments entering the LSRP. Management of the LSRP and water resources projects would have the same effects as their present operations do. Sediment accumulation in portions of the federal navigation channel would reduce it to less than its congressionally authorized depth.

Threatened and Endangered Fish

Reasonably foreseeable future activities in the cumulative effects area would generally continue the effects on threatened and endangered fish that have resulted from past and present actions. Continued operation of the LSRP and other water resource development projects would perpetuate the effects on populations and habitat of listed species in the LSRP. Reasonably foreseeable future actions, like land development or redevelopment for industrial, commercial and residential uses, would have localized effects on water quality and other environmental resources that could indirectly affect threatened and endangered fish. Implementation of recovery plans are intended to improve habitat and populations for listed species, but are dependent on a wide variety of factors. Predictions about the future effects of recovery plans would be speculative at this time.

Socioeconomics

Continued agricultural and industrial production, future population growth, and market factors would continue the need for moving goods by multiple modes. Lack of recent and reasonably foreseeable future maintenance of the navigation channel to re-establish its congressionally authorized dimensions would continue to reduce depth in portions of the channel. Barge operators could modify their operations to adjust to the reduced depth in the navigation channel. As noted above, a navigation system has developed around the dimensions of the federal navigation facilities in the LSRP, including optimization of loads and drafts to provide for cost-effective operations. Modifying barge operations to accommodate shallower drafts would adversely affect barge operators, shippers, producers and consumers of commodities by reducing the cost-effectiveness of transportation by this mode. Modifying barge operations could be done to the point where it is no longer cost-effective to transport cargo and commodities via barge, and shipments would shift to other modes (i.e., rail and truck). Other modes could experience adverse effects due to capacity limitations and shippers would lose an option that has historically transported a large proportion of commodities and cargo to and from the region. Reduced capacity and the potential loss of barge transportation on part of the LSRP would have a substantial adverse effect on the regional economy that has developed as a result of past and present actions.

Proposed dredging of port facilities at the Port of Walla Walla's Cargill grain terminal on the Snake River would serve to maintain the existing barge access and use of that facility, and would not contribute to a change in the cumulative socioeconomic effects of past and present actions. The development and operation of the McCoy Unit Train Grain Terminal near Rosalia, Washington would provide the capacity to handle about 300,000 bushels of wheat per day (which equates to about 9,000 short tons). The economic effect of this action would be to provide another shipping option to regional producers and shippers of grain, and one that promotes competition within rail transport and among other transportation modes (i.e., barge and truck). Full operation of the McCoy terminal would enhance transportation of grain, but would be unlikely to shift transport of grain substantially away from barge (the other major mode of shipment) in the foreseeable future.

Redevelopment of riverfront areas of Lewiston, Idaho consistent with the city's Waterfront Future Plan would be likely to have a positive socioeconomic effect on the Lewiston/Clarkston area by providing new and potentially enhanced commercial and community activities in the urban area. The scope of redevelopment that would ultimately occur cannot be predicted at this time. Economic benefits from redevelopment add to, but would be unlikely to substantially change, the cumulative economic effects of past and present actions.

The planned straw pulp plant would have positive effects on the local economy by providing a major new employer in the region. Project proponents estimate the plant will employ 130 employees when it is completed and in operation. This would represent a substantial local effect on Columbia County (where the plant would be located), which has a current civilian labor force of about 1,490 (Washington State Employment Security Department 2014). The economic benefit from the development of a large industrial facility like the straw pulp plant would contribute to the overall economy of the region but would be unlikely to substantially change the cumulative economic effects of past and present actions.

4.11.4 Summary of Cumulative Effects of Past, Present, and Reasonably Foreseeable Future Actions on Resources

The cumulative effects analysis requires consideration of past and present actions, as well as reasonably foreseeable future ones. It is apparent that for most of the environmental resources covered by this analysis, historic actions have resulted in significant impacts. The level of impact to a resource from past and present actions has lead to the present condition of each resource. However, to evaluate the cumulative impacts, it is also necessary to look forward in time. Future actions and ongoing present actions will continue to affect resources. However, future actions will take place in a dramatically different regulatory and political climate than most historic actions. Future actions are subject to detailed review at the federal, state, and/or local level. As appropriate, this review could include NEPA, ESA, CWA, NHPA, state wetlands and growth management regulations, and local protections for critical resources. Accordingly, unlike historic actions, future actions will be more apt to avoid and minimize detrimental effects to key resources.

Water Quality and Sediment Quality

The cumulative effects of past, present, and reasonably foreseeable future actions on water quality are that modification of the Snake River and its tributaries has, and will have, substantially changed flow regimes, water temperature, turbidity and suspended sediments, and other water quality characteristics. Sediment quality has been affected by past actions and could be affected by current or future actions.

Hydrology and Sediment

Historic modification of the Snake River, its tributaries, and the landscape of the watershed have changed sediment loading to and transport by the river system. Land development for agriculture, logging, mining, and urban land uses has led to increased sediment loading to tributaries. Fire has affected large areas within the watershed and generally has increased erosion from burned areas. Construction of dams on the Snake River has created conditions in which sediment accumulates and can affect existing authorized purposes of the LSRP. Historic dredging has temporarily addressed sediment that interferes with the existing authorized purposes of the LSRP. Observed sediment trends in Lower Granite Reservoir indicate that the confluence area of the reservoir may be at or approaching a localized equilibrium in terms of sediment accumulation (Corps 2011b). This means that sediment accumulating near the confluence of the Snake and Clearwater Rivers is generally being transported downstream during high flow conditions, such that over time there is little change in the flow conveyance capacity of the Lewiston levee system.

Threatened and Endangered Fish

The cumulative effects of past, present and reasonably foreseeable future actions have resulted in environmental conditions that have led to the threatened or endangered status of anadromous fish species in the Snake and Columbia Rivers. The profound changes to the Columbia-Snake River system documented in Section 3 and Section 4.11.3.1 have adversely affected the habitat and populations of listed fish species. Navigation objective reservoir operations reduce reservoir levels to MOP, or as close to it as possible while still providing a 14-foot-deep navigation channel, during juvenile salmonid outmigration. This management measure aids fish migration in accordance with the 2008/2010 BiOp (RPA Action 5). Continued recovery efforts would incrementally improve conditions for anadromous fish, having a cumulative beneficial effect on anadromous fish populations, including threatened and endangered species. However, fish would continue to be faced with multiple environmental factors that present challenges, such as dams and degraded habitat.

Socioeconomics

Past actions such as agricultural development, timber harvests, water resources projects, transportation systems, and urban development have led to the economic conditions in the LSRP region. The navigation channel in the Snake River is used to ship cargo and commodities to and from the region and has had a positive effect on the region's economy. Ports and related facilities have developed to support shipping and industrial activities that contribute to the regional economy. Present actions largely generally facilitate a continuation of current economic conditions, subject to a variety of external forces (such as the national and global economies). Development of levees as upstream appurtenances of Lower Granite Dam has reduced flood risk to portions of Lewiston. The recent lack of maintenance of the federal navigation channel to keep its congressionally authorized dimensions has adversely affected the ability to move commodities by barge on the lower Snake River; continued lack of such maintenance will likely to continue impede the transport of commodities for the reasonably foreseeable future. reasonably foreseeable actions, including the dredging of Port berthing areas, the development of a new grain rail terminal, redevelopment of urban areas, and new industrial development, would all have positive effects and contribute to sustaining the regional economy, but would not create substantial changes in the economy.

4.11.5 Cumulative Effects of Alternatives

The cumulative effects analysis considers how the direct and indirect effects of the alternatives would contribute to the cumulative effects of past, present and future actions and change the conditions that have and are expected to result from those actions.

4.11.5.1 Alternative 1: No Action (Continue Current Practices)

Water Quality and Sediment Quality

Alternative 1 would result in water quality impacts associated with decreased depth in the navigation channel and recreation areas. Shallow depths would have more stirring of sediment from prop wash from commercial and recreational vessels that would greater depths, creating localized increases in turbidity. Potential groundings of commercial vessels would increase the risk of releases of substances that could adversely affect water and sediment quality. Water and sediment quality effects of Alternative 1 would be localized and minor and, when combined with the effects of past, present, and reasonably foreseeable future actions, would not contribute to cumulative effects on water quality or sediment quality.

Hydrology and Sediment

Alternative 1 would not result in changes to the sediment loading to the LSRP. Sediment would continue to accumulate in portions of the LSRP and would impede existing authorized project purposes. Past actions have resulted in the current conditions in the cumulative effects area of erosion, sediment transport and deposition that substantially contribute to the accumulation of sediment that interferes with authorized purposes of the LSRP. Present and reasonably foreseeable future actions can be expected to have the same effects. Alternative 1 would address the accumulation of sediment by modifying reservoir levels when they interfere with existing authorized project purposes, but would not affect hydrology or sediment loading and transport in the Snake River system. Therefore, Alternative 1 would not contribute to cumulative effects of past, present and reasonably foreseeable future actions on hydrology and sediment.

Threatened and Endangered Fish

Alternative 1 would not change fish passage or habitat conditions from their current states or likely future states that would result from past, present, and reasonably foreseeable future actions. The Corps would continue operating the LSRP within current operating ranges.

Taking no action to remove sediment from the federal navigation channel would result in decreased depth of the navigation channel (depending on flow regimes). In the Snake/Clearwater confluence area of Lower Granite Reservoir, sediment deposition could result in a localized increase in shallow habitat suitable for rearing of juvenile fall Chinook salmon. Conversely, as the depth in the navigation channel becomes less than the congressionally authorized 14 feet, vessels using the impaired channel would stir up sediment and increase local turbidity, which can adversely affect listed fish. Similar effects would occur in recreation areas with decreased depth, but those are likely to be substantially less in magnitude. Increased shoaling in the navigation channel would increase the risk of barge grounding and potential spills of transported materials such as petroleum or chemicals, which could adversely affect listed fish.

These effects of Alternative 1 on threatened and endangered fish, when combined with past, present, and reasonably foreseeable future actions, would not change current conditions of the resource, including the listing status of threatened and endangered fish. Alternative 1 would not noticeably contribute to a change in the conditions of threatened and endangered fish, or the trend of the condition of the resource. Therefore, Alternative 1 would not have a cumulative effect on threatened and endangered fish species.

Socioeconomics

Reduced depth in the federal navigation channel has affected commercial navigation in the LSRP. Continued shoaling will lead to increased adverse effects on commercial navigation, with related adverse effects on the elements of the regional economy that rely on barge transportation as a mode of shipping cargo and commodities. Additionally, cruise ships' inability to dock at intended locations has had an adverse effect on business related to cruise ships and associated tourist activities. Alternative 1 would maintain navigation to the extent that navigation objective reservoir operation would maintain, as far as possible, the authorized depth in the navigation channel, but would not preclude the continued accumulation of sediment and reduction of depth of the navigation channel, further impeding its use for commercial navigation. Continued sedimentation in the lower Snake River (and in particular in Lower Granite Reservoir) would adversely affect commercial navigation and have adverse economic effects on the region. Effects of the No Action Alternative would include indirect effects on other modes of transportation, potentially requiring substantial investments in the upgrade of rail and road systems to accommodate the share of commodities historically shipped by barge. Under this alternative no action would be taken to address flood risk in the Lewiston levee system. No action would be undertaken to address flow conveyance, so flood risk in the Lewiston levee system could increase. The No Action Alternative's effect on transportation and regional economy would substantially change the conditions that have resulted from past and present action and are expected to result from reasonably foreseeable future actions, and would therefore have an adverse cumulative socioeconomic effect.

4.11.5.2 Alternative 5: Dredging-Based Sediment Management

Water Quality and Sediment Quality

Alternative 5 would have intermittent, temporary adverse water quality effects of increased turbidity from periodic dredging. In-water placement of dredged material (either for beneficial use or disposal) would cause similar intermittent and temporary increases in turbidity. Dredging for flow conveyance, if used under this alternative, would affect larger areas of Lower Granite Reservoir than would navigation dredging, and would result in larger quantities of dredged material. Effects would be confined to the dredging and dredged material placement areas within the Lower Snake River. Sediment sampling indicates the majority of sediment that would be dredged would be sand and would have little or no contamination. Alternative 5 would not affect sediment quality. The water and sediment quality effects of Alternative 5 when combined with the effects of past, present, and reasonably foreseeable future actions would not contribute to cumulative effects on water quality or sediment quality.

Hydrology and Sediment

Past and present actions have resulted in the current conditions in the cumulative effects area of erosion, and sediment transport and deposition that substantially contribute to the accumulation of sediment that interferes with authorized purposes of the LSRP. Alternative 5 would address the accumulation of sediment at the point where it interferes with authorized purposes, but would not affect hydrology or sediment loading or transport of the Snake River system. If upland disposal or upland beneficial use of dredged material were used, the sediments placed upland would remain outside the reservoirs. The hydrology and sediment effects of Alternative 5 when combined with the effects of past, present, and reasonably foreseeable future actions would not contribute to cumulative effects on the resource.

Threatened and Endangered Fish

The cumulative effects of past actions have resulted in environmental conditions that have led to the threatened or endangered status of anadromous fish species in the Snake and Columbia Rivers. The profound changes to the Columbia-Snake River system documented in Section 3 and Section 4.11.4 have adversely affected the habitat and populations of listed fish species. Present and reasonably foreseeable future actions are expected to continue this pattern of environmental impacts. Periodic maintenance dredging in the LSRP and dredged material management would not significantly change the regional conditions that have adversely affected listed fish species. Beneficial use of dredged material could have a beneficial effect for fish and would contribute to incrementally improving habitat in the LSRP. Continued recovery efforts could incrementally improve conditions for anadromous fish, having a cumulative beneficial effect on anadromous fish populations, including threatened and endangered species. However, fish would continue to face multiple environmental factors that present challenges, such as dams and degraded habitat. The effects of Alternative 5 on threatened and endangered fish, when combined with past, present, and reasonably foreseeable future actions, would not change current conditions in the cumulative effects area, including the listing status of threatened and endangered fish. Therefore, Alternative 5 would not change the cumulative effects of past, present, and reasonably foreseeable actions on threatened and endangered fish species.

Socioeconomics

Alternative 5 would maintain the congressionally authorized dimensions of the federal navigation channel by dredging and dredged material management, thus allowing continued operation of the navigation system in the lower Snake River. Dredging and dredged material management could also be used address flood risk in the Lewiston levee system. Alternative 5 would allow for the continuation of the transportation of commodities and cargo by barge and the socioeconomic conditions that result from the development and use of the LSRP as an element of the Columbia-Snake Inland Waterway. Alternative 5 would contribute to continuation of the regional economic cumulative effects of past, present, and reasonably foreseeable future actions, but would not change the magnitude or intensity of those effects.

4.11.5.3 Alternative 7: Comprehensive (Full System and Sediment Management Measures)

Water Quality and Sediment Quality

Alternative 7 would have the same effects as Alternative 5 with respect to dredging and dredged material management measures. Under this alternative, additional structural sediment management and system management measures would generally have temporary and localized water quality effects of increased turbidity during implementation of measures. Drawdown of Lower Granite Reservoir to flush sediments would create high levels of turbidity for up to 6 weeks (Corps 2005), and would have the potential to disturb and mobilize sediments that have not yet been evaluated for chemicals of concern. Drawdown to flush sediment has a high potential for moving fine-grained sediments from areas that are not planned for dredging. Fine-grained sediment, which is often found in backwater areas, has the highest potential for contamination. Because drawing down the reservoir would likely cause some backwater areas to erode, it has the potential of releasing contaminants into the water, if they are present, and water quality would be negatively affected. Water quality and sediment quality effects of drawdown would generally be limited to Lower Granite and Little Goose reservoirs. The water quality and sediment quality effects of Alternative 7, when combined with past, present, and reasonably foreseeable future actions, would not have a cumulative effect on water and sediment quality.

Hydrology and Sediment

Alternative 7 would have the same effects as Alternative 5 with respect to dredging and dredged material management measures. Alternative 7 would have both direct and indirect effects on sediment accumulation and transport within the LSRP system. Alternative 7 includes structural and system management measures that would move or redirect sediment within reservoirs. Uncontrolled redistribution of sediments from drawdown to flush sediments could produce negative effects depending on whether the deposition of mobilized sediments downstream creates a problem for navigation or other existing authorized project purposes. However, like Alternative 5, Alternative 7 would not affect the current condition of sediment loading and transport in the Snake River system that has resulted from past and present actions and is unlikely to change substantially as a result of reasonably foreseeable future actions. Sediment entering the LSRP from upland sources is the result of and is subject to a variety of factors that would not be affected by Alternative 7 (see Section 3.7 and Appendices C, D and F). Conditions related to climate change could change sediment loading and transport dynamics in the cumulative effects area; these are discussed in Section 4.12 below. The hydrology and sediment effects of Alternative 7 when combined with the effects of past, present, and reasonably foreseeable future actions would not contribute to cumulative effects on the resource.

Threatened and Endangered Fish

Alternative 7 would have the same effects as Alternative 5 with respect to dredging and dredged material management measures. In addition, Alternative 7 includes structural sediment management and system management measures that the Corps could potentially implement. Some of these measures address sediments at the locations where they accumulate; others potentially reduce or potentially avoid problem sediment accumulation. The measures considered in Alternative 7 would affect a relatively small area of habitat for threatened and endangered species. In-water structures may have both adverse and beneficial effects. Drawdown to flush sediment would have a negative effect on fish due to potential loss of shallow-water shoreline habitat for rearing. Juvenile fish could be stranded in pools and along exposed shorelines. Beneficial use of dredged material could have a beneficial effect for fish and would contribute to improving habitat in the LSRP. Other measures would have both potential adverse and beneficial effects (see Section 4.1). As part of implementation of any action, the Corps would work with resource agencies to design projects that minimize and avoid adverse effects on listed species and their habitat. The direct and indirect effects of Alternative 7 on threatened and endangered fish, when combined with past, present, and reasonably foreseeable future actions, would not change current conditions of this resource and therefore would not contribute to cumulative effects on threatened and endangered fish species.

Socioeconomics

Alternative 7 would have the same effects as Alternative 5 with respect to dredging and dredged material management measures. Structural sediment management and system management measures that result in maintaining the navigation channel at its congressionally authorized dimensions would have the same beneficial effects on navigation and socioeconomic conditions as Alternative 5. Raising the Lewiston levee or dredging and dredged material management would be considered as needed to address flood risk in the Lewiston levee system. Alternative 7 would allow for the continuation of the transportation of commodities and cargo by barge and the socioeconomic conditions that result from development and use of the LSRP as an element Columbia-Snake Inland Waterway.

4.11.5.4 Cumulative Effects of the Current Immediate Need Action

Water Quality and Sediment Quality

Dredging and dredged material management proposed for the current immediate need action of re-establishing the federal navigation channel to its congressionally authorized dimensions would have direct short-term effects on water quality by causing localized turbidity increases in the areas where dredging and dredged material placement is proposed. Sediment testing indicates little to no contamination of the sediments proposed for dredging and in-water placement. The Corps has conducted dredging on the scale proposed multiple times in the past. The proposed current immediate need action would not change the water quality or sediment quality conditions in the cumulative effects area and would not contribute to the cumulative effects of past, present, and reasonably foreseeable future actions on water quality and sediment quality.

A related action would involve dredging to maintain the Ports' berthing areas. As with the current immediate need action of dredging the federal navigation channel, this action would not change the water quality or sediment quality conditions in the cumulative effects area and would not contribute to the cumulative effects of past, present, and reasonably foreseeable future actions on water quality and sediment quality.

Hydrology and Sediment

The proposed current immediate need action would re-establish the federal navigation channel. The proposed action would move approximately 480,000 cubic yards of sediment from locations where it has interfered with the existing authorized purpose of navigation, and place it in another area where it would not affect navigation. The current immediate need action would not change the hydrology or affect sediment transport or deposition conditions in the cumulative effects area that have resulted from past, present, and reasonably foreseeable future actions.

A related action would involve dredging to maintain the Ports' berthing areas. As with the current immediate need action of dredging the federal navigation channel, this action would not change the hydrology or affect sediment transport or deposition conditions in the cumulative effects area that have resulted from past, present, and reasonably foreseeable future actions

Threatened and Endangered Fish

The proposed current immediate need action would result in temporary, localized turbidity effect that could indirectly affect fish. Proposed dredging and dredged material management would occur during the winter in-water work window when fish presence would be minimal.

A related action would involve dredging to maintain the Ports' berthing areas. As with the current immediate need action of dredging the federal navigation channel, this action would not directly affect conditions for listed fish in the cumulative effects area that have resulted from past, present, and reasonably foreseeable future actions.

4.12 Climate Change

Global climate change refers to long-term changes in temperature, precipitation, wind, and other elements of the earth's climate. Changes in climate resulting from myriad natural processes have occurred throughout the earth's history; however, evidence suggests that changes in climate are currently being accelerated by human-caused GHG emissions, primarily carbon dioxide (CO_2) (USFS 2009).

Draft NEPA Guidance on Consideration of Effects of Climate Change and Greenhouse Gas Emissions (CEQ 2010) and federal water management agencies' guidance (Brekke et al. 2009) indicate that changing climate should be considered a reasonably foreseeable future condition. While climate trends and analysis of climate change in the inland Northwest and northern Rocky Mountains indicate warmer and drier future conditions, which could result in more wildfire in large portions of the watershed study area, accurately predicting how those future conditions affect sediment accumulation in the Lower Snake River system is not currently feasible. However, the Corps and land management agencies can continue to gain a fuller understanding of the implications of climate change with respect to managing sediment that interferes with the authorized purposes of the LSRP through long-term monitoring (i.e., channel condition surveys, sediment range surveys, channel impediment reports from commercial and recreational river users) and analysis of changing conditions as proposed in Section 3.2.1 of the PSMP (Appendix A).

The CEQ's draft guidance recommends consideration of the following in NEPA documents: GHG emissions' effect on a proposed action and alternatives; the relationship of climate change effects of a proposed action; and mitigation and adaptation measures. Given that the PSMP is a programmatic plan to manage sediments that interfere with authorized purposes of the LSRP, the primary consideration related to climate change for this EIS is how climate change may affect hydrology and sediment within the Snake River basin and how those changes may, in turn, affect other resources. This section presents information on how future actions, considered programmatically, may affect GHG emissions and how climate change may affect the measures that are considered. It also presents the GHG and climate change considerations for the proposed current immediate need action and related Ports' berthing-area maintenance actions.

4.12.1.1 GHG Emissions Effects

Future Actions

As noted in Section 4.9, emissions of GHGs from most measures to manage sediment would result from the use of internal combustion engines in dredges, tug boats, barges, and construction equipment associated with dredging, dredged material management, and other sediment or system management measures that involve construction activities. For the three alternatives considered, emissions would be temporary and of low quantities, falling well short of the annual emissions thresholds in EPA's GHG reporting rule. Similarly, GHGs from construction activities associated with sediment management measures identified as part of Alternative 7 would also generally be temporary, occurring primarily during construction activities, and would be below the thresholds of the EPA GHG reporting rule.

Actions by the Corps to maintain the navigation channel at its authorized dimensions would not change the use of the LSRP for commercial navigation. Therefore, GHG emissions from ongoing barge transportation would not change from existing levels associated with LSRP barge traffic. Similarly, small quantities of GHGs are generated by recreational boating, but the Corps' actions to maintain access to recreation areas or marinas would not change the levels of recreation boating on the LSRP and therefore would not result in an increase of GHGs from recreation.

Current Immediate Need Action

Proposed dredging and dredged material management to re-establish the navigation channel dimensions would involve the temporary use of mechanical equipment for dredging equipment and barges. As described above, the emissions of GHGs from these activities would be below the threshold for EPA's GHG reporting.

4.12.1.2 Climate Change Effects on the PSMP

Future Actions

Any proposed action must be evaluated in the context of global climate change because the Corps' management of sediment that interferes with the authorized purposes of the LSRP may be affected by climate change. Many climate models predict a trend of warmer, dryer conditions in the inland Pacific Northwest and northern Rocky Mountains. The Columbia River basin, which includes the Snake River, is predicted to experience a shift as to when and in what form precipitation occurs, with resulting effects on stream flows.

Collaborative research and analysis by the agencies responsible for managing water resources in the Columbia River basin estimates a future shift in flow regimes to lower summer flows and higher high flows occurring earlier in the year than have historically occurred (Reclamation et al. 2011). These studies predict that air temperatures are likely to increase by 2 to 5 degrees Fahrenheit by 2059. Predicted changes in annual precipitation are expected to change slightly; however, models predict that there are likely to be notable shifts in when precipitation occurs and what form it takes (e.g., more rain and less snow). Models indicate more winter precipitation would fall as rain than presently occurs, producing more runoff earlier in the winter and spring and less the summer months. The River Management Joint Operating Committee's summary report (Reclamation et al. 2011) notes that, because of the uncertainties associated with climate change analysis, the full extent of potential effects of climate change on the Columbia River system requires further analysis.

Potential long-term effects of climate change on the Columbia River basin that were identified include:

- Increased winter/early spring runoff and decreased summer runoff may result in irrigation water supply reductions, increased flood risk in winter/early spring, and decreased hydropower generation in summer.
- Warmer conditions may increase stress on fisheries and aquatic environments.
- Increased plant growth induced by increased precipitation as rain, combined with warmer, drier summers, may increase forest fire risk. (Reclamation 2011)

Climate change may potentially affect the resources evaluated in this EIS. Potential effects on hydrology and sediment, water quality, and aquatic resources are presented below since these are the resources that may be most noticeably affected by climate change.

The *Third National Climate Change Assessment* (Mote et al. 2014) includes information on climate change in the Northwest. Key findings presented in that document include:

- Changes in timing of streamflow related to snowmelt will continue, with peak flows occurring earlier in the year.
- Hydrologic responses to climate change will depend on the dominant form of precipitation within a particular watershed. Watersheds with mixed precipitation are likely to see less variation from historic patterns of flow conditions than those dominated by snowmelt.
- Summer flows for snowmelt-driven watersheds are predicted to be substantially reduced when compared to historic levels. Modeling studies indicate that these conditions would "…with near 100 percent likelihood…" occur by 2050.

The Snake River basin contains a mix of snowmelt- and mixed-precipitation-driven watersheds, and may experience a combination of predicted effects with respect to shifts in streamflow timing and reduced summer flows. Given the multiple authorized purposes and operational objectives of the LSRP, climate change is likely to have important implications on how the reservoir system is operated as predicted changes in timing and volume of flows in the lower Snake River reservoirs occur. The adaptive capacity of freshwater ecosystems in managed systems like the LSRP will depend on the degree to which streamflow and water quality for fish can be balanced with other uses of water resources (Mote et al. 2014).

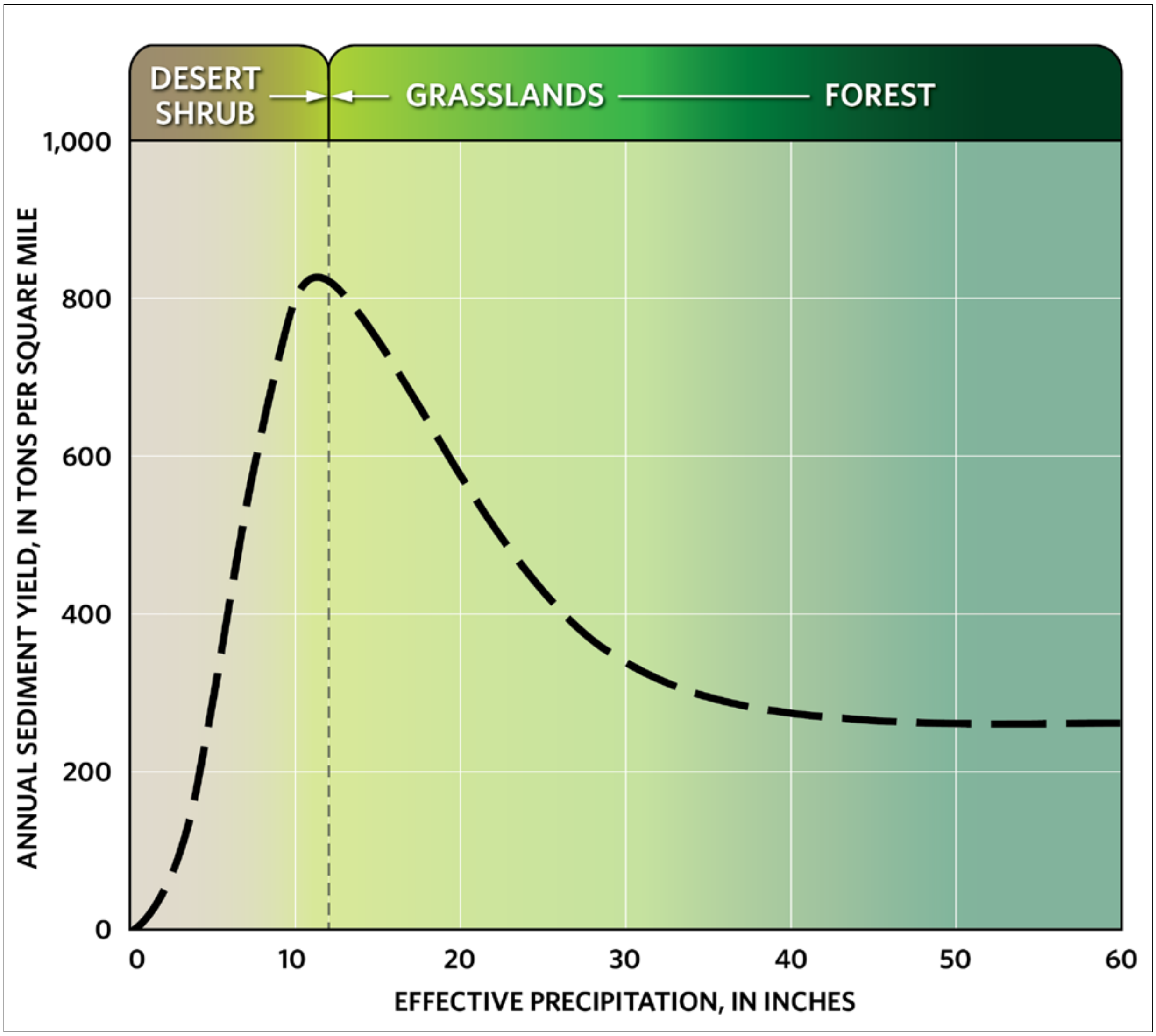
The implications of climate change for future actions are discussed below with respect to key resources considered in this EIS.

Hydrology and Sediment

The Corps' hydrologic and hydraulic investigations (Appendix F) considered climate change considerations in the assessment of future sedimentation in Lower Granite Reservoir. The investigations concluded that total annual precipitation in the Lower Granite Reservoir watershed are unlikely to change substantially, though patterns of precipitation are likely to shift to more rain and less snow. Findings presented in Appendix F also indicate that changes to sediment production and transport possibly resulting from climate change cannot be accurately predicted at this time. Additional studies referenced below provide further evidence of uncertainty surrounding predictions of future geomorphological conditions in response to climate change.

Appendix D presents potential scenarios of future conditions that could result in increased sediment loading to watersheds within the lower Snake River Basin (particularly the mountainous, semi-arid watersheds that make up a substantial portion of the watershed study area). The potential increased sediment loading is primarily due to an increase in conditions favorable to wildfires, which typically result in increased erosion and sediment loading from burned areas. However, whether or not these conditions would affect sediment transport and accumulation when considered in combination with changes in precipitation and tributary flows cannot be reasonably predicted at this time.

Figure 4-1 below illustrates the relationship between sediment yield relative to hydroclimate and the regulating role of vegetation. Specifically, the figure shows that maximum sediment yield generally occurs where effective precipitation is on the order of 10 inches per year. This annual precipitation is generally experienced over a large portion of the effective drainage basin for the Lower Granite Reservoir. Climate change may not significantly increase sediment yield within the Snake River Basin since it appears that present basin climactic conditions, with respect to effective precipitation, may already provide the maximum long-term sediment yield conditions.



Source: Langbein and Schumm 1958.

Figure 4-1. Relationship of Precipitation and Sediment Yield

Ultimately, considering the regional predictions for climate change (Reclamation et.al. 2011; Mote et al. 2014) and specific assessments of the Snake River (Appendices D and F), long-term monitoring and analysis is necessary to more accurately assess changing conditions, estimate changes in sediment yield and transport, and adaptively manage the lower Snake River reservoirs. Coordination with land and water resource management agencies, through LSMGs and in conjunction with plan-level monitoring and evaluation, may help the Corps and other agencies adaptively manage resources to address changes attributable to climate change.

Water Quality

Increasing air temperatures and changes in hydrologic regimes may result in gradually increasing water temperatures. Anticipated shifts in streamflow timing and lower summer streamflow conditions in some tributaries, along with predicted increases in air temperatures, would lead to warming conditions in the LSRP. Effects of anticipated climate changes on water temperature have not been subject to detailed modeling (Reclamation et al. 2011) and therefore the effects to water quality cannot be quantified.

Aquatic Resources

Analysis to date of climate change-related effects on aquatic resources, and in particular ESA-listed fish species, has considered these effects relative to other impacts to system operations, namely hydropower and flood control. In general, changes in the timing and magnitude of high- and low-flow periods could adversely affect the life cycles of salmonids, including disruptions to overwintering juvenile fish and incubating eggs in streambeds (Bisson 2008). Higher flows predicted in January though April could result in greater spills at dams, including the LSRP dams, which could adversely affect fish by increasing dissolved gases in the water. Reduced inflows in summer months may impact the ability of the Corps and other agencies to meet future flow management requirements of prevailing biological opinion(s) (Reclamation et al. 2011). Changes in streamflow timing and volume will be critical factors in how the LSRP is managed (for multiple purposes) and would have implications for the aquatic ecosystem with the LSRP.

4.12.1.3 Conclusion

The potential changes in hydrology, sediment, water quality and aquatic resources resulting from climate change are difficult to predict given the current body of literature and available data. The *Third National Climate Change Assessment* (Mote, P.A. et. al. 2014) notes the vulnerabilities of aquatic systems to adapt to predicted changes and the challenges for managing systems like the LSRP in the context of climate change. While there is general scientific consensus around the concept of climate change, there remains considerable uncertainty about the magnitude, timing, and patterns of that change and the implications of climate change on management of water resources. USGS Climate Change and Water Resources Management: A Federal Perspective (Brekke et al 2009) recommends monitoring and adaptive management to address changing conditions, and the Corps' Climate Change Adaptation Policy Statement and 2012 Climate Change Adaptation Plan and Report provide direction on climate change adaptation for water resources management. An overarching objective of the PSMP (Appendix A), regardless of the alternative ultimately selected by the Corps, is to systematically monitor conditions and take steps to plan sediment management in the most environmentally sound and cost-effective manner consistent with the limits of the Corps' authorities and available funding.

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SECTION 5.0 COMPLIANCE WITH APPLICABLE ENVIRONMENTAL LAWS AND REGULATIONS

This section addresses federal statutes, implementing regulations, and executive orders potentially applicable to the proposed PSMP adoption and implementation both for future actions and the proposed current immediate need action. In addition, the Corps' regulatory action for proposed Port dredging would comply with applicable laws and regulations. In each case, the text provides a brief summary of the relevant aspects of the law or order. The conclusions on compliance are based on the impact analysis presented in Section 4, Environmental Effects of Alternatives. The Corps would comply with all applicable laws and regulations for the proposed current immediate need action to address current sediment interference with authorized purposes; these specific procedures are discussed where applicable.

5.1 Federal Statutes

5.1.1 American Indian Religious Freedom Act (AIRFA)

The American Indian Religious Freedom Act (AIRFA) of 1978 (42 USCA 1996) established protection and preservation of Native Americans' rights of freedom of belief, expression, and exercise of traditional religions. Courts have interpreted AIRFA to mean that public officials must consider Native Americans' interests before undertaking actions that might harm those interests. The Corps will continue to coordinate with affected Native American tribes on this study and future implementation of the PSMP. The Corps will coordinate with tribes regarding the proposed current immediate need action, in accordance with AIRFA.

5.1.2 Archeological Resources Protection Act

The Archeological Resources Protection Act (16 USC 470aa-470ll) provides for the protection of archeological sites located on public and Native American lands, establishes permit requirements for the excavation or removal of cultural properties from public or Native American lands, and establishes civil and criminal penalties for the unauthorized appropriation, alteration, exchange, or other handling of cultural properties.

The Corps will continue to protect archeological resources and sites on lands within the Corps' jurisdiction. The Corps will configure individual PSMP implementation measures to avoid known cultural properties and will consult with appropriate authorities should inadvertent discoveries occur during measure implementation. The proposed current immediate need is not anticipated to adversely affect archaeological sites (see 5.1.12 below).

5.1.3 Clean Air Act

The Clean Air Act (CAA) (42 USC 7401 et seq.), amended in 1977 and 1990, was established "to protect and enhance the quality of the nation's air resources so as to promote public health and welfare and the productive capacity of its population." The CAA authorizes the EPA to establish the National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The CAA establishes emission standards for stationary sources, volatile organic compound emissions, hazardous air pollutants, and vehicles and other mobile sources. The CAA also requires the states to develop implementation plans applicable to particular industrial sources.

Construction activities associated with some PSMP measures have the potential to increase dust and create other temporary air quality effects. With the implementation of BMPs, activities associated with implementation of the PSMP are not anticipated to adversely affect air quality. Operation of heavy equipment (dredges, barges, etc.) associated with the current immediate need action would have localized, temporary increases of emissions, but would not adversely affect air quality.

5.1.4 Endangered Species Act

The ESA (16 USC 1531-1544), amended 1988, established a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitat upon which they depend. Section 7(a) of the ESA requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) and NMFS, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats.

The Corps has and will continue to consult with the NMFS concerning listed species within the study area that could be affected by the actions addressed in the PSMP. Section 7(c) of the ESA and the federal regulations on endangered species coordination (50 CFR § 402.12) require that federal agencies prepare biological assessments of the potential effects of major actions on listed species and critical habitat. The Corps has coordinated with the NMFS concerning ESA compliance for the PSMP, has prepared and submitted a programmatic Biological Assessment (BA), and requested formal consultation formal consultation with the NMFS for the PSMP (the BA is included in Appendix K). The programmatic BA broadly evaluates the measures that the Corps has considered for implementation as part of future actions. The Corps will not finalize its decision until the completion of the programmatic consultation. The Corps anticipates that, when specific projects are developed following adoption of the PSMP, the Corps would consult with the NMFS about the details of the proposal, as required by the NMFS BiOP and the ROD.

The Corps has prepared a BA documenting the anticipated effect of the proposed current immediate need action to reestablish the navigation channel to its authorized dimensions (included in Alternatives 5 and 7) to address sediment accumulation that currently interferes with commercial navigation. The BA is included as Appendix K. The Corps is requesting formal consultation with the NMFS and the USFWS for this proposed current immediate need action. The Corps will not sign a ROD for the PSMP or the proposed current immediate need action until ESA consultation is complete.

5.1.5 Federal Water Pollution Control Act (Clean Water Act)

The Federal Water Pollution Control Act (33 USC 1251 et seq.) is more commonly referred to as the CWA. This act is the primary legislative vehicle for federal water pollution control programs and the basic structure for regulating discharges of pollutants into waters of the United States. The CWA was established to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA sets goals to eliminate discharges of pollutants into navigable water, protect fish and wildlife, and prohibit the discharge of toxic pollutants in quantities that could adversely affect the environment. The CWA has been amended numerous times and given a number of titles and codifications.

Water quality certification for projects developed pursuant to the adopted PSMP will be requested from the regulating agencies for the state(s) in which projects are proposed, as appropriate each time a project is proposed. There is insufficient information available about future actions to request water quality certification for the adopted PSMP. Corps actions involving the discharge of dredged or fill materials into the waters of the United States will be in accordance with guidelines promulgated by the EPA in conjunction with the Secretary of the Army under the authority of CWA Section 404(b)(1). Section 404(b)(1) evaluations will be prepared as needed for each future action involving discharges of dredged or fill material in waters of the United States, and submitted to the appropriate state(s) along with a request for water quality certification.

For the proposed current immediate need action to reestablish the navigation channel dimensions, the Corps has prepared a CWA Section 404(b)(1) evaluation, which is included as Appendix L. The Corp's Walla Walla District worked with Seattle District Dredged Material Management Office and the Dredged Material Management Program agencies to obtain a Suitability Determination for unconfined in-water disposal for the proposed current immediate need action. Summer 2013 sediment sampling included z-layer samples from the sediment core locations. These samples were archived but not analyzed since the dredge prism results were below the screening limits. The sediment at one of the potential dredging sites, the Port of Clarkston's Crane Dock site at RM 137, had not been evaluated for contaminants at the time the PSMP draft EIS was prepared. The CWA 404(b)(1) evaluation and the PSMP and associated EIS will be updated with those results prior to finalization. The CWA 404(b)(1) evaluation and the PSMP/EIS will be updated with those results prior to finalization. The Corps anticipates the sediment from the Crane Dock will be suitable for unconfined open in-water disposal. The Corps will be issuing a public notice for the proposed current immediate need action and requesting Section 401 water quality certification from Ecology as the dredged material disposal would occur in Washington. Although the Corps would not be disposing of any dredged material in Idaho, the Corps will be requesting a short-term activity exemption from IDEQ for the dredging activities that would take place in Idaho.

The Corps will not sign the ROD for the current immediate need action until regulatory approvals described above are complete.

5.1.6 Federal Water Project Recreation Act

In the planning of any federal navigation, flood control, reclamation, or water resources project, the Federal Water Project Recreation Act (16 USCA 4612 et seq.) requires that full consideration be given to the opportunities that the project affords for outdoor recreation and fish and wildlife enhancement. More specifically, the act requires planning with respect to development of recreation potential. Projects must be constructed, maintained, and operated in a manner consistent with this act if recreational opportunities are a potential component of a proposed project and would not counter the purpose of the project.

Recreation sites have been developed on the lower Snake River reservoirs and are operated by a variety of entities. No PSMP measures are expected to have a significant, long-term impact on recreation facilities, activities, or use patterns. Small boat marinas and HMUs would experience a positive effect from several measures that would keep access clear or involve reconfiguration of the facilities to avoid sediment accumulation problems.

5.1.7 Fish and Wildlife Coordination Act (FWCA)

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC 661 et seq.) requires consultation with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose. The USFWS and state agencies charged with administering wildlife resources are to conduct surveys and investigations to determine the potential damage to wildlife and the mitigation measures that should be taken. The USFWS incorporates the concerns and findings of the state agencies and other federal agencies, including the NMFS, into a report that addresses fish and wildlife factors and provides recommendations for mitigating or enhancing impacts to fish and wildlife affected by a federal project. The Corps is not required to consult with the USFWS for existing water resource projects with standard operation and maintenance procedures in place.

This PSMP EIS has been coordinated with the USFWS and other federal and state resource agencies. The Corps will continue to consult with wildlife agencies through the adoption and implementation of the PSMP.

5.1.8 Fishery Conservation and Management Act of 1976

The Fishery Conservation and Management Act of 1976 (16 USC 1801-1882; 90 Stat. 331; as amended), also known as the Magnuson Fishery Conservation and Management Act, established a 200-mile fishery conservation zone, effective March 1, 1977, and established the Regional Fishery Management Councils consisting of federal and state officials, including the USFWS. The fishery conservation zone was subsequently dropped by amendment and the geographical area of coverage was changed to the Exclusive Economic Zone, with the inner boundary being the seaward boundary of the coastal states. Columbia River salmon and steelhead are found in this zone. Therefore, the potential effects of the alternatives on the fisheries in this zone have been examined in Section 4.1 of this EIS. The BAs (Appendix K) document the essential fish habitat effects of the PSMP and the proposed current immediate need action to reestablish the navigation channel to its authorized dimension.

5.1.9 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918, as amended, (16 USC 715 et seq.) requires that lands, waters, or interests acquired or reserved for purposes established under the Act be administered under regulations promulgated by the Secretary of the Interior. This act involves conservation and protection of migratory birds in accordance with treaties entered into between the United States and Mexico, Canada, Japan, and the former Union of Soviet Socialist Republics. It protects other wildlife, including threatened or endangered species, and restores or develops adequate wildlife habitat. The migratory birds protected under this act are specified in the respective treaties. In regulating these areas, the Secretary of the Interior is authorized to manage timber, range, agricultural crops, and other species of animals, and to enter into agreements with public and private entities. The Corps has determined there would be no potential effects on migratory birds from the proposed current immediate need action to reestablish the navigation channel to its authorized dimensions. Compliance with the act would be conducted on a project-specific basis for future actions.

5.1.10 National Environmental Policy Act (NEPA)

This PSMP EIS was prepared pursuant to regulations implementing the NEPA (42 USC 4321 et seq.). The NEPA provides a commitment that federal agencies will consider the environmental effects of their actions. It also requires that an EIS be included in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment. The EIS must provide detailed information regarding the proposed action and alternatives, the environmental impacts of the alternatives, potential mitigation measures, and any adverse environmental impacts that cannot be avoided if the proposal is implemented. Agencies are required to demonstrate that these factors have been considered by decision-makers prior to undertaking actions. Development of this PSMP EIS is in compliance with NEPA requirements for the proposed action. The NEPA compliance will be considered complete with the signing of a ROD.

This is a programmatic EIS, which means that the EIS alternatives define broad programs for managing sediments as they relate to the existing authorized project purposes of the LSRP. This EIS addresses the environmental effects of the PSMP and the first proposed site-specific action to be taken under this plan, the proposed current immediate need action to dredge four locations to reestablish the navigation channel to its authorized dimension. Specific actions to be taken in the future (following approval of this programmatic EIS) will require project-specific environmental reviews, including preparation of NEPA documents (i.e., EAs or EISs).

5.1.11 Native American Graves Protection and Repatriation Act (NAGPRA)

The NAGPRA (25 USCA. 3001) addresses the discovery, identification, treatment, and repatriation of Native American (and Native Hawaiian) human remains, associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony. This act also establishes fines and penalties for the sale, use, and transport of Native American cultural items. Consistent with procedures set forth in applicable federal laws, regulations, and policies, the Corps will proactively work to preserve and protect cultural resources, establish NAGPRA protocols and procedures, and allow reasonable access to sacred sites. Should human remains or associated objects be discovered during implementation of the current immediate need action or of any future action under this PSMP, all work would stop, and the Corps would notify Native American tribes and comply with the requirements of NAGPRA.

5.1.12 The National Historic Preservation Act (NHPA)

Section 106 of the NHPA (16 USC 470) requires that federal agencies evaluate the effects of federal undertakings on historic properties and afford the Advisory Council on Historic Preservation opportunities to comment on the proposed undertaking. The first step in the process is to identify cultural resources included in (or eligible for inclusion in) the National Registry of Historic Places (NRHP) that are located in or near the study area. The second step is to identify the possible effects of proposed actions. The lead agency must examine whether feasible alternatives exist that would avoid such effects. If an effect cannot reasonably be avoided, measures must be taken to minimize or mitigate potential adverse effects. Cultural resource literature searches have been conducted in support of the EIS. The Corps has identified alternatives for broad programs for managing sediments as they relate to the existing authorized project purposes of the LSRP. As such, the PSMP does not define or evaluate specific future actions, but rather it identifies a range of potential actions over a wide area and long period of time. Specific actions to be taken following approval of this programmatic EIS will require project-specific determination of effects in accordance with Section 106 of the NHPA.

The Corps also proposes the current immediate need action to dredge four locations in 2013/2014. The Corps has determined that the proposed immediate dredging will result in no adverse effects to historic properties. This determination has been provided to the State Historic Preservation Officers of both Washington and Idaho, as well as interested tribes in accordance with Section 106 of the NHPA.

The following cultural resource protection laws were also considered in the preparation of this PSMP EIS:

- The Antiquities Act of 1906 (16 USC 431).
- Historic Sites Act of 1935 (16 USC 461).
- Reservoir Salvage Act of 1960 (16 USC 469).
- Archeological and Historic Preservation Act of 1974 (16 USC 469a-1).

The Corps has also consulted with the state historic preservation officers of Washington and Idaho regarding an effect determination for the proposed current immediate need action to address sediment that currently interferes with commercial navigation. In the future, the Corps will consult with state historic preservation officers on a project-specific basis.

5.1.13 Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act)

The Northwest Power Act was passed by Congress on December 5, 1980 (16 USC 829d-1). This law created the eight-member Northwest Power Planning Council (NPPC), an interstate agency whose members are appointed by the Idaho, Montana, Oregon, and Washington governors. The NPPC was entrusted with adopting a Fish and Wildlife Program for the Columbia River Basin by November 1982 and preparing a 20-year Regional Electric Power and Conservation Plan by April 1983. These plans are periodically updated and amended.

The NPPC's Fish and Wildlife Program established a number of goals for restoring and protecting fish and wildlife populations in the basin. These goals led to changes in the operation of the Coordinated Columbia River System during the mid-1980s. One of the most notable changes resulted in the Water Budget, which provides for the release of specific amounts of water in the upper Columbia and Snake Rivers to help juvenile salmon migrate downstream in the spring. More recently, the NPPC developed its own proposals to protect threatened and endangered salmon stocks. The NPPC has completed amendments to its Columbia River Basin Fish and Wildlife Program. The amendments adopted to date include mainstem survival, harvest, production, habitat, and flow measures that can be used to increase salmon and steelhead runs, and resident fish and wildlife measures. The Corps takes these amendments into consideration when making operating plans. The alternatives considered in the PSMP EIS to maintain the existing authorized project purposes of the LSRP would have no long-term, adverse impacts on generation of electrical power in the Northwest or on fish and wildlife populations present in the study area.

5.1.14 Pollution Control at Federal Facilities

In addition to their responsibilities under NEPA, federal agencies are required to carry out the provisions of other federal environmental laws. To the extent applicable to an alternative presented in this EIS, compliance with the standards contained in the following legislation was included in this evaluation:

- The Safe Drinking Water Act, as amended (42 USC 300F et seq.).
- The Solid Waste Disposal Act (42 USC 6901 et seq.).
- Oil Pollution Act (33 USC 2701 et seq.).
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended (42 USC 9601 [9615] et seq.).

- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended (7 USC 136 et seq.).
- The Resource Conservation and Recovery Act (RCRA) of 1976, as amended (42 USC 6901 et seq.).
- Toxic Substances Control Act (TSCA), as amended; Title 40 CFR Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions" (15 U.S.C. et seq.).
- The Noise Control Act of 1972, as amended (42 USC 4901 et seq.).
- Occupational Health and Safety Act (29 USC 651 et seq.).

5.1.15 Rivers and Harbors Act of 1899

Section 10 of the Rivers and Harbors Act of 1899 (33 USC 401-418) regulates structures or work in or affecting navigable waters of the United States including discharges of dredged or fill material. The EIS considered effects to navigation (as well as water resources in accordance with the Clean Water Act). The public will be notified each time the Corps proposes to perform in-water work in projects developed pursuant to the adopted PSMP.

The Corps has issued a public notice for the proposed current immediate need action to reestablish the navigation channel dimensions. This notice was combined with the request to Ecology for CWA Section 401 water quality certification.

5.1.16 Treaties with Native American Tribes

Treaties between the United States and regional mid-Columbia/lower Snake River tribes document agreements reached between the federal government and the tribes. In exchange for Native American tribes ceding much of their ancestral land, the government established reservation lands and guaranteed that it would respect the treaty rights, including fishing and hunting rights. These treaties, as well as statutes, regulations, and national policy statements originating from the executive branch of the federal government provide direction to federal agencies on how to formulate relations with Native American tribes and people. Treaties with area tribes (e.g., Treaty of June 9, 1855, Nez Perce Tribe, 12 Stat. 957 (1859)) explicitly reserved unto the tribes certain rights, including the exclusive right to take fish in streams running through or bordering reservations, the right to take fish at all usual and accustomed places in common with citizens of the territory, and the right of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed lands. These reserved rights include the right to fish within the geographical area of the potential affected environment identified in the PSMP EIS.

The potential environmental effects associated with the PSMP were evaluated on a programmatic level and a site-specific level for the proposed current immediate need action to reestablish the congressionally authorized navigation channel. The proposed actions would have no long-term, adverse impacts on important treaty resources. Meaningful consultation on the EIS and PSMP (Appendix G) with area tribes is described in Section 6.2.

5.2 Executive Orders

5.2.1 Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971

Executive Order 11593 outlines the responsibilities of federal agencies to consider effects to historic properties in consultation with the Advisory Council on Historic Preservation where a federal undertaking may adversely affect a property. Agencies are also to preserve, rehabilitate, and restore historic properties. Agencies are encouraged to avoid, or at least mitigate, an adverse effect on listed properties. The Executive Order furthers the purpose and policies associated with the National Environmental Policy Act of 1969; the National Historic Preservation Act of 1966; the Historic Sites Act of 1935 and the Antiquities Act of 1906. Sections 3.4, 4.4, and 5.1 provide summaries of how the Corps has considered potential effects on historic properties, including compliance with applicable cultural resources management requirements.

5.2.2 Executive Order 11988, Floodplain Management Guidelines, May 24, 1977

This Order outlines the responsibilities of federal agencies in the role of floodplain management. Each agency shall evaluate the potential effects of actions on floodplains and should avoid undertaking actions that directly or indirectly induce growth in the floodplain or adversely affect natural floodplain values. Sediment management actions developed pursuant to the adoption of the PSMP will need to comply with the provisions of this Executive Order. The proposed current immediate need action would not affect floodplains.

5.2.3 Executive Order 11990, Protection of Wetlands

Executive Order 11990 encourages federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands when undertaking federal activities and programs. It has been the goal of the Corps to avoid or minimize wetland impacts associated with their planned actions. Future actions taken pursuant to the PSMP will consider potential effects on wetlands, as well as opportunities to minimize effects and preserve and enhance wetlands and wetland values. The proposed current immediate need action would have no effect on wetlands.

5.2.4 Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994

Executive Order 12898 requires federal agencies to consider and address environmental justice by identifying and assessing whether agency actions may have *disproportionately high and adverse human health or environmental effects on minority or low-income populations*. Disproportionately high and adverse effects are those effects that are *predominantly* borne by minority and/or low-income populations *and* are appreciably more severe or greater in magnitude than the effects on nonminority or non-low income populations.

This EIS programmatically considered activities related to long-term management of sediment. Plan measures, as proposed, are not expected to disproportionately affect any particular demographic group. The proposed current immediate need action similarly is not expected to affect any particular demographic group.

5.2.5 Executive Order 13007, Native American Sacred Sites, May 24, 1996

Executive Order 13007 directs federal agencies to accommodate access to and ceremonial use of tribal sacred sites by tribal religious practitioners. Agencies are to avoid adversely affecting the physical integrity of such sacred sites and to maintain the confidentiality of sacred sites when appropriate. The act encourages government-to-government consultation with tribes concerning sacred sites. Some sacred sites may qualify as historic properties under the NHPA.

The Corps welcomes discussion of concerns or issues involving sacred sites and invites tribes to bring concerns as a part of the consultation process for the PSMP and for the proposed current immediate need action.

5.3 Executive Memoranda

5.3.1 Council on Environmental Quality Memorandum, August 11, 1990, Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA

The CEQ Memorandum establishes criteria to identify and consider the adverse effects of federal programs on the preservation of prime and unique farmland; to consider alternative actions, as appropriate, that could lessen adverse effects; and to ensure federal programs are consistent with all state and local programs for the protection of farmland. Implementation of measures potentially affecting prime or unique agricultural lands must address this requirement. The proposed current immediate need action would not affect prime or unique farmland.

5.4 State Statutes

The CEQ regulations (40 CFR 1506.2) require consideration of the consistency of a proposed action with approved state and local plans and laws. In-water sediment management activities proposed in this PSMP EIS have been evaluated with regard to applicable state statutes and regulations. Compliance issues have been considered and addressed where applicable to the subject activities. A few statutes considered include, but are not limited to:

- Stream Channel Alteration Permit (Idaho)
- Hydraulic Project Approval (Washington)
- Shoreline Management Act (Washington)

The Corps will coordinate with the appropriate state agencies regarding conditions the states would normally require for compliance with the statutes, but the Corps would not obtain the state permits.

For the proposed current immediate need action to reestablish the navigation channel, the Corps will coordinate with the appropriate habitat biologists from the Washington Department of Fish and Wildlife (WDFW) regarding conditions normally required under a hydraulic project approval. The Corps will not need to coordinate with Idaho Department of Water Resources regarding a stream channel alteration permit as the proposed current immediate need action would take place within the Port of Lewiston Port District and is therefore exempt from this permit requirement. The Corps will not make a final decision or sign a ROD until compliance with these state statutes is complete.

SECTION 6.0 NOTICE OF INTENT COORDINATION, CONSULTATION, AND PUBLIC INVOLVEMENT

The Corps published a Notice of Intent (NOI) in the Federal Register on October 3, 2005. The NOI provided a summary of the objectives of the PSMP and the watershed approach. In addition, the NOI provided background on the Corps' historic approach to sediment management, the array of sediment management measures that would be considered, and the scoping process.

6.1 Scoping

Scoping is the process by which the Corps gathered input from the public, tribes, and government agencies to help determine the scope of the EIS' alternatives and analysis. Public scoping is a critical component of the NEPA process, and one of the first steps taken in developing an EIS. During the scoping process, the Corps informs the public about the EIS preparation and allows the public and other agencies to provide input on the EIS. Public involvement allows the Corps to identify and address important issues early in the EIS process. In the case of the PSMP, it also aids the Corps in developing a range of measures and alternatives to consider in the EIS and in developing evaluation methods to assess the measures and alternatives.

Following the NOI, the Corps conducted several scoping activities to gather public input. These included:

- LSMG meetings
- Agency scoping workshops in each of the study area subbasins
- Considering written comments submitted by agencies and the public

In addition, the Corps conducted extensive coordination with agencies that have specific expertise in erosion, hydrology, and sediment management.

6.1.1 Local Sediment Management Group

The Corps reconvened the group in 2006 to conduct scoping for the PSMP. Prior to the preparation of the draft EIS, the Corps held another LSMG meeting to update the group on the project. The group adopted a new charter and has met throughout the EIS preparation process, providing input and direction to the Corps on sediment management on the lower Snake River. The Corps has convened the LSMG four times since 2006 to share information with the member agencies and stakeholders.

6.1.2 Agency Scoping Workshops

As part of scoping, the Corps conducted targeted agency outreach to gather the input and encourage the participation of federal and state agencies within the study area. In 2006 and 2007, the Corps met with federal agencies involved in land and water resource management in each of the major subbasins to solicit input on the scope of the study and specific technical expertise on sediment management from those agencies (Appendix G).

6.1.3 Public Scoping

Public scoping activities included public scoping open houses and meetings during February 2007 in Clarkston, Washington, Boise, Idaho, La Grande, Oregon, and Portland, Oregon. The Corps received public comments (submitted at the scoping meetings and by mail and e-mail), and considered all comments in the development of the EIS. The Corps received 21 written comments from federal and state agencies, conservation districts, a county advisory committee, a city, ports, nongovernmental organizations, and citizens. Appendix G presents a complete scoping summary. The Corps considered these comments in developing the scope of analysis and in preparing this draft EIS.

Information on the PSMP EIS has been made available since the initiation of scoping on the Corps' website http://www.nww.usace.army.mil/Missions/Projects/ProgrammaticSedimentManagementPlan.aspx.

6.2 Tribal Consultation

Treaties between the United States and the three of the four lower Snake River tribe's document agreements reached between the federal government and the tribes. In exchange for the tribes ceding much of their ancestral land, the government established reservation lands and guaranteed it would respect the treaty rights, including fishing and hunting rights. These treaties, as well as statutes, regulations, and national policy statements originating from the executive branch of the federal government provide direction to federal agencies on how to formulate relations with Native American tribes and people. The following policies are those most often referred to by federal and tribal representatives:

- *1983 - Presidential Statement on American Indian Policy 19 Weekly Comp. Doc. 98-102).* President Reagan's statement dated January 24, 1983, provided direction on treatment of Native American tribes and their interests.
- *1984 - Department of Defense Directive No. 4710.1*- June 21, 1984.
- *1993 - Executive Order 12866, Regulatory Planning and Review.* The order enhanced planning and coordination concerning new and existing regulations. It made the regulatory process more accessible and open to the public. Agencies were directed to seek views of tribal officials before imposing regulatory requirements that might affect them.
- *1994 - Executive Order 12898 on Environmental Justice.*

- *1994 - White House Memorandum for the Heads of Executive Departments and Agencies*. This memorandum emphasized the importance of government-to-government relations with tribal governments and the need to consult with tribes prior to taking actions that may affect tribal interests, rights, or trust resources.
- *1994 - Government-to-Government Relations with Native American Tribal Governments, Memorandum* of April 22, 1994.
- *1995 - Government-to-Government Relations.* The United States Justice Department, Attorney General, issued and signed a policy statement on government-to-government relations on June 1, 1995. It includes references to tribes' sovereignty status and the federal government's trust responsibility to tribal governments.
- *1998 - Executive Order 13084, Consultation and Coordination with Indian Tribal Governments*, May 14, 1998.
- *Policy Guidance Letter No. 57, Indian Sovereignty and Government Relations with Indian Tribes.* Implements Executive Order 13084.
- *1998 - DOD American Indian and Alaskan Native Policy*, October 20, 1998.
- *1999 - Project Operations Native American Policy*, July 12, 1999.

As noted in Executive Order 13084, the federal government continues to work with tribes on issues concerning tribal self-government, trust resources, tribal treaty, and other rights as one government to another government. The Order directs agencies to consider affected federally recognized tribes through the following policy principles:

- The United States has a unique legal relationship with tribal governments as set forth in the Constitution, treaties, statutes, executive orders, and court decisions.
- Tribes, as dependent nations, have inherent sovereign powers over their members and territories with rights to self-government. The United States works with tribes as one government to another government addressing issues concerning tribal self-government, trust resources, and tribes' treaty and other rights.
- Agencies will provide regular, meaningful, and collaborative opportunities to address the development of regulatory practices that may have significant or unique effects on tribal communities.
- Cooperation in developing regulations on issues relating to tribal self-government, trust resources, or treaty and other rights should use, where appropriate, consensus-building methods such as rule-making.

The Corps sent letters to the tribal chairs of the Umatilla Tribe, the Nez Perce Tribe, the Colville Tribe, and the Yakama Nation at the onset of the NEPA process.

6.3 Agency Coordination

The ESA requires the Corps to consult with the NMFS and the USFWS concerning the listed and proposed threatened and endangered species that may occur in the study area. The Corps has coordinated with the USFWS and NMFS regarding compliance with the ESA for the PSMP planning process and subsequent projects developed following PSMP adoption. The BA documenting the anticipated effects of the proposed current immediate need action on listed species is included as Appendix K.

The Corps has also coordinated with the EPA and other agencies regarding plan development and NEPA compliance during the EIS development. As noted in Section 2, the Corps conducted a measures-screening workshop that involved representatives from the EPA, USFS, and USGS.

6.4 Public Outreach and Comment on the DEIS

Upon release of the Draft EIS, the Corps published a notice of availability in the Federal Register. The Corps held two public information meetings in Lewiston, Idaho to discuss the PSMP and the accompanying Draft EIS. Notes were taken to capture general items of public concern and those present were encouraged to submit comments on the Draft EIS at the meeting on comment forms provided, online at a Corps-provided website, or by mail. A summary of the meeting, public comments on the Draft EIS, and the Corps’ responses to comments is provided in Appendix G.

SECTION 7.0 LIST OF PREPARERS

Preparer	Role in EIS Preparation	Experience
U.S. Army Corps of Engineers, Walla Walla District		
Gent, John	Geotechnical Analysis	BSCE, Civil Engineering MSCE, Civil Engineering (geotechnical) 32 years of experience PE, geotechnical endorsement
Hall, Scott	Cultural Resources	BA, Anthropology MA, Anthropology 14 years of experience
Juul, Steve	Water Quality, Sediment Quality	BS, Wildlife Science MS, Environmental Science PhD, Civil Engineering 27 years of experience
Newcomb, Craig	Socioeconomics	BA, Economics 25 years of experience
Shelin, Sandra	Environmental Compliance and Coordination	BS, Wildlife Science 34 years of experience
Teasdale, Gregg	Sediment and Hydrology	BS, Forestry MS, Civil Engineering PhD, Civil Engineering 25 years of experience PE
Tice, Ben	Aquatic and Terrestrial Resources, Endangered Species Act Consultation	BS, Fisheries Management MS, Environmental Science 17 years of experience
Trachtenbarg, David	Anadromous Fish	BS, Fisheries and Wildlife Science 7 years experience
Turner, Richard	Project Manager	BS, Civil Engineering 18 years of experience PMP
HDR Engineering, Inc.		
Auten, Mark	Water Quality, Sediment Quality, Soils	BS, Environmental Science 9 years of experience
Burch, Carey	Quality Review	BS, Forestry MS, Environmental Planning 33 years of experience AICP
Cook, Jeremy	Socioeconomics	BA, Economics MA, Economics 9 years of experience
Diediker, Nona	EIS Consultant Team Manager	BS, Zoology/Botany 22 years of experience

Preparer	Role in EIS Preparation	Experience
Gregory, James	EIS Consultant Team Deputy Manager	BS, Biology MA, Environmental Planning 23 years of experience
Millken, Craig	Air Quality	BA, Geography MS, Environmental Science Research 15 years of experience
Ostrem, Meagan	Aesthetics, Wetlands, Document Preparation	BS, Environmental Science 8 years of experience
Spellecacy, Rona	Sediment and Hydrology	BA, Biological Sciences BA, Anthropology MA, Political Science/Environmental Studies 8 years of experience AICP
Thurin, Steve	Sediment and Hydrology	BS, Civil Engineering MS, Civil Engineering 34 years of experience P.E.
Twitchell, Sara	Recreation	BS, Ecology/Evolutionary Biology MS (in progress), Environmental Science 6 years of experience
Wallace, Mike	Terrestrial Resources	BS, Biology 12 years of experience
Welch, Ian	Aquatic Resources	BS, Marine Biology MS, Wildlife Biology 15 years of experience
Winters, Nancy	HTRW	BA, Biology MS, Environmental/Civil Engineering MS, Zoology/Limnology 27 years of experience LID, CESCL
BST Associates		
Sorenson, Paul	Transportation	BA, Political Economics MA, Economics 32 years of experience
Winningham, Brian	Transportation	BA, Business Administration BA, Economics 33 years of experience
SWCA/Northwest Archaeological Associates, Inc.		
Piper, Jesse	Cultural Resources	MA, Anthropology 15 years of experience

SECTION 8.0 DISTRIBUTION

FEDERAL AGENCIES

Bonneville Power Administration
Fish and Wildlife Division, Manager
Bill Maslen

Bonneville Power Administration
Public Affairs
Crystal Ball

Bureau of Indian Affairs
Northwest Regional Office, Director
Stanley M. Speaks

Bureau of Indian Affairs
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Bernard Burnham

Bureau of Indian Affairs
Yakama Agency
Terry W. Berkompas

Bureau of Indian Affairs
Environmental Coordinator
Toppenish, WA

Bureau of Reclamation
Ephrata Field Office Manager
Stephanie Utter

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Salmon Office
Anthony L. Simpson

Bureau of Reclamation
Snake River Area Office Manager
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Corps of Engineers, Engineer Research and Development
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SECTION 10.0 GLOSSARY

Term	Definition
adfluvial	Migrating from lakes into rivers and streams to spawn (referring to fish).
alkaline	A solution having a relatively low concentration of hydrogen ions and correspondingly higher concentrations of hydroxide ions, therefore with a pH greater than 7, and the ability to neutralize acids.
alluvial	Pertaining to the fan-shaped deposit of soil or sediment formed where a fast-flowing stream flattens, slows and spreads.
ammocoetes	The larval form of lamprey.
anadromous	Pertaining to the migration of fish from the ocean to spawn in fresh water.
anthropogenic	Caused by the influence of human beings.
appurtenant	An accessory or additional component element.
backwater	Water held by a dam.
batholith	A large body of igneous rock formed beneath the Earth’s surface by the intrusion and solidification of magma.
bed load	Particles of sand, gravel and soil carried by the natural flow of a stream on or immediately above its bed (in contrast to “suspended sediment”).
benthic	Pertaining to the collection of organisms that live on or in the sediment at the bottom of a water body.
berm	A linear mound of earthen material.
biological oxygen demand	A measure of the oxygen required for metabolism by aerobic organisms in an aquatic environment.
biomass	Biological material from living or recently living organisms.
broodstock	A group of mature individuals (generally fish) used in aquaculture for breeding purposes.
cairn	A mound of stones erected as a memorial or landmark (generally associated with archaeological sites).
camas	A plant with grassy leaves and an edible bulb.
chironomid	A member of the insect family Chironomidae; nonbiting midges.
chlorophyll a	The type of chlorophyll that is most common and predominant in all oxygen-producing photosynthetic organisms such as vascular plants and algae.
chokepoint	A geographical constriction that reduces flow of water through a channel.
congener	Derivatives of related chemicals with similar properties and toxicities.
Corophium species	Species belonging to the family Amphipoda, which are very small organisms mainly found in aquatic environments where they act scavengers, eating decaying material in the sediments.
diadromous	Pertaining to migration of fish between fresh and salt water.
distinct population segment (DPS)	An animal population or group of populations that is discrete from other populations of the species and significant in relation to the entire species; DPSs, as a classification, are eligible for listing under the ESA.
diurnal	Relating to or occurring within a 24-hour period; daily.
drawdown	The lowering of a water body’s water surface level, as by releasing flow through a dam.
elutriate	To purify, separate, or extract, or related to the chemical process to do so.
embayment	A bay or bay-like shape of a water body.

Term	Definition
entrainment	To be gathered up unintentionally.
epibenthic	Living on the surface of bottom sediments in a water body.
escapement	The number of fish arriving at a natal stream or river to spawn.
ethnographic	Pertaining to the study or systematic recording of human cultures.
eutrophication	The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates.
evolutionarily significant unit	A population of organisms that is considered distinct for the purposes of conservation.
extirpated	The condition of a species which ceases to exist in a given geographic area but still exists elsewhere; local extinction.
fault-block	A rock mass that is bounded by faults; the faults may be elevated or depressed and not necessarily the same on all sides.
fluvial	Pertaining to or inhabiting a stream or river.
flyway	A seasonal route followed by birds migrating to or from wintering or breeding regions.
forb	A broad-leaved herb other than a grass, especially one growing in a field, prairie, or meadow.
forebay	The portion of a reservoir immediately behind a dam.
freeboard	The vertical distance from the water surface and the top of a confining levee.
fry	The life stage of fish that occurs just after hatching
gabion	A container usually made of metal wire and filled with earth and stones, used in the construction and rerouting of waterways.
gallinaceous	Relating or belonging to the bird order Galliformes, including domestic fowl, pheasants, grouse, etc., having a heavy rounded body, short bill, and strong legs.
geomorphology	Pertaining to the characteristics, origin, and development of landforms.
glide	Portion of a stream at which the water has motion but the surface is generally not broken or turbulent.
habitat management unit	Areas set aside by the Corps for wildlife habitat as a way to mitigate for lost habitat due to reservoir impoundments.
hydrograph	The graphical representation of stage, flow, velocity, or other characteristics of water over time at a given location.
hyporheic flow	The percolating flow of groundwater and surface water through sand, gravel, sediments and other permeable substrate under the streambed.
indigenous	Produced, growing, living, or occurring naturally in a particular region or environment.
intermontane	Occurring or situated between mountain ranges.
interstitial	Pertaining to or situated between parts of a structure, tissue, or matter.
invertebrate	Pertaining to organisms without a spinal column.
jack salmon	Salmon that return to freshwater after spending relatively little time at sea (1 to 2 years as opposed to 2 to 8 years).
kelt	A salmon that has recently spawned.
kokanee	Land-locked lake populations of sockeye salmon.
lacustrine	Of or pertaining to a lake.
lanceolate	Tapered from a rounded base toward a narrow tip or apex.

Term	Definition
Laramie orogeny	A series of mountain-building events that affected much of western North America in Late Cretaceous and Early Paleogene time (about 65.5 million years ago).
lek	The communal area in which two or more males of a species gather and perform courtship displays.
lithics	Items consisting of or relating to stone or rock, typically related to items found at archaeology sites.
loaded draft	A measure of how much lower a vessel will sit in the water after loading cargo, passengers, fuel, and such other items necessary for use its voyage.
loess	Windblown deposit of fine-grained, calcareous silt or clay.
macroinvertebrate	Any invertebrate organism large enough to be seen without magnification.
macrophyte	Aquatic plants, growing in or near water, that are either emergent, submerged, or floating.
maritime	Climate conditions influenced by the ocean.
mass-wasting	The dislodging and down slope transport of loose rock and soil material under the direct influence of gravitational stresses; a landslide is an example of mass wasting.
mesic	Characterized by, related to, or requiring a moderate amount of moisture.
metabolite	The product of a metabolic action.
mima mounds	Circular or oval domelike structures composed of loose silt and soil, generally generated by a combination of geomorphic processes and burrowing by animals.
minimum operating pool	The lowest level of water in the river channel that the Corps must maintain to allow for commercial navigation.
montane	Of, related to, growing in, or being the biogeographical zone of relatively cool, moist upland slopes below timberline dominated by large coniferous (evergreen) trees.
mustelids	The family carnivorous mammals including skunks, ferrets, otters, badgers, martens, weasels and minks.
nephalometric turbidity unit	A standard unit of measurement for turbidity. Higher NTU measurement indicates more suspended sediment and turbidity.
noxious weed	Any plant or plant product that can directly or indirectly cause damage to: crops, livestock, poultry, or other agricultural interests of agriculture; irrigation; navigation; and/or natural resources (such as native plants and wildlife).
oligochaete	A class of the phylum Annelida that include terrestrial and freshwater worms.
palustrine	Relating to a system of inland, nontidal wetlands characterized by the presence of trees, shrubs, and emergent vegetation.
passerines	Of or relating to birds of the order Passeriformes, which includes perching birds and songbirds.
pelagic	Open water that is not close to the bottom of the water body or near to the shore.
periphyton	A complex mixture of algae, other microbes, and detritus (dead or decaying material) that are attached to submerged surfaces in most aquatic ecosystems.
petroglyph	A carving or inscription on rock surfaces.
photic zone	The upper layer of a water body delineated by the depth to which enough sunlight can penetrate.
phytoplankton	Small plants and photosynthetic bacterial suspended in the water columns
pictograph	An ancient or prehistoric drawing or painting on a rock wall.
piscivorous	Habitually feeding on fish; fish-eating.

Term	Definition
planktonic	Of or pertaining to small or microscopic organisms, including algae and small floating plants and animals, that float or drift in great numbers, especially at or near the water surface, and serve as food for fish and other larger organisms.
point bar	A feature of a river or stream composed of a series of low, sand and/or gravel ridges formed on the inside of a bend by the gradual deposition of transported sediments.
pool tailout	The most downstream part of a pool, or slow flowing portion of a stream, just before the beginning of a more swiftly flowing riffle.
primary productivity	The rate at which biomass is produced by organisms that convert inorganic substrates or complex organic compounds.
prolarvae	A newly hatched fish in which the mouth parts are underdeveloped and nutrition is provided by the yolk sac.
protohistoric	Pertaining to the study of culture just before the time of its earliest recorded history.
rain shadow	An area having relatively little precipitation due to the effect of a barrier, such as a mountain range, that causes the prevailing winds to lose their moisture before reaching it.
recruitment	The natural increase in the harvestable portion of the population (fish above a certain size) by growth of smaller (e.g., newly hatched) fish; typically only a small fraction of eggs become recruits.
redd	A spawning nest made by a fish, particularly salmon or trout.
refugia	An area where prevailing conditions have enabled a species or community of species to survive/function when surrounding areas are degraded.
revetment	A wall, as of stone or concrete, used to support an embankment.
riffle	A stretch of relatively turbulent water in a stream caused by an underlying shoal, sandbar, or other rough bottom condition.
rill	A small, transient narrow channel.
riparian	Situated or taking place along or adjacent to the bank of a river.
riverine	Of or pertaining to a river.
salmonids	Fish belonging or pertaining to the family of Salmonidae, including salmon, trout, chars and whitefishes.
sediment yield	The amount of sediment eroded and exported from a particular drainage basin or watershed.
sedimentation	The process of deposition of a solid material from a state of suspension in a water body.
seral	An intermediate stage found in the ecological succession, or maturation, of a vegetative community. Forests typically go through multiple successional stages as they reach a mature, or climax, stage.
shoaling	The formation of sandbars or other similar increases in the elevation of the bottom of a body of water, sometimes constituting a hazard to navigation.
slough	A generally slow-moving side channel, inlet, or backwater associated with a river.
smolt	A juvenile salmonid, one or more years old, that has undergone physiological transformations to cope with a marine environment.
standard project flood	A hypothetical river flow level expected to result from the most severe combination of meteorological and hydraulic conditions which area reasonably characteristic of the geographic region involved.
steppe	An extensive, generally open plain and its associated vegetative community.
stratigraphic	Of or pertaining to rock layers, especially the distribution, deposition and age of sedimentary material.

Term	Definition
suspended sediment	Typically fine-grained soil particles that remain suspended in water.
tailrace	The channel for carrying water away from a dam.
tailwater	The portion of a water body immediately downstream of a dam or other hydraulic structure.
talus pit	An area or pit dug into a field or slopes used as meat caches and hunting blinds
thalweg	The line defining the lowest points along the length of a river marking the direction of the river's flow as well as line of the river's fastest flow.
trophic state indicators	Water quality parameters used to make a rough estimate of its biological condition.
turbidity	An optical characteristic or property of water, which generally describes its cloudiness.
ungulate	Any mammal with hooves.
uplands	Area of land lying above the level where water flows or where flooding occurs.
water bar	A road or trail construction feature that is used to prevent erosion on sloping roads or trails by cutting a diagonal channel across the road surface that diverts surface water that would otherwise flow down the whole length of the road.
watershed	The area drained by a river, stream, etc.; drainage area.
young-of-the-year	Fish that are less than one year old.
zooplankton	Very small animals suspended in the water column with little or no ability to move on their own.

SECTION 11.0 INDEX