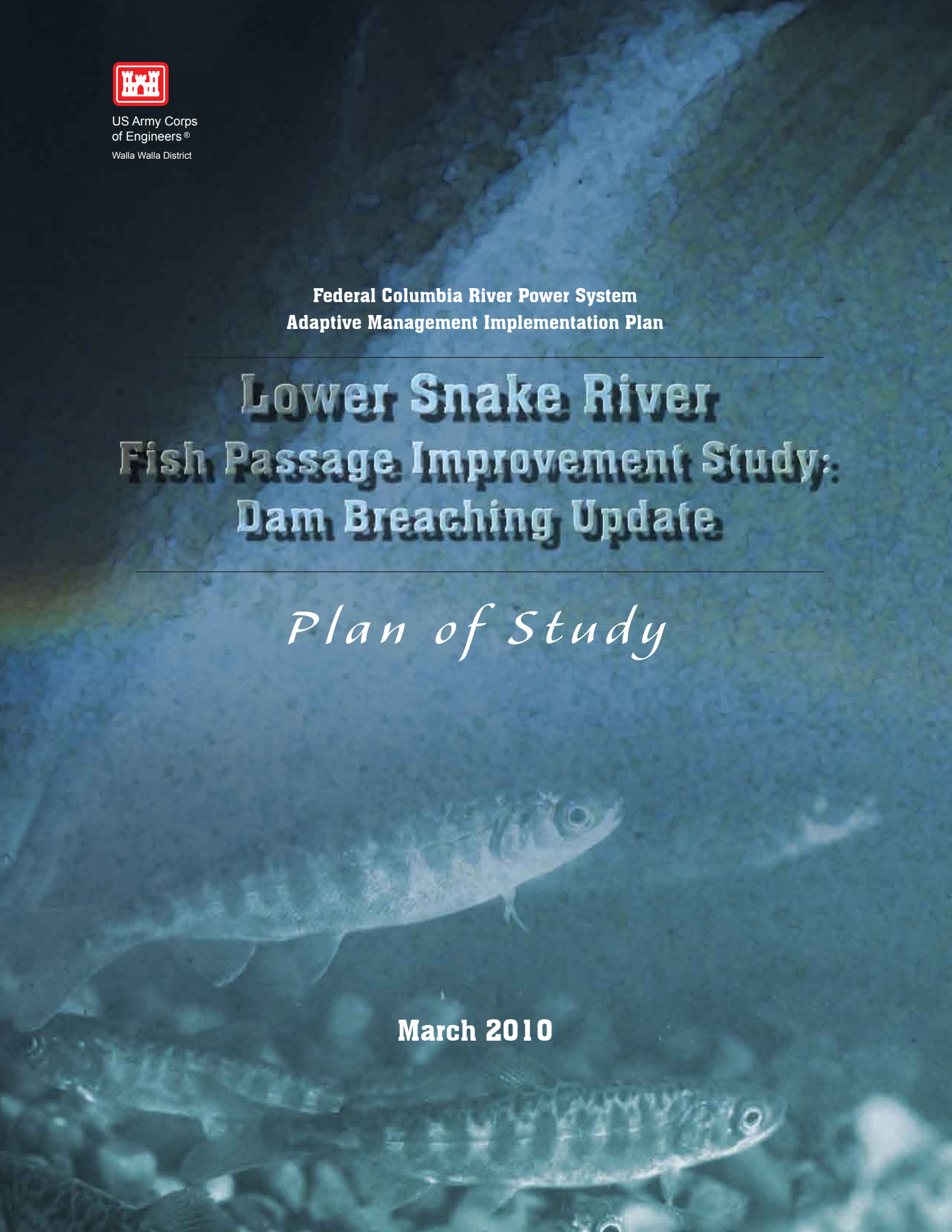


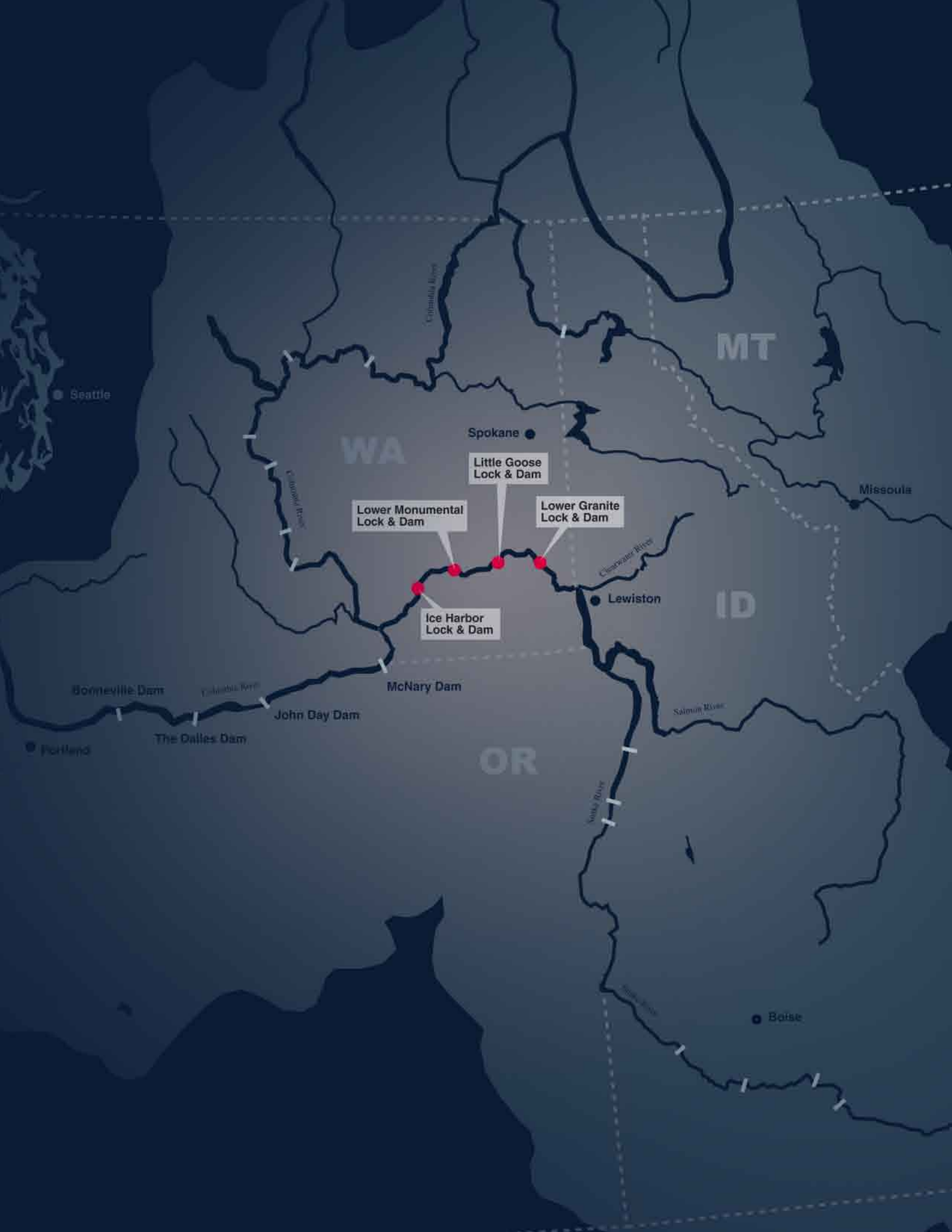
US Army Corps
of Engineers®
Walla Walla District

Federal Columbia River Power System
Adaptive Management Implementation Plan

Lower Snake River Fish Passage Improvement Study: Dam Breaching Update

Plan of Study

March 2010


MT
WA
OR
ID
Seattle
Spokane
Missoula
Lewiston
Boise
Portland
Columbia River
Snake River
Clearwater River
Salmon River
Little Goose Lock & Dam
Lower Monumental Lock & Dam
Lower Granite Lock & Dam
Ice Harbor Lock & Dam
McNary Dam
John Day Dam
The Dalles Dam
Bonneville Dam

Acronyms and Abbreviations

AIRFA	American Indian Religious Freedom Act
AMIP	Adaptive Management Implementation Plan
ARPA	Archaeological Resources Protection Act
ATR	Agency Technical Review
BA	Biological Assessment
BiOp	Biological Opinion
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
CE	cost-effectiveness (analysis)
CE-QUAL-W2	No specific acronym for water quality model version developed by the Corps of Engineers
Corps	U.S. Army Corps of Engineers
CSRA	cost and schedule risk analysis
DDT	dichlorodiphenyltrichloroethane
EC	Engineer Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ER	Engineer Regulation
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FWCA	Fish and Wildlife Coordination Act
GIS	Geographic Information System
HMU	Habitat Management Unit
HQ	headquarters
ICA	incremental cost analysis
MASS1	Modular Aquatic Simulation System 1D
MCACES	Micro-Computer Aided Cost Estimating System
MOA	Memorandum of Agreement
MSC	Major Subordinate Command
NAGPRA	Native American Graves Protection and Repatriation Act
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NHPA	National Historic Preservation Act
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries Service
NMFS	National Marine Fisheries Service (now NOAA Fisheries)
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NWD	Northwestern Division
PCX	Planning Center of Expertise
PDT	Project Delivery Team
PIT	passive integrated transponder
RBM-10	River Basin Model – Region 10
Reclamation	Bureau of Reclamation
RED	Regional Economic Development
RIOG	Regional Implementation Oversight Group
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SOR	System Operation Review
SOS	System Operating Strategies
TEQ	toxic equivalent
USFS	USDA Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQRRS	Water Quality for River-Reservoir Systems

1.0 PROJECT STUDY PLAN PURPOSE

The purpose of this Plan of Study is to define how a Lower Snake River Fish Passage Improvement/Dam Breaching Feasibility Study (Feasibility Study) will be managed and conducted, should such a study be initiated in accordance with provisions set forth in the Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) Adaptive Management Implementation Plan (AMIP). The Feasibility Study would address breaching of four Federal dams on the lower Snake River that are operated by the U.S. Army Corps of Engineers (Corps). Breaching these dams has been considered as a potential action to address the problem of declining salmon and steelhead populations in the Snake River Basin. The Obama Administration views dam breaching as a "contingency of last resort," although it recognizes the need for a contingency measure to be ready for implementation. Consequently, the Corps is preparing a plan for a science-driven study on breaching that would be initiated if the status of Snake River salmonid species declined to the level of a pre-defined biological "trigger."

This Plan of Study documents assumptions and defines the scope, work tasks, products, responsibilities, and the level of detail necessary to prepare a feasibility study. The Feasibility Study would formulate a range of alternatives, assess their effects, and present a clear decision process and rationale for selection of a final recommended plan. This Plan of Study also presents a baseline cost estimate for the Feasibility Study. In short, the Plan of Study will be the road map used to guide the Feasibility Study.

2.0 BACKGROUND

2.1 Introduction

The Columbia River is the second largest river, by volume, in the United States. From its source in British Columbia, the river flows 1,270 miles through four mountain ranges and drains an area of 258,000 square miles (Mighetto and Ebel 1994). As the largest tributary of the Columbia, the Snake River is itself one of the country's major rivers. The Snake River flows 1,670 miles from its headwaters in Wyoming and drains an area of 109,000 square miles (more than 40 percent of the Columbia River Basin) in Idaho, Wyoming, Utah, Nevada, Washington, and Oregon.

Fish resources, specifically Pacific salmon and steelhead, are one of the most prominent features of the Columbia River Basin. These fish are termed "anadromous" because they hatch in freshwater, migrate to the ocean where they mature, and then return to freshwater to spawn. The region was historically home to five species of salmon and the anadromous form of rainbow trout known as steelhead. Another defining feature of the Columbia River Basin has been the extensive development of dams and related facilities to provide hydroelectric power, flood control, navigation, irrigation and domestic water supply, and other human uses of the basin's water resources.

The decline of salmon and steelhead populations in the Pacific Northwest is a well documented and complex problem. Scientists in the region have long been evaluating a variety of interrelated factors that have contributed to a general reduction of wild salmon and steelhead runs in the Columbia-Snake River Basin over the past several decades. These factors include overharvest; habitat loss and degradation in rivers, tributaries, lakes, and estuaries; competition and other dangers posed by hatchery fish; altered habitat and related challenges posed by dams and reservoirs; and other human-related causes such as timber harvest, farming, industrial facilities, and urbanization.

2.1.1 History of the FCRPS and the Endangered Species Act

Responding to concerns about reduced run size, in 1990 the National Marine Fisheries Service (NMFS) initiated a status review under the Endangered Species Act (ESA) of sockeye salmon in the Salmon River Basin of Idaho, and in 1991 the agency listed the Snake River sockeye salmon as an endangered species under the ESA. (The NMFS is a division of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration [NOAA]. Based on current terminology, the agency is identified as the NOAA Fisheries Service or NOAA Fisheries throughout the remainder of this document.) In 1992, Snake River spring/summer Chinook and Snake River fall Chinook salmon were listed under the ESA, and lower Snake River steelhead were also listed in 1997. By 1999, another nine anadromous fish stocks throughout the Columbia-Snake River Basin were listed under the ESA (Corps 2002).

Snake River ESU	ESA Listing Status	ESA Critical Habitat
Spring/summer Chinook salmon	Listed as threatened on June 28, 2005	Critical habitat designated on October 25, 1999
Fall Chinook salmon	Listed as threatened on June 28, 2005	Critical habitat designated on December 28, 1993
Steelhead	Listed as threatened on January 5, 2006	Critical habitat designated on September 2, 2005
Sockeye salmon	Listed as endangered on June 28, 2005	Critical habitat designated on December 28, 1993

Snake River anadromous salmonids as currently listed under the Endangered Species Act

The operation of 14 Federal hydroelectric dams on the Columbia and Snake rivers, referred to as the FCRPS, affects 13 stocks of Columbia River Basin salmon and steelhead protected under the ESA. The agencies that operate the FCRPS (the Action Agencies) must ensure that their actions are not likely to jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of habitat designated as critical to its conservation. The three FCRPS Action Agencies are the Corps, the Bureau of Reclamation (Reclamation), and the Bonneville Power Administration (BPA). Under the ESA, the Action Agencies must formally consult with NOAA Fisheries on actions that may adversely affect a listed species of anadromous fish or its critical habitat. The product of this consultation is a BiOp.

Following the first Columbia-Snake River salmon listings, NOAA Fisheries issued several BiOps regarding operation of the FCRPS from 1992 through 1994, each time finding that the proposed operations provided no jeopardy to the continued existence of the listed species. NOAA Fisheries re-evaluated the 1994 BiOp in response to litigation and new information, replacing it with a 1995 BiOp. The new document concluded that operation of the FCRPS as proposed would jeopardize Snake River salmon, and therefore included a "reasonable and prudent alternative" for FCRPS operation that would avoid jeopardy. The 1995 BiOp generally marked the start of a move toward significant changes in the operation and configuration of the hydro system to improve conditions for the listed species.

In 2000, NOAA Fisheries issued a new FCRPS BiOp, which built on the previous opinion and addressed 12 salmon and steelhead species that were listed by that time. The 2000 BiOp was challenged in U.S. District court and remanded to NOAA Fisheries for resolution. In response to this remand, NOAA Fisheries issued a revised FCRPS BiOp in 2004. In October 2005, U.S. District Court Judge James Redden found the 2004 FCRPS BiOp invalid and remanded it to NOAA Fisheries. The Court directed NOAA Fisheries to collaborate with the sovereign entities participating in the BiOp litigation (the Action Agencies, the four Northwest states, and regional tribal governments) to develop a new BiOp. The Action Agencies have been working collaboratively with NOAA Fisheries and the other sovereign parties since November 2005 in response to the Court's remand order.

The Action Agencies prepared a new Biological Assessment (BA) for the FCRPS operation and submitted it to NOAA Fisheries on August 21, 2007, for consultation. The Action Agencies submitted this BA to NOAA Fisheries on August 21, 2007,

for evaluation and consultation. Based on the BA, NOAA Fisheries released a draft FCRPS BiOp and Supplemental Comprehensive Analysis on October 31, 2007. Following evaluation of extensive comments on these drafts, NOAA Fisheries issued a revised BiOp for the FCRPS on May 5, 2008 (2008 BiOp). Several environmental groups, the State of Oregon, and the Nez Perce Tribe challenged the adequacy of the 2008 BiOp and a decision is pending.

2.1.2 Context for the Plan of Study

In April 2009, Judge Redden agreed with the proposal for the Obama Administration to review the new BiOp. Administration officials found the BiOp to be scientifically sound, but to ensure additional safeguards were in place, the Adaptive Management Implementation Plan was developed using the BiOp's adaptive management framework. The AMIP contains a number of actions and measures that could be implemented if unanticipated changes occur that affect salmon recovery. Among the potential Long-term Contingency Actions identified in the AMIP is a study to examine the short- and long-term risks and benefits of breaching four dams, collectively called the Lower Snake River Project, on the 140-mile-long lower Snake River reach between Lewiston, Idaho, and the Tri-Cities in Washington. The four Lower Snake River Project facilities are: Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam.

In the AMIP, the Corps is to prepare a Plan of Study for the evaluation of breaching the Lower Snake River dams. Breaching of the four lower Snake River dams has been considered as a potential action to improve the status of the four ESA-listed salmon and steelhead populations in the Snake River Basin. Dam breaching, as described in the 2002 Lower Snake River Juvenile Salmon Migration Feasibility Study (referred to hereafter as the 2002 Feasibility Study), would involve removing the earthen embankment section and eliminating the reservoirs at each dam to create a 140-mile stretch of river with near-natural flow. The powerhouses, spillways, and navigation locks would not be removed, but they would no longer be functional. All facilities for hydropower operation, commercial and large recreational vessel navigation, and transportation of fish around the dams would cease operation.

While the Administration views dam breaching as a "contingency of last resort," it recognizes the need for the contingency measures to be ready for implementation. Consequently, the Administration asked the Corps to prepare a plan for a science-driven study on breaching that would be initiated if the biological status of Snake River salmonid species reached a pre-defined Significant Decline Trigger (see Section 2.3 for more information).

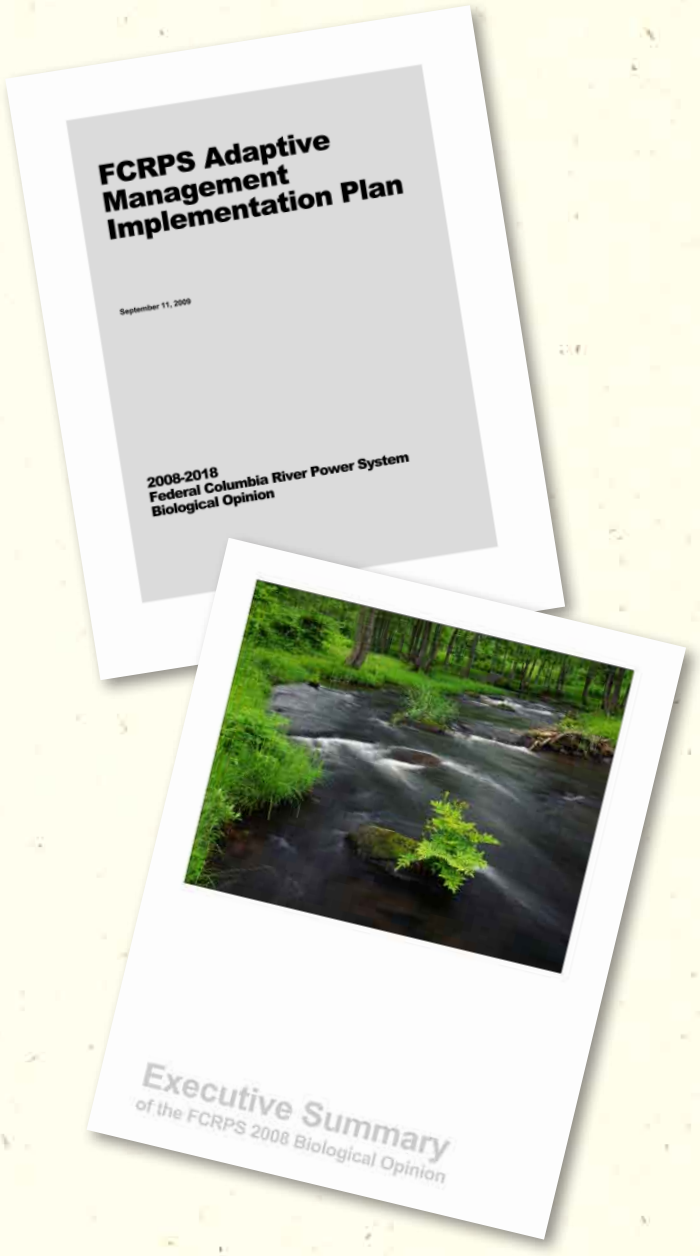
The following subsections provide additional discussion of NOAA Fisheries' 2008 BiOp, the Obama Administration's review of the 2008 BiOp, the Corps' role in salmon recovery, and other key studies that are closely related to the Lower Snake River Project and the activities addressed in this Plan of Study.

2.2 NOAA Fisheries' 2008 Biological Opinion

NOAA Fisheries released a final BiOp and Reasonable and Prudent Alternative (RPA) for the operation of the FCRPS for salmon and steelhead listed under the ESA on May 5, 2008. In August 2008, the regional executives of the Action Agencies signed Records of Decision to implement the BiOp and RPA. In preparing the final BiOp, NOAA Fisheries substantially strengthened the provisions of an earlier draft issued on October 31, 2007. In addition to enhancing an important section on the effects of climate change on listed Columbia River fish, NOAA Fisheries also:

- Identified new, higher performance standards for survival of juvenile fish through the dams
- Defined hydropower system spill and operations better timed relative to the needs of individual species
- Expanded the habitat program
- Expanded the predation-management program
- Set specific commitments and timetables for site-specific hatchery consultations and reforms

The BiOp is the result of NOAA Fisheries' consultation with the Action Agencies, an evaluation of the BA documents they prepared, and a determination on whether their actions pose jeopardy for listed species



or their habitat. The Action Agencies reached the conclusion that operation of the FCRPS, without mitigation, would jeopardize listed species. As a result, in the BA, the Action Agencies presented NOAA Fisheries not only with proposed operations, but also with a package of additional measures designed to benefit listed species. NOAA Fisheries included the additional mitigation proposed by the Action Agencies in its analysis, as well as other mitigation measures NOAA Fisheries believed to be needed to avoid jeopardizing the listed species. This RPA for the FCRPS operations contains 73 detailed mitigation actions that are required to avoid jeopardy and adverse modification of critical habitat. With implementation of the actions in the RPA, NOAA Fisheries determined, based on the best available scientific information, that

the FCRPS operations will avoid jeopardy and adverse modifications of critical habitat.

The RPA takes a comprehensive approach to ESA protection that includes hydropower, habitat, hatchery, harvest, and predation measures to address the biological needs of salmon and steelhead in every life stage. It is based on a comprehensive analysis of the salmon life-cycle and outlines planned improvements to the hydropower system to boost both juvenile passage survival and adult returns. These actions include water management operations, dam modifications, spill, juvenile transportation, and other activities. In addition, the RPA requires mitigation actions for the benefit of all ESA-protected salmonid species adversely affected by the FCRPS, including projects to improve tributary and estuarine salmon and steelhead habitat, to reduce fish and bird predation, and to use hatcheries to help protect wild stocks. These actions are supported by ongoing research, monitoring, and evaluation about the status of the listed species and the effects of the RPA on them. The Action Agencies and NOAA Fisheries are responsible for managing the RPA actions through 2018 to incorporate the best available science, and to adapt to the current status of listed salmonids.

To gauge the effectiveness of its recommended actions and to explore areas of scientific and biological uncertainty, the RPA includes a strong adaptive management and monitoring program. This program will allow the Action Agencies to assess whether RPA implementation is on track, and it will signal potential problems early. Specific contingency actions are identified within an adaptive management framework, such as hydro project improvements and tributary and estuary habitat actions. Additionally, the RPA includes implementation planning, annual reporting, and comprehensive evaluations to provide any needed adjustments within the 10-year FCRPS BiOp time frame.

The Action Agencies report on their progress annually, to better adapt their efforts based on new information and the results of monitoring and evaluation. This

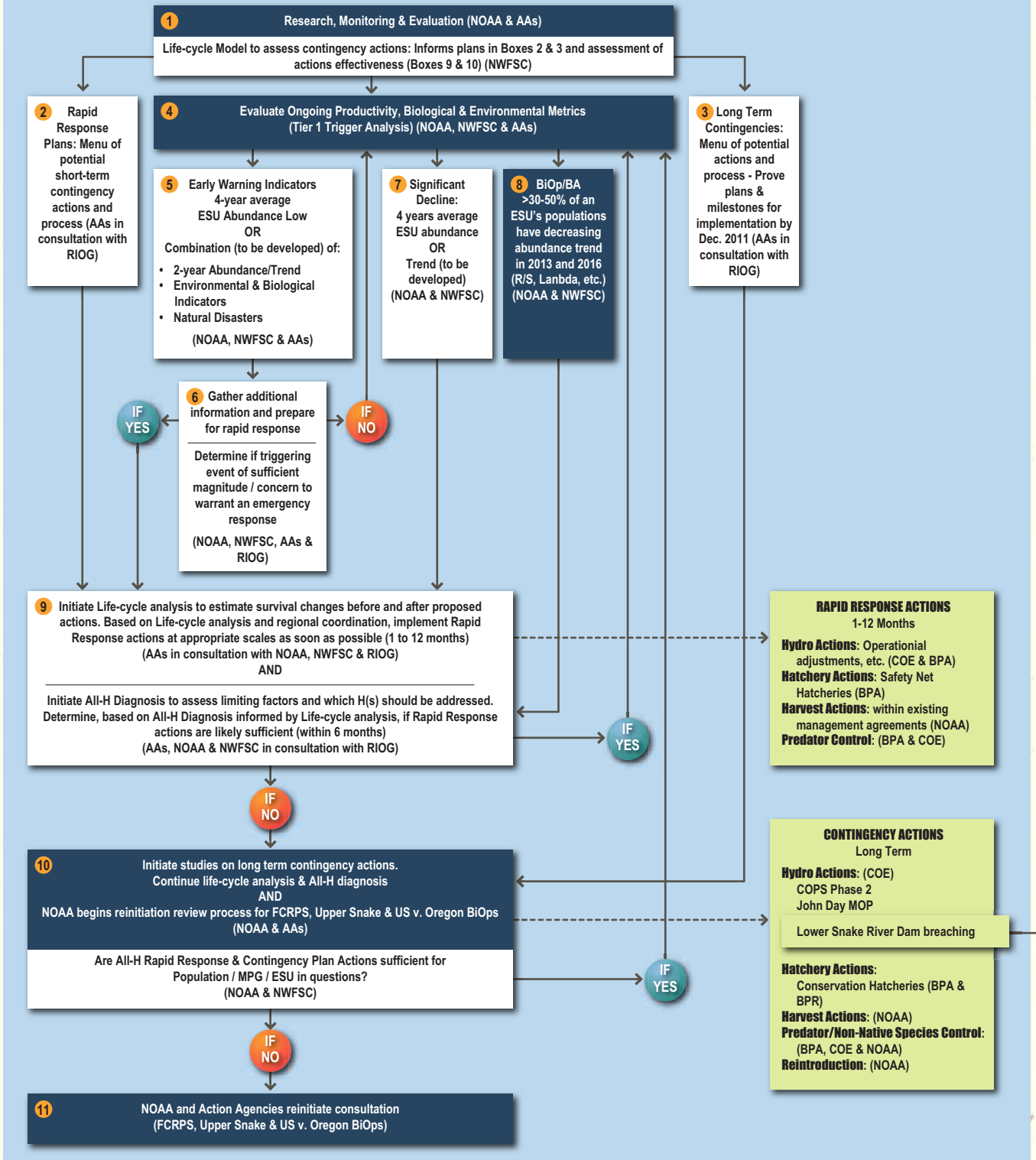
approach to adaptive management augments the specific RPA actions to adjust to new or changing information or conditions. It provides a specific means to modify actions to address unanticipated adverse effects on listed fish. These efforts will be coordinated with states and tribes through ongoing collaboration. The Action Agencies have negotiated Memoranda of Agreement (MOAs) with various regional Indian tribes and states that support and advance the RPA and its implementation.

2.3 Obama Administration Review of 2008 Biological Opinion

The 2008 BiOp and RPA have received intense scrutiny as a consequence of ongoing court challenges and the change of Federal administrations. The Court presiding over the litigation challenging the adequacy of the 2008 BiOp allowed the new administration of President Obama time to fully understand the 2008 BiOp and RPA. The Obama Administration conducted a thorough review of the 2008 BiOp and RPA, the science on which they are based, their adaptive management approach, issues raised by litigants, and U.S. District Court Judge James A. Redden's perspectives in his May 18, 2009 letter. The process included listening to the views of the parties to the litigation, as well as those of agency and independent scientists. This review identified several issues associated with implementation of the RPA and the Action Agencies' ability to respond to a significant decline in the status of listed fish.

The Obama Administration determined that the science underlying the BiOp is fundamentally sound. Because there are uncertainties in some predictions regarding the future condition of the listed species, however, the AMIP for the BiOp was developed as an "insurance policy for the fish." The AMIP includes a series of contingency measures to be implemented in case of a significant decline in fish abundance. This plan improves on efforts to track and detect climate change and its effects on listed species and other uncertainties that could emerge over the 10-year life of the BiOp.

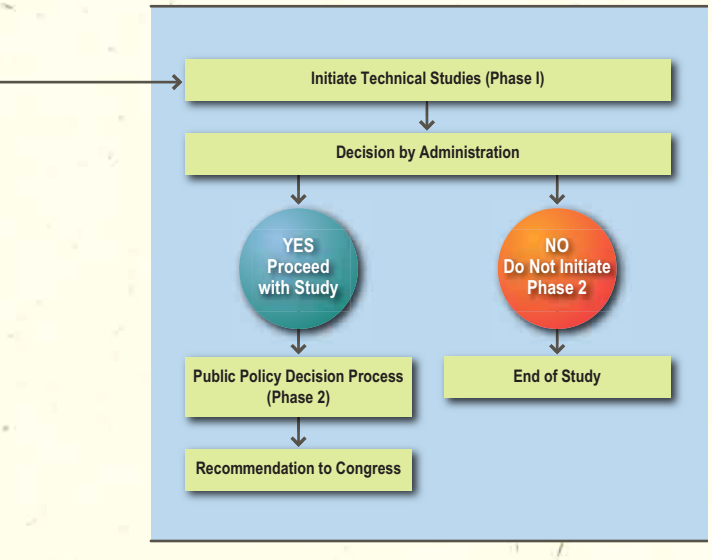
Adaptive Management Plan & Contingency Process



The Administration concluded that, as implemented through the AMIP, the 2008 BiOp is biologically and legally sound, is based on the best available scientific information, and satisfies the ESA jeopardy standard. The AMIP was submitted to the U.S. District Court of Oregon on September 15, 2009.

Highlights of the AMIP include:

- **Accelerated and Enhanced Actions** to protect the species, including additional estuary habitat actions, efforts to control predators and invasive species, and changes to spring and summer spill at the dams.
- **Regional Collaboration and Independent Scientific Review** to continue partnerships with states and tribes for ongoing scientific input and reporting on implementation progress.
- **Enhanced Research and Monitoring** to improve the certainty of the information needed for decision making. Improvements include:
  - Expanding adult status and trend monitoring to better understand fish populations
  - Expanding Intensively Monitored Watersheds to monitor the effects of climate change
  - Developing a new life-cycle model to evaluate contingency actions
  - Enhancing research on predators, invasive species, and potential reintroduction
- **Specific Biological Triggers for Contingencies**, which are linked to declining abundance of listed fish at odds with BiOp expectations. The triggers, if tripped, would activate rapid-response or long-term actions to address significant declines in the abundance of naturally produced salmon and steelhead. An Early Warning Indicator will focus attention on possible problems to come, and may result in implementation of Rapid Response contingency actions, if deemed necessary. A Significant Decline Trigger will result in implementation of Rapid Response contingency actions.
- **Short-Term (Rapid Response) and Long-Term Contingency Actions** to improve fish survival, including additional hydropower operations, increased predator controls, certain harvest controls, and safety-net hatcheries. Long-Term Contingency Actions are measures taken across "All Hs" (habitat, harvest, hatcheries, and hydropower), including lower Snake River dam breaching as a contingency of last resort.



The AMIP uses the adaptive management provisions of the RPA to develop and implement contingency actions if the biological indicators for listed fish populations reach pre-defined warning levels. The Action Agencies and NOAA Fisheries will use enhanced salmonid data and analytic tools to evaluate the status of each Evolutionarily Significant Unit or Distinct Population Segment, and to inform the choice of necessary actions in the case of a significant decline in any of the listed species populations. Contingency Actions will be implemented as soon as practicable to benefit the status of listed salmon and steelhead.

A science-driven study of lower Snake River dam breaching is included in the AMIP as a potential Long-Term Contingency Action. Breaching would be recommended to Congress only when the best available scientific information indicates it would be effective and is necessary to avoid jeopardizing the continued existence of the affected Snake River species. A study of lower Snake River dam breaching would have to consider the short-term, long-term, and cumulative effects of such action, the Federal government's Treaty and Trust responsibilities to

FCRPS BiOp Adaptive Management Implementation Plan
Significant Decline Trigger for Chinook Salmon and Steelhead

"**The purpose of the Significant Decline Trigger is to check each year for a significant decline in the natural abundance of species. A significant decline is judged to occur when:**

> **the running four-year mean of natural-origin adult abundance falls below a 10% likelihood of occurrence based on historical data (generally since 1978-80 and ending with the most recent year available, depending on species)**

The principle underlying the Significant Decline Trigger is that the observed condition would be a significant deviation from the biological expectations in the 2008 BiOp. If it were to persist despite the AMIP's short- and long-term contingency actions, it could call into question the BiOp's No Jeopardy conclusion for one or more species, resulting in the reinitiation of consultation."

AMIP, p. 31

Indian Tribes, and compliance with other statutory and regulatory requirements.

Breaching of the lower Snake River dams would be studied as a contingency of last resort because the status of the Snake River species has been improving and the 2008 BiOp analysis concluded that dam breaching is not necessary to avoid jeopardy to the listed species. In addition, breaching lower Snake River dams would have significant effects on local communities, the broader region, and the environment. It would require a major investment of resources and time; therefore, the decision to seek congressional authority for dam breaching must be driven by the "best available scientific information."

The Administration's review of the 2008 BiOp noted uncertainty about the short-term negative biological effects of lower Snake River dam breaching, such as effects caused by sediment and contaminants, that could compromise the long-term benefits expected from breaching. These and other uncertainties would need to be better understood if a biological trigger is tripped for a Snake River species. The Federal agencies also recognize that there may be conditions, such as global climate change and its potential effects on the life-cycle of salmon, which are not yet well understood.

2.4 Corps' Role in Salmon Recovery

The role of the Corps in salmon recovery derives from the agency's mission and the responsibilities assigned to it under a wide range of Federal laws. Nationally, the Corps' mission is to "provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risks from disasters." The Corps' program areas are broadly defined as civil works for water resources, coastal protection, environmental protection and restoration, flood protection, and hydropower. With respect to the Pacific Northwest, Corps involvement in salmon recovery has occurred primarily through the agency's responsibility for planning, engineering, constructing, and operating water resources projects for a variety of legally authorized purposes. Project purposes typically include navigation, flood control, hydroelectric power generation, recreation, and natural resources management. In addition to activity associated with

Primary Corps of Engineers Functions in Columbia-Snake River Salmon Recovery

1. Operate Corps dams and reservoirs to minimize adverse effects on adult and juvenile fish passage
2. Operate the juvenile fish transportation program
3. Construct and operate improved facilities for fish passage (e.g., surface bypass facilities, spillway weirs)
4. Provide technical and engineering expertise related to hydro system structures and operations

its civil works responsibilities, the Corps has been involved in salmon recovery through its regulatory functions for waters and wetlands, and through its expertise and continuing authorities related to environmental restoration and watershed management.

2.4.1 Hydrosystem Development and Operation

The Corps' involvement with development of the FCRPS effectively began with a comprehensive study of potential water resource development on the Columbia River that Congress requested under the Rivers and Harbors Act of 1927 (Mighetto and Ebel 1994). This report, published as House of Representatives Document 308 and generally known as the Columbia River 308 Report, established a comprehensive plan for a system of multi-purpose dams on the river system. Construction of Bonneville Dam was authorized in 1933 under provisions of the National Industrial Recovery Act, followed soon by construction of Grand Coulee Dam. Congress subsequently authorized McNary Dam on the Columbia and the Lower Snake River Project under the Rivers and Harbors Act of 1945, and The Dalles and John Day Dams under the Rivers and Harbors Act of 1950.

The four lower Snake River dams were constructed with facilities designed to aid the migration of both juvenile and adult fish. Since their construction, the Corps has continued to investigate and adopt new technologies for maximizing the number of fish that safely pass the dams in both directions. Successful features at the lower Snake River dams include adult fish ladders, juvenile bypass systems, and the fish transportation program.

When the lower Snake River dams were built in the 1960s and early 1970s, scientists and engineers had a good understanding of what features adult fish needed to pass upstream to spawn. So, as part of the initial construction, fish ladders were installed to assist passage of adult fish returning from the Pacific Ocean to spawn. Fish ladders and devices to attract fish to the entrances of the ladders are the primary aid to their passing the dams. Improvements to these ladders have been made at all four dams. Since 1996, the cumulative survival for adult salmon through all four

lower Snake River dams and reservoirs ranges from 92 to 98 percent. The survival rate through each dam and reservoir is 96 to 100 percent.

For juvenile fish traveling downriver, the dams and reservoirs present a more complex set of challenges. In the reservoirs near the dams, where the water is deep and slow, fish move more slowly than they do upstream. Slower-moving water exposes juvenile fish to resident fish predators for a longer time.

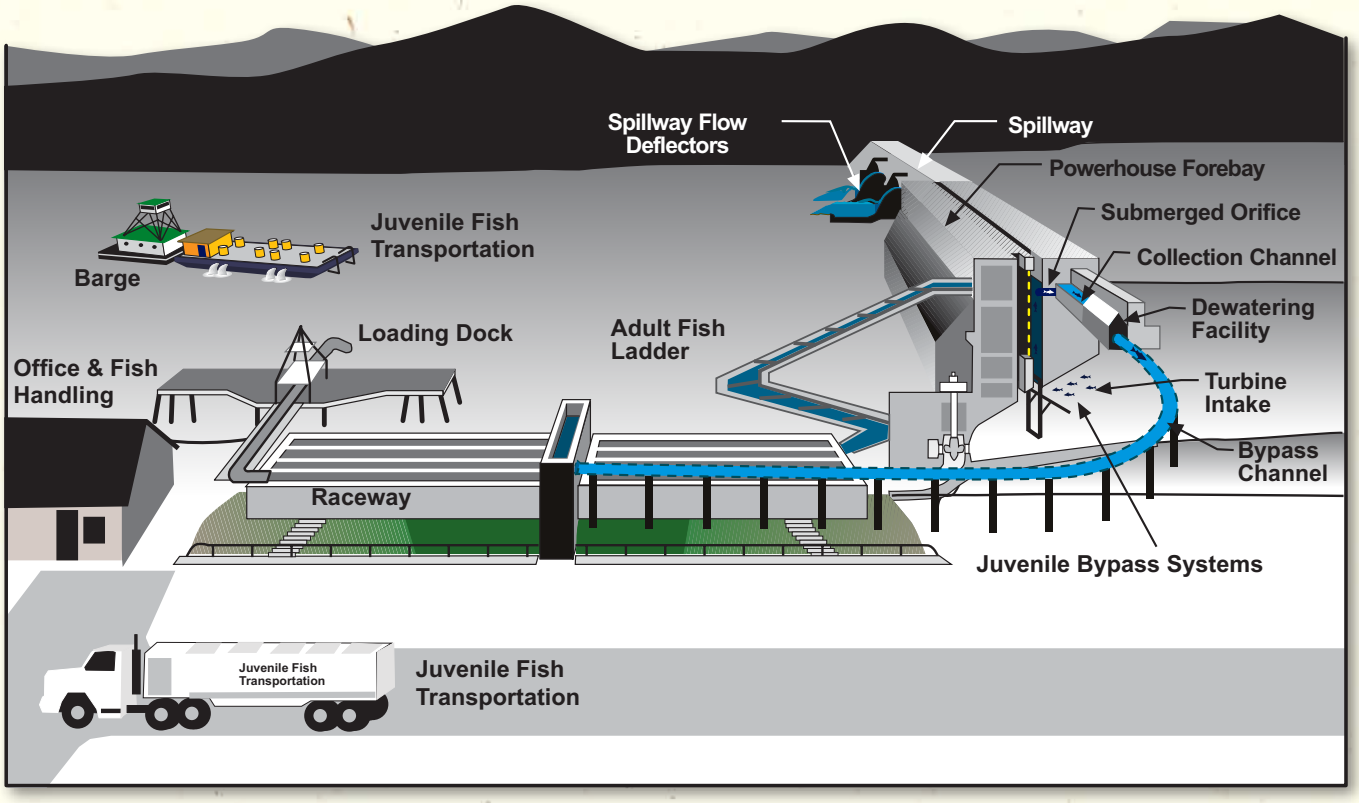
When juvenile fish arrive at a dam, they can pass it in three ways: through the turbines, through the spillway, or through juvenile bypass systems. Turbine passage is often considered to be the least desirable juvenile passage route. In recent years, juvenile bypass systems, spill, and other passage improvements are used to divert the vast majority of migrating fish away from the turbines. In addition, at three of the four Snake River dams, juvenile transport is used to collect the fish from the juvenile bypass systems and transport them by barge or truck to below Bonneville Dam. The timing and conditions for the fish transportation program are determined based on research and adaptively managed on an annual basis. Survival rates for juvenile salmon transported to below Bonneville Dam currently exceed 95 percent.

For the fish migrating in-river (i.e., not transported) the average survival through a dam and reservoir on the lower Snake River for most stocks of juvenile salmon is in the 90-percent range. Cumulative survival for juvenile salmon through all four dams and reservoirs is over 80 percent. Cumulative survival for juvenile salmon through all eight dams on the Columbia River System ranges from 45 to 60 percent.

2.4.2 Hydropower and Fish Management

The Corps conducts its salmon recovery activities in coordination with a variety of other entities with

Fish Ladder



Existing Fish Passage System

responsibilities related to endangered species. The Corps is a member of the Federal Caucus, a group of nine Federal agencies operating in the Columbia River Basin that have natural resource responsibilities related to the ESA. A key responsibility of these agencies is coordination of activities related to the operation of the FCRPS. The Corps, BPA, and Reclamation are the three Federal Caucus agencies with direct responsibilities for operation of the hydropower system. NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) both have jurisdiction for multiple Columbia River Basin species listed under the ESA. Accordingly, NOAA Fisheries and the USFWS are responsible for consulting with other Federal agencies regarding the effects of their actions on listed species (as documented in the BiOps for operation of the Federal hydropower system) and for developing formal recovery plans to guide the recovery of the species under their jurisdiction. Four other agencies, the USDA Forest Service (USFS), Bureau of Land Management (BLM), U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS), are also members of the Federal Caucus as a result of their respective agency missions. While these agencies are not directly responsible for actions in the 2008 BiOp, they have jurisdiction and expertise related to resources that are important for the survival and recovery of listed Columbia Basin fish. As members of the Federal Caucus, the USFS, BLM, EPA, and USGS coordinate their ESA-related work with the Action Agencies, NOAA Fisheries, and the USFWS.

Numerous BiOps have guided the operation of the FCRPS since the first Columbia Basin fish stocks were listed, as discussed in Section 2.1.1. Through a coordinated set of hydropower management actions, the Action Agencies' goals are to enhance juvenile and adult fish survival, to achieve the performance standards set in the 2008 BiOp, and to provide benefits to resident fish. Several planning and coordination efforts help guide this process, as summarized below:

- An interagency Technical Management Team makes recommendations on FCRPS operations for ESA-listed salmon. Membership includes representation from the FCRPS Action Agencies, NOAA Fisheries, USFWS, and tribal and state fish managers. The

Corps chairs the Technical Management Team.

- Annual Water Management Plans describe how the Action Agencies will operate the FCRPS dams and reservoirs during a specific water year (from October 1 through September 30) consistent with the applicable NOAA Fisheries and USFWS BiOps, while also meeting non-BiOp operations such as flood control, hydropower, irrigation, navigation, and recreation.
- Fish Passage Plans are developed by the Corps in coordination with the region's fish managers and BPA. The Fish Passage Plan describes year-round project operational procedures, maintenance, and research at the Corps-operated dams on the Columbia River mainstem and the Snake River to protect and enhance ESA-listed fish.
- Fish Operations Plans are prepared annually by the Corps to describe spill, transport, and flow management for the mainstem Snake and Columbia River projects during the April through August fish migration season.

The Corps and the other Federal Action Agencies also fund and carry out a wide range of actions to help listed fish at all stages of their life-cycle. An approach that focuses solely on hydropower operations, and their effects on upstream and downstream migrations, will not recover the species. Many other factors such as harvest, hatcheries, habitat, and ocean conditions that affect salmon must be addressed. Consequently, salmon recovery planning has followed a comprehensive "All Hs" (hydro, habitat, hatcheries, and harvest) program to address the needs of fish throughout their life-cycle. Consistent with this approach, the FCRPS BiOp considers habitat restoration, improved hatchery practices, and harvest management in addition to improved river conditions and better survival past the dams.

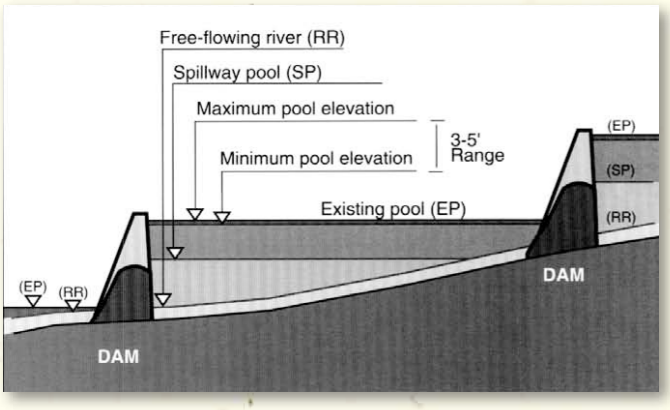
2.5 Other Related Studies

Since the initial salmon listings, the Corps has led or participated in a variety of studies that addressed the

lower Snake River dams or the entire FCRPS and their relation to fish and other natural resources. Four of these studies have particularly direct relevance to the Plan of Study and are summarized below.

2.5.1 Snake River Drawdown Test

As part of its 1992 Operation Plan, the Corps conducted a test drawdown at the Lower Granite and Little Goose Dams on the lower Snake River. The objective for a drawdown is to increase river velocities to more closely resemble natural migration conditions for juvenile fish. The 1992 test was intended primarily to determine the physical (as opposed to biological) effects of a partial drawdown, and it was scheduled to occur when few anadromous fish were present in the river. In March 1992, the Corps drafted the reservoirs behind Lower Granite Dam 36 feet and Little Goose Dam 12.5 feet below the levels for which they were designed. The Corps also conducted nine spill tests during the drawdown to determine impacts to structures, gas supersaturation levels from spilling, and potential adult passage conditions at these lower



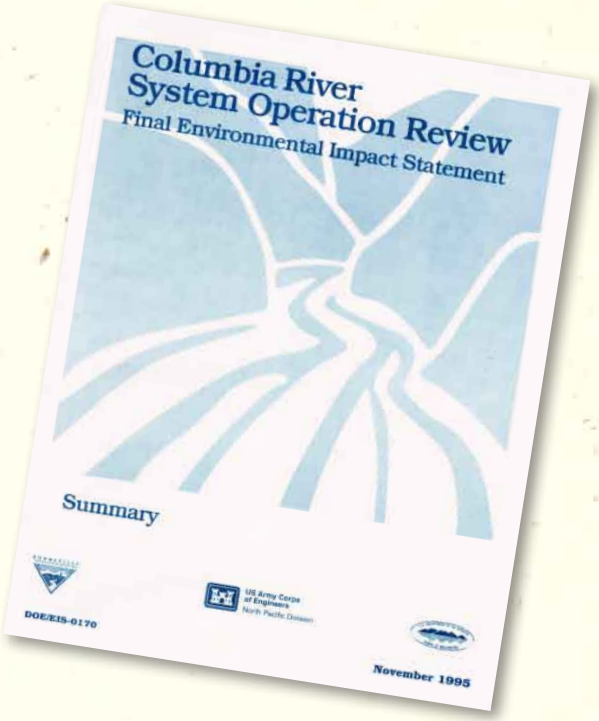
reservoir elevations. The 1993 Corps report (Corps 1993) on the drawdown experiment concluded:

- There was no major damage to dam facility structures, although some minor damage to the stilling basin at Lower Granite occurred.
- Turbines continued to operate safely, but their efficiency decreased (potentially indicating an increase in juvenile fish mortality); there was some vibration in the turbines.

- Water velocity measurements indicated that velocities increased substantially in the upstream end of the reservoir as it returned to a free-flowing river; however, drawdown effects on velocity were considerably reduced in the deeper water near the dam.
- There was an increase in dissolved gas supersaturation in the stilling basin (which may result in gas bubble trauma in fish) during spill. Dissolved gas levels as a result of spills ranged up to 135 percent, compared to a background level of 100 to 104 percent. The supersaturation level was related to total spill discharge.
- Some roads and railroad beds were damaged and embankment sloughs occurred in various areas along the reservoir.
- Many resident fish, clams, mussels, and crayfish were lost due to stranding from receding water elevations.
- The test stopped commercial barge traffic and caused some damage to floating docks.
- Use of recreation areas was affected by lack of water.
- Some cultural resources were exposed; these were mapped and documented during the test and precautions were taken to protect exposed artifacts.

2.5.2 System Operation Review

The Columbia River System Operation Review (SOR), a joint effort of the Corps, BPA, and Reclamation, was begun in 1990. The SOR started as a comprehensive study to review operations of the system of Federal water resource projects on the Columbia River and its tributaries in view of present and future needs of all users, and to develop a strategy for long-term system operation. The SOR included technical, social, economic, and environmental analysis of alternatives for operation of the FCRPS. The scope of the review included 14 major Federal projects on the Columbia River and its tributaries (12 operated by the Corps, 2 operated by Reclamation). With the ESA listings of



Snake River sockeye and Chinook stocks in 1991 and 1992, the SOR began to focus on the role that system operations could play in salmon recovery. The Draft Environmental Impact Statement (EIS) for SOR was issued in July 1994. It contained several System Operating Strategies (SOS), including alternatives identified as Pre-ESA Operation, Current Operations, Stable Storage Project Operation, Natural River Operation, Fixed Drawdown, and Federal Resource Agency Operations.

While the SOR agencies were finishing the Draft EIS in spring 1994, the U.S. District Court issued a ruling that the 1993 FCRPS BiOp had failed to meet the necessary legal standard. A key issue in this lawsuit was whether enough water in the Columbia River System had been dedicated to salmon recovery. Shortly after this ruling, the 9th Circuit Court of Appeals issued a ruling in another case, which said that the Northwest Power Planning Council had not given proper consideration to the recommendations of state resource agencies and tribes in preparing its Fish and Wildlife Program. Many people interpreted this decision to mean that state agency and tribal proposals should be given more weight in FCRPS operating decisions. It became

clear to the SOR co-lead agencies that the selected SOS would need to take these legal decisions into account. A new BiOp on hydropower system operations was issued in March 1995. Two additional court decisions issued in June 1995 recognized the 1995 BiOp as the guideline for operating the hydropower system in light of the ESA.

The Final SOR EIS evolved from these events and activities. It addressed a modified set of alternatives from the Draft EIS that included new SOSs identified as Optimum Load-Following Operation, 1994-98 BiOp, Permanent Natural River Operation, Lower Granite Drawdown Operation, Detailed Fishery Operating Plan, Adaptive Management, Balanced Impacts Operation, and the Preferred Alternative.

The Corps signed the SOR Record of Decision (ROD) selecting the Preferred Alternative in February 1997.

2.5.3 Lower Snake River Juvenile Salmon Migration Feasibility Study

As a result of the BiOp issued in 1995, the Corps conducted a comprehensive Feasibility Study to analyze the Lower Snake River Project's effects on four Snake River salmon and steelhead stocks listed for protection under the ESA. The Corps led this study, with support from BPA, Reclamation, and EPA as cooperating agencies. This effort produced a Final Feasibility Report/EIS in February 2002 (the 2002 Feasibility Study) analyzing four alternatives to improve juvenile salmon migration through the Lower Snake River Project: Alternative 1—Existing Conditions, Alternative 2—Maximum Transport of Juvenile Salmon, Alternative 3—Major System Improvements (Adaptive Migration), and Alternative 4—Dam Breaching.

Based on a comprehensive analysis of the best available biological, economic, social, environmental, and other related information, as well as sensitivity and trade-off analyses for each alternative, the Corps selected a modified version of Alternative 3—Major System Improvements (Adaptive Migration) as the recommended plan (Preferred Alternative) for improving juvenile salmon migration through the Lower Snake River Project. The recommended plan combined a series of structural and operational

Lower Snake River Juvenile Salmon Migration Feasibility Report/EIS - Alternatives Evaluated

Alternative 1	Existing Conditions
Alternative 2	Maximum Transport of Juvenile Salmon
Alternative 3	Major System Improvements (Adaptive Migration)
Alternative 4	Dam Breaching

measures intended to improve fish passage through the four lower Snake River dams. The evaluation concluded that this alternative provided the maximum operational flexibility for juvenile fish passage; it optimized in-river passage when river conditions are best for fish and optimized the transportation of juveniles around the dams by truck or barge when that operation is best for fish. The key factors supporting the selection of this alternative were:

- High current juvenile and adult salmon and steelhead survival rates through the Lower Snake River Project
- Maximum flexibility in optimizing both in-river migration conditions and transport conditions
- Lesser magnitude of uncertainty in current biological information
- Compatibility with NOAA Fisheries and USFWS 2000 BiOps
- Minimal economic impacts to users
- Minimal effects to other environmental resources

Other factors considered included effects associated with social and community resources, Native American Indians, technical feasibility, effectiveness of structural modifications, regional acceptability, public comments, and length of implementation. The Corps' selection of the recommended plan was consistent with recommendations for the Lower Snake River Project in the 2000 BiOp. This BiOp concluded that dam breaching on the lower Snake River was not necessary at the time, but reserved this action as a contingency management alternative if the listed stocks continued to decline in the near future (2005 to 2008) (Corps 2002).

2.5.4 Programmatic Sediment Management Plan

The Corps' Walla Walla District is preparing a

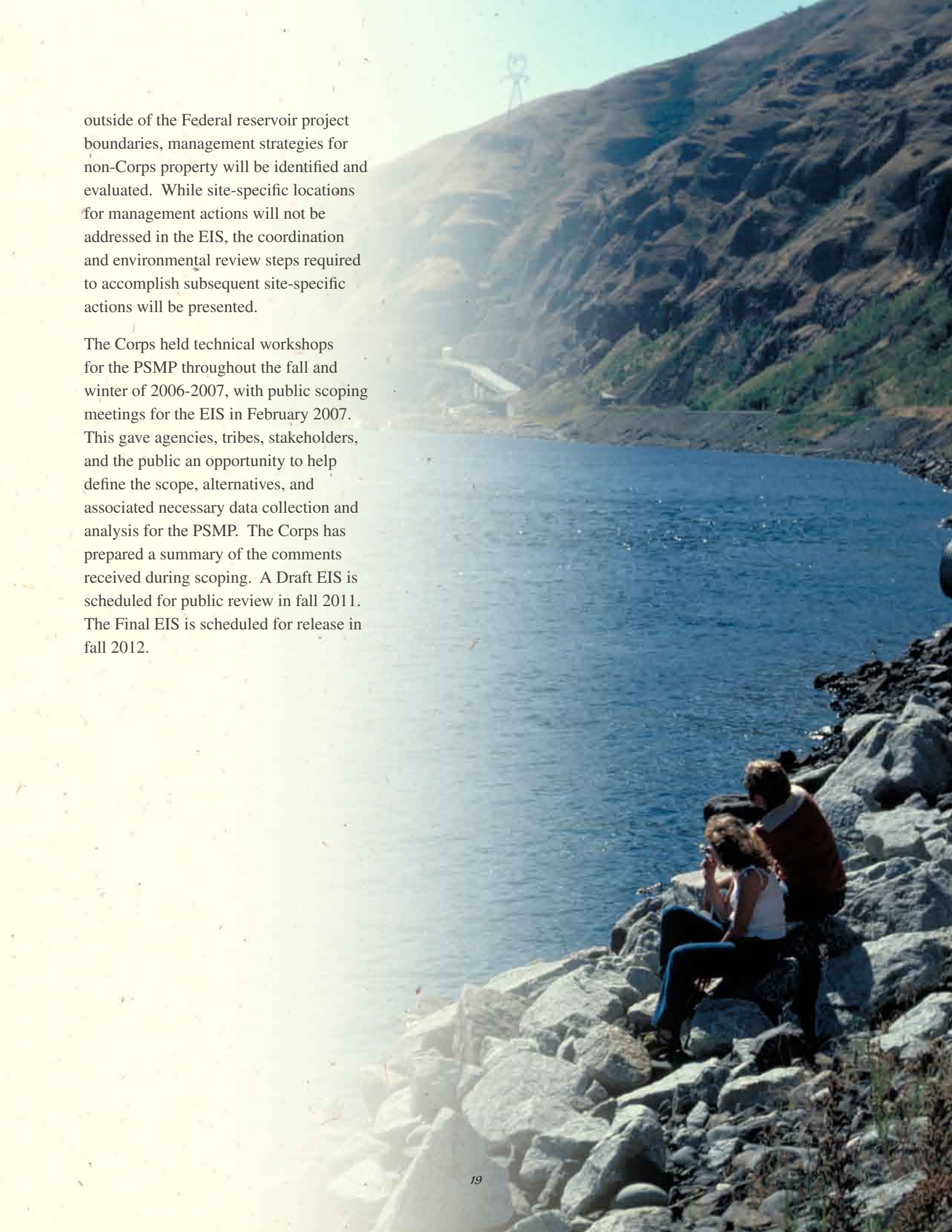
Programmatic Sediment Management Plan (PSMP) and EIS that will address sediment management within the four lower Snake River reservoirs and the portion of the McNary Reservoir contained within the lower Snake River. A Notice of Intent (NOI) for this effort was published in the Federal Register on October 5, 2005.

Sediment management in the lower Snake River has been an ongoing maintenance issue since the completion of Ice Harbor Dam. Sedimentation issues have been handled on a case-by-case basis to date, primarily through maintenance dredging activities; however, the Corps believes that this ongoing problem can best be handled by evaluating sediment management throughout the entire system, as well as on a watershed basis. The planned PSMP/EIS is identifying and evaluating ways to manage sediment within the lower Snake River reservoirs, and is examining the sources and transport of this sediment. This study will determine the most effective ways to reduce sediment build-up, manage sediment once it reaches the reservoirs, and identify possible changes to structures and/or operations to reduce maintenance needs, while still providing for all authorized purposes.

The PSMP study area extends from the mouth of the Snake River upstream to the communities of Lewiston, Idaho, and Clarkston, Washington. All tributaries that significantly contribute sediment to the lower Snake River will also be included in the study. Although the Corps does not have the authority to manage lands

outside of the Federal reservoir project boundaries, management strategies for non-Corps property will be identified and evaluated. While site-specific locations for management actions will not be addressed in the EIS, the coordination and environmental review steps required to accomplish subsequent site-specific actions will be presented.

The Corps held technical workshops for the PSMP throughout the fall and winter of 2006-2007, with public scoping meetings for the EIS in February 2007. This gave agencies, tribes, stakeholders, and the public an opportunity to help define the scope, alternatives, and associated necessary data collection and analysis for the PSMP. The Corps has prepared a summary of the comments received during scoping. A Draft EIS is scheduled for public review in fall 2011. The Final EIS is scheduled for release in fall 2012.



3.0 STUDY AUTHORITY

The four lower Snake River dams, collectively known as the Lower Snake River Project, were constructed, and continue to be operated, under congressional authority, including:

- Laws which initially authorized the construction of the project
- Laws specific to the dams passed subsequent to project construction
- Laws that generally apply to all Corps projects

Using these and other authorities, the Corps operates multiple-use water resources development projects. Authorized uses for the Lower Snake River Projects include:

- Hydropower generation (Public Law 79-14)
- Inland navigation (Public Law 79-14)
- Fish and wildlife (Public Law 85-624)
- Irrigation (Public Law 79-14)
- Recreation (Public Law 79-14)

The Corps does not currently have authority to breach the four Lower Snake River dams. However, the Corps has authority to carry out feasibility studies. This Feasibility Study would be conducted with consideration of applicable laws including ESA; the Pacific Northwest Electric Power Planning and Conservation Act; the Fish and Wildlife Coordination Act; Section 216 of the 1970 Flood Control Act; River and Harbor Act of 1945; Sections 103, 105, and 905 of the 1986 Water Resources Development Act; Water Supply Act; Federal Water Pollution Control Act; and the water resources appropriations bills passed by Congress in 1996, 1997, 1998, and 2007.

"On-the Shelf" Contingency Procedures and Actions

"With respect to lower Snake River dam breaching, a science driven study of dam breaching is included as a potential Long-term Contingency Action. By March 2010, the Corps will develop a study plan regarding the scope, schedule and budget for the technical studies that would be needed. Within six months of a Significant Decline Trigger being tripped for a Snake River species, the Corps would initiate those technical studies, if an All-H Diagnosis is completed that concludes dam breaching is necessary to address and alleviate the biological trigger conditions for the applicable Snake River species."

AMIP, p. 31

Trigger Scenarios

1. **Population decline trigger is tripped, and an "All-H" analysis indicates that breaching is necessary**
2. **Population decline trigger is tripped, and the "All-H" analysis is unclear about the benefits of dam breaching**
3. **Population decline trigger is tripped, and the "All-H" analysis is not completed within the required 6 months**

4.0 STUDY PURPOSE AND SCOPE

4.1 Purpose

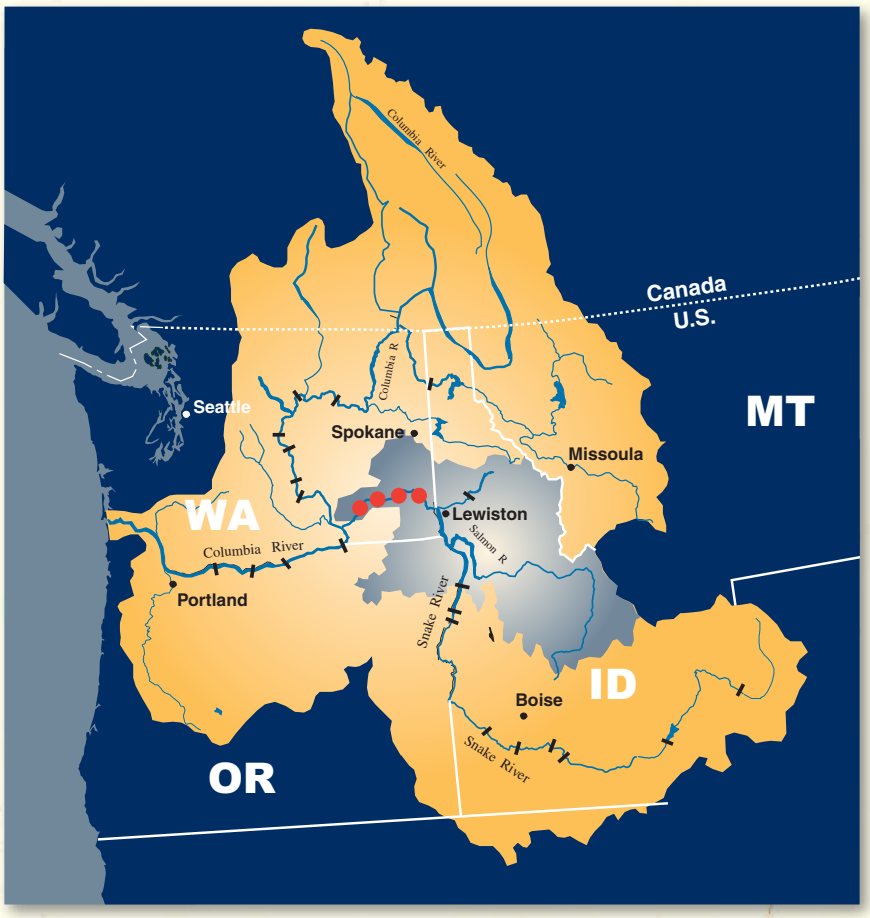
The purpose of the Feasibility Study is to support the Corps' efforts pursuant to the FCRPS BiOp AMIP. The intended Feasibility Study is to provide the basis for a sound, scientifically based decision regarding the risks and benefits of breaching the four lower Snake River dams to support salmon recovery. This decision would form the foundation for a recommendation to the U.S. Congress about the future of the lower Snake River dams.

As provided in the AMIP, the Feasibility Study would follow a two-phased approach. If the Significant Decline biological trigger were tripped for a Snake River species and the corresponding conditions for a dam breaching study were met, the Corps would initiate a 2-year technical study process as the first phase. The results of these studies would be used by salmon policy leaders at the national level to make a decision whether the Corps would move forward with an overall evaluation study and National Environmental Policy Act (NEPA) compliance process. The latter process would result in a decision whether to seek congressional authorization to undertake dam breaching.

4.2 Description of the Study Area and Facilities

The geographic area covered by this Plan of Study focuses on the 140-mile-long lower Snake River reach between Lewiston, Idaho, and the Tri-Cities (Pasco, Kennewick, and Richland), Washington.

The Snake River is the principal tributary to the Columbia River, draining approximately 109,000 square miles in Idaho, Wyoming, Utah, Nevada, Washington, and Oregon. The Corps owns and operates four locks and dams on the lower Snake River: Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam.



The Four Dams

Juvenile fish from the lower Snake River drainage system have to travel past as many as eight Federal dams before reaching the Pacific Ocean, four of which are on the mainstem Columbia River. The four Columbia River dams will be addressed in the Feasibility Study, where appropriate, because they are part of the FCRPS and the corridor that juvenile salmon travel between the lower Snake River projects and the ocean. Federal and private dams on the middle and upper Snake River may be considered for their cumulative impacts to the river system and the salmon life-cycle, but they will not be the specific focus of the Feasibility Study.

Ice Harbor Dam

Ice Harbor Dam, near river mile 10 (as measured from the Snake River's joining with the Columbia River), was placed in service in 1961. It is nearest to the point where the Snake River flows into the Columbia River. There are more than 4,000 acres of Corps-managed lands surrounding the dam and its reservoir, Lake Sacajawea. The reservoir extends 31.9 miles upstream. The dam has three 90-megawatt and three 110-megawatt generators, and a 90-foot-high, 86-foot-wide single-lift navigation lock. The spillway has 10 spillbays. Benefits are derived from the dam's hydroelectric power generation, seven developed recreation areas, navigation lock, wildlife habitat areas, irrigation water, fish passage facilities, and two port facilities.

Lower Monumental Dam

Lower Monumental Dam, near river mile 42, was placed in service in 1969. There are more than 9,100 acres of Corps-managed lands surrounding the dam and its reservoir, Lake Herbert G. West. The reservoir extends 28.7 miles upstream. The dam has six 135-megawatt generators and a 100-foot-high, 86-foot-wide single-lift navigation lock. The spillway has eight spillbays. Benefits are derived from the dam's hydroelectric power generation, six developed recreation areas, navigation lock, wildlife habitat areas, fish passage facilities, provision for irrigation water, and one port facility.

Little Goose Dam

Little Goose Dam, near river mile 70, was placed in service in 1970. There are more than 4,800 acres of Corps-managed lands surrounding the dam and its reservoir, Lake Bryan. The reservoir extends 37.2 miles upstream. The dam has six 135-megawatt generators and a 100-foot-high, 86-foot-wide single-lift navigation lock. The spillway has eight spillbays. Benefits are derived from the dam's hydroelectric power generation, seven developed recreation areas, navigation lock, wildlife habitat areas, fish passage facilities, three port facilities, and provision for irrigation water.

Lower Granite Dam

Lower Granite Dam, near river mile 107, was placed in service in 1975. Of the four dams, it is the farthest upstream. There are more than 9,200 acres of Corps-managed lands surrounding the dam and its reservoir, Lower Granite Lake. The reservoir extends 39.3 miles upstream. The dam has six 135-megawatt generators and a 100-foot-high, 86-foot-wide single-lift navigation lock. The spillway has eight spillbays. Benefits are derived from the dam's hydroelectric power generation, 13 developed recreation areas, navigation lock, wildlife habitat areas, fish passage facilities, water for six municipal and industrial pump stations, and three port facilities on Lower Granite Lake.

4.3 Types of Studies Required

The Feasibility Study would consist of a comprehensive analysis of the with- and without-project alternatives defined for the study. As discussed previously, the Feasibility Study would follow a two-phased approach in which technical studies designed to inform a decision on the viability of dam breaching would be conducted over an initial two-year period. If the results of the technical studies led the Administration to make a decision for the Corps to move forward with an overall evaluation study and NEPA documentation, a public decision process to achieve compliance with environmental and related laws would proceed to determine whether to seek congressional authority to implement dam breaching. The types of studies required to complete this comprehensive, two-phased analysis would include the following:

Phase 1: Technical Studies

- Biological Investigations. This work consists of qualitative and quantitative evaluations of the effects of dam removal on anadromous fisheries and other aquatic and terrestrial ecological resources. The study would determine the effectiveness of the alternatives in improving the survival of juvenile and adult salmon. To effectively evaluate biological investigations and forecast the outcome of potential alternatives, an Expanded Life-cycle Model will be developed by NOAA Fisheries. This model will be completed by December 2012, and will be used to evaluate proposed actions and alternatives. It will include emerging climate data; habitat and hatchery effects and monitoring; interactions among species; and short-term, transitional, and long-term effects of breaching on the lower Snake River dams. The Corps will collaborate with NOAA Fisheries to develop a dam breaching module for the model.
- Hydrologic Investigations. These tasks involve analyses of water quantity and quality conditions, river channel characteristics, and the generation and movement of sediment within the river system. One key area of uncertainty remaining from the 2002 Feasibility Study is the chemical characteristics of the river sediments. Extensive depositional areas have not been sampled; these areas represent sources of risk related to the toxicity to aquatic organisms and human health when the sediment becomes re-suspended in the water column. The Corps would use analytical laboratory methods, chemical kinetics, and hydro-dynamic modeling techniques, which have evolved since 2002, to predict the potential toxicity effects of breaching the four lower Snake River dams.
- Engineering Analysis. These tasks consist of engineering evaluations of construction needed to implement the various alternatives and associated mitigation measures, including the development of operational plans and security plans (where necessary), facility designs, cost estimates, implementation plans, and construction schedules. Dam safety and risk analyses would be included among the engineering studies.
- Economic Analysis. An economic analysis of the effects of construction and operation on hydropower, navigation, irrigation, commercial fishing, and recreation would be conducted. This analysis would focus on national economic effects, regional economic effects, environmental effects, and other social effects.

Phase 2: Public Policy Decision Process

- Environmental Compliance. Compliance with environmental laws (e.g., NEPA), ESA, Fish and Wildlife Coordination Act [FWCA], Clean Water Act) would be coordinated and documented.
- Cultural Resources. The effects of the construction and change in the hydrologic regime on known cultural resources would be evaluated, along with development of appropriate mitigation plans. Action plans for dealing with newly exposed cultural sites would be developed. All required coordination would be completed.

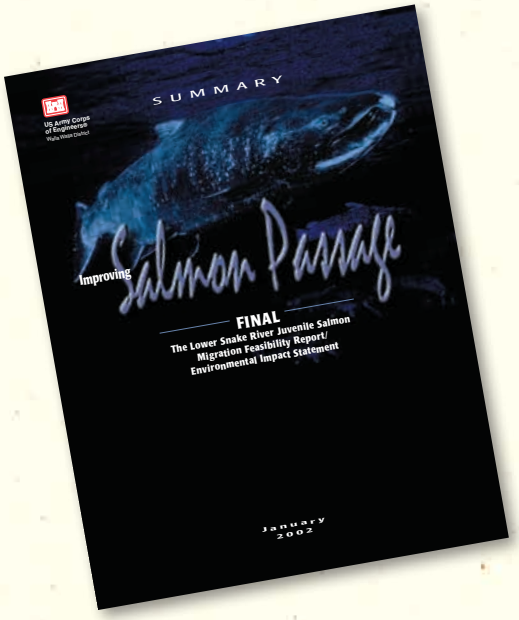
- Cost Effectiveness and Incremental Cost Analysis. A risk and uncertainty analysis would be the cornerstone of this Feasibility Study. The focus would be on uncertainty related to biological outputs or goals for dam breaching; however, other areas of risk and uncertainty would also be addressed (e.g., construction cost, hydrological and biological uncertainty).
- Institutional Studies. The Feasibility Study would investigate requirements for authorization for dam breaching and related legal issues.

4.4 Level of Detail

The Feasibility Study, if conducted, would present study methods, results, and findings, including a detailed analysis of the costs and benefits of the proposed alternatives. The Feasibility Study would document compliance with applicable laws, statutes, Executive Orders (EOs), and policies, and is intended to provide a sound basis for decision makers at all levels to understand the alternatives and reasons for the recommended action. The following section describes the purpose and process of a feasibility study.

5.0 FEASIBILITY STUDY PROCESS

The purpose of a feasibility study is to identify, evaluate, and recommend to decision makers an appropriate, coordinated, and implementable solution to the identified water resources problems and opportunities. The resulting report is a decision document that provides a complete presentation of study results and findings; indicates compliance with applicable statutes, EOs, and policies; and provides a sound and documented basis for decision makers at all levels to judge the recommended solutions.



5.1 Feasibility Study Assumptions

The Corps team has made the following assumptions in the preparation of this Plan of Study:

- The Feasibility Study would vary from the typical Corps process, because the study would be undertaken in accordance with the AMIP, which was developed by the Action Agencies as part of the 2008 FCRPS BiOp. There would be no reconnaissance study to determine Federal interest, and no non-Federal sponsor for this effort.
- The purpose of the Feasibility Study would be to analyze the costs and benefits of breaching the four lower Snake River dams, and it is considered a decision document. The outcome of the Feasibility Study would be a recommendation to Congress regarding the breaching of the four lower Snake River dams. Congress would ultimately decide what actions will be authorized regarding the four lower Snake River dams.
- This Plan of Study assumes compliance with the schedule set out in the AMIP. Technical studies for dam breaching are scheduled to take 2 years. At the end of 2 years, enough information would be available to recommend whether breaching will significantly contribute to recovery of salmon stocks and the Corps should proceed with the overall evaluation study and NEPA process.
- In some instances, the data gathering and analysis associated with a technical study may take more than 2 years, but less than 3 years. The Corps would notify the Action Agencies and other regional interests if it is anticipated that this action would have a significant effect on the Corps' ability to make a recommendation about further study.
- If at the end of Phase 1 (technical studies) it is determined that there is benefit to continuing with the study, NEPA and other environmental compliance actions (e.g., Coordination Act Report, Clean Water Act, ESA) would proceed. Public involvement is considered a major component of the NEPA process.
- The Corps completed a comprehensive evaluation of options for fish passage in the 2002 Lower Snake River Juvenile Salmon Migration Feasibility Report. Dam breaching was one of an array of alternatives evaluated in the 2002 study. The Lower Snake River Fish Passage Feasibility Study for Dam Breaching would build on the information gathered and analyzed in the 2002 Study. The new study would use the NOAA lifecycle model and focus on areas of uncertainty identified in the 2002 study, such as short and long term impacts of sediments and contaminants on fish, a power analysis, and embankment stability. NEPA work associated with the new study would build upon that completed in 2002.

- If the Feasibility Study is initiated, the Corps would approach alternative development and evaluation using increments, not necessarily with an "all or none" approach. Thus, if breaching is a recommended outcome, the analysis would examine the benefits of breaching one, two, three, or all four of the dams, as well as different methods of breaching. The Corps would use the best available science to support development of a plan for breaching, including lessons learned from other dam breach activities.
- The Corps team would draw upon existing information and previous efforts for the lower Snake River (the SOR, 2002 Feasibility Study, Snake River Drawdown Test, and PSMP) to identify data gaps in previous analyses. The Corps would pursue new data and technologies to formulate robust alternatives for dam breaching that would undergo rigorous technical review and public coordination.
- Completion of the Feasibility Study and NEPA requirements implies that a final plan has been identified, baseline cost estimates prepared, benefits quantified, environmental and economic impacts quantified, risk identified, mitigation measures identified, and legal and authority issues evaluated fully.
- Draft and final reports (Feasibility Study and NEPA documents) would be prepared by the Corps, with review by other Action Agencies, NOAA Fisheries, USFWS, Regional Implementation Oversight Group (RIOG), and the public. The final report would also be reviewed by the Corps' Northwestern Division Office (NWD), the Corps' Headquarters (HQ), Assistant Secretary of the Army for Civil Works, and the Office of Management and Budget; and then transmitted to Congress with a recommendation.
- Plan formulation would consider alternatives for breaching the four lower Snake River dams. Other measures addressing the four Hs, such as habitat improvements, harvest restrictions, and hatchery operation improvements, would not be addressed, because analyses of those alternatives would have already taken place.
- Data from a new life-cycle model, to be developed by NOAA Fisheries by December 2012, would be used to inform decisions. If the Feasibility Study were initiated prior to completion of the model, the Corps would use the best available science in analyzing impacts and benefits of each alternative.
- The implications of global climate change would be a key component of many analyses conducted for the Feasibility Study. The new life-cycle model used as the key tool in the analysis of effects on anadromous salmonids would include a module addressing the effects of climate change. Treatment of climate change in the Feasibility Study would be closely coordinated with

other ongoing regional studies related to climate change. The Feasibility Study would recognize that climate change is an area of substantial uncertainty.

- Cost estimates and work plans presented in this Plan of Study reflect 2010 dollar levels. It is unknown exactly when the Corps might undertake the Feasibility Study; therefore, budgets, schedules, and work plans would require updating and adjustment if, and when, the Feasibility Study is initiated.
- The Corps has mitigation requirements associated with the construction of the four lower Snake River Dams. Hatcheries, the Lower Snake River Fish and Wildlife Compensation Plan, and the Woody Riparian Initiative are programs that were put into place to address Corps mitigation requirements. In a dam breach scenario, the Corps would reevaluate the mitigation requirements with the State and Federal agencies and Tribes.
- Additional data and/or changes in the scientific knowledge of factors affecting fish may result in a change of scope. The scope may be adjusted to capture new scientific information.

5.2 Plan Formulation

Plan formulation is the process of identifying problems and developing alternatives that solve that problem. The Feasibility Study addressed here would be the result of the process described in the AMIP, with the objective of examining benefits and impacts to anadromous fish populations from breaching the four lower Snake River dams. The formulation would be narrower in scope than that in a traditional feasibility study. The Corps would use a cost effectiveness and incremental cost analysis to help rank and identify the least costly plan that meets the goals and objectives identified.

The plan formulation and feasibility study process practiced by the Corps includes seven steps that are summarized below, by phase of the study process.

Phase 1

Identify Specific Problems and Issues The scoping process helps planners identify and refine their understanding of the problems to be solved in order to identify appropriate goals and objectives for the Feasibility Study. This process involves reviewing existing information, including ongoing research efforts, and communicating and collaborating with stakeholders. Outreach may be conducted in a single or series of meetings for the specific purpose of identifying issues and gathering input and ideas for addressing the issues.

Develop Alternatives If triggered, the Corps' task would be to study dam breaching as a means of increasing salmon populations. This would limit development of alternatives to various increments and methods of breaching, as compared to a no-action alternative. Each alternative would be evaluated to determine the costs, benefits, and impacts of the proposed action.

Develop Evaluation Criteria Criteria under which alternatives would be evaluated and compared would be identified and established by the study team, made up of interdisciplinary Corps staff. Examples of the type of criteria to be developed include biological effectiveness, cost effectiveness, regional acceptability, other environmental effects, and risk and uncertainty. These criteria would be coordinated with the Corps' team, located in the district and division offices, and other regional interests.

Preliminary Screening The identified alternatives would be screened for completeness, effectiveness, efficiency, and acceptability. This initial screening would rely primarily on subjective examination of these criteria. The entire study team would participate in this screening process.

Trade-Off Analysis A trade-off analysis would be conducted to compare all of the alternatives that were selected to be carried forward after the preliminary screening. The information used in this trade-off analysis would come from existing information and interim engineering, economic, biological, and other technical evaluations identified and scheduled to be at least 75 percent complete within Phase 1. The screening process would isolate and identify the most promising dam breaching alternative, which would then be evaluated in more detail.

Phase 2

Evaluation of Preferred Alternative The Corps would conduct technical evaluations (e.g., biological, engineering) of the preferred alternative.

Feasibility Report Preparation The Corps would produce a Feasibility Report in conformance with Engineer Regulation (ER) 1105-2-100, Appendix G, which would document the plan formulation and evaluation process. The report would identify the problems and opportunities, lay out assumptions, forecast the without-project conditions, document the array of alternatives considered and the screening process, and describe the assumptions regarding the projected impacts of the preferred alternative.

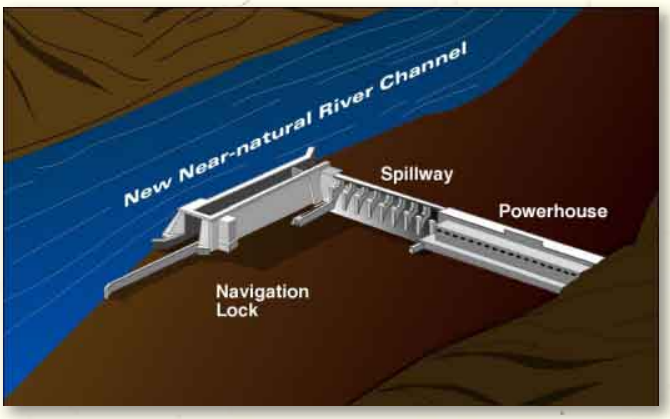
An important part of the study process would be input from regional stakeholders, regional technical groups, and agency technical and policy staff. Ultimately, the Feasibility Report would recommend a preferred plan, which would form the basis of a Corps recommendation to Congress.

Lower Snake River Fish Passage Improvement Study Alternatives

- Per the AMIP, objective is to study dam breaching
- Study scope limited to alternatives for breaching lower Snake River dams
- Non-breach actions at dams not in scope
- Habitat, harvest, and hatchery actions not in scope

5.3 Potential Alternatives

The Corps would undertake the Feasibility Study, if triggered, as described in the AMIP. An array of alternatives, using an incremental approach (breaching one to four dams using varying methods) would be formulated. Formulation of alternatives would consider the best available science, legal directives, or other new information, as necessary.



5.4 Corps' Review Process

Corps operating procedures provide for multiple levels and types of internal review of project studies, depending on the circumstances of a specific study. Engineer Circular (EC) 1165-2-209 outlines the Corps review process for planning studies. The EC cites several criteria that, if met, require a study to be reviewed outside of the Corps:

- The requirement for an EIS
- Study costs exceeding $45 million
- Studies that are controversial, or relate to human safety
- Studies that have a high level of complexity or use precedent-setting approaches
- Studies with significant interagency interest
- Studies that have significant economic, environmental, and social effects to the nation

Studies that meet these criteria must undergo external peer review. In support of this requirement, the Corps' project delivery team (PDT) will prepare a review plan for approval by the NWD Commander, as discussed below.

5.4.1 Level of Review

A Corps project or study may undergo varying levels of review. The Feasibility Study, because of the costs, complexity, potential outcomes, and level of NEPA documentation required, would undergo the most rigorous level of technical review, an Independent External Peer Review (IEPR).

The Corps requires that all decision documents and their supporting analyses undergo review to "ensure the quality and credibility of the government's scientific information." The Corps also requires that the program known as DrChecks, a document review and checking system be used to document that all Agency Technical Review (ATR) and IEPR comments, responses, and associated resolutions are accomplished.

The different types of technical review are described below. The internal review requirements that would specifically apply to the Feasibility Study are summarized in Section 5.4.2. The phrase "home district" refers to the office that produced the report. The term "home Major Subordinate Command (MSC)" or "home division" refers to the division office that has been assigned responsibility to ensure policy compliance and review for a study or project. Depending on the type of project, approval may be assigned at the district, division, or HQ level.

District Quality Control EC 1165-2-209 defines District Quality Control as the review of basic science and engineering work products focused on fulfilling the project quality requirements defined in the Project Management Plan. It is managed at the district level, and may be conducted by district staff who have not worked on the project. Basic quality control tools include a Quality Management Plan that provides for seamless review, quality checks and reviews, supervisory reviews, and PDT reviews. The PDT is responsible for a complete review to ensure the overall integrity of the report, technical appendices, and the recommendations prior to approval by the District Commander (or the appropriate approval authority).

Agency Technical Review The ATR replaces the level of review formerly known as Independent Technical Review. It is an

in-depth review, managed within the Corps, but conducted by team members outside of the home district who have not been involved in the study. The purpose of the review is to ensure the proper application of clearly established criteria, regulations, laws, codes, principles, and professional practices. The ATR is managed by the appropriate Planning Center of Expertise (PCX), which selects and manages the review team. The team reviews the various work products and ensures that all parts fit together in a coherent whole. These ATR teams are composed of senior Corps personnel, and may be supplemented by outside experts, as appropriate. To ensure independence, the leader of the ATR team is located outside of the home division.

Policy and Legal Compliance Review The Feasibility Study would be coordinated through a vertical team made up of Walla Walla District and NWD leadership and policy and legal experts to ensure compliance with policy and law. Ultimately, the reviews would culminate with an HQ-level review and determination that the recommendations in the reports and supporting analyses comply with law and policy, and warrant approval or further recommendation to higher authority by the Chief of Engineers.

Independent External Peer Review An IEPR is the most intensive level of review. It is applied in cases where the risk and magnitude of the proposed project are such that a critical examination by a qualified team outside of the Corps is warranted. An IEPR is managed by an outside eligible organization that is described in Internal Revenue Code Section 401(c)(3); is exempt from Federal tax under section 501(a) of the Internal Revenue Code of 1986; is independent; is free from conflicts of interest; does not carry out or advocate for or against Federal water resources projects; and has experience in establishing and administering IEPR panels. An IEPR team is not expected to be knowledgeable of Army or Administration policies, but should be given the flexibility to bring important issues to the attention of decision makers.

An IEPR would be conducted at the end of Phase 1 and prior to completion of Phase 2. The Corps would designate a qualified organization external to the Corps to implement the independent peer review of the Feasibility Study. The scope of this review would address all the underlying planning, engineering (including safety assurance), economic, and environmental analyses performed for the study. The Walla Walla District, with assistance from the Ecosystem Restoration Planning Center of Expertise (ECO-PCX), would prepare a written proposed response to the IEPR Review Report. This response would discuss whether the views expressed in the report are to be adopted or not, the actions to be undertaken in response to the report, and the reasons those actions are believed to satisfy key concerns stated in the report. The proposed response

would be coordinated with NWD and HQ to ensure consistency with the law, policy, project guidance, ongoing policy and legal compliance review, and other Corps or National considerations. The IEPR comments and responses would be discussed at the Civil Works Review Board. Upon satisfying its concerns, HQ would determine the appropriate command level for issuing a formal response to the IEPR Report. Upon issuance of the formal response, the Walla Walla District would disseminate the final IEPR Review Report, Corps response, and all other materials related to the review on its website. These materials would also be included in the Feasibility Study Review Plan appendix. This documentation would become part of the review record, and would be addressed in recommendations made by the Chief of Engineers.

Planning Center of Expertise Coordination The EC outlines PCX coordination in conjunction with preparation of the Review Plan. The Walla Walla District would prepare the Review Plan in coordination with the ECO-PCX, located in the Mississippi Valley Division. The MSC Commander's approval of the Review Plan is required to ensure that the plan is in compliance with the principles of this Circular and the MSC Quality Management Plan (ER 5-1-11). The Review Plan would define the appropriate level of review and approval of any models used in the analysis and decision. All reviews are expected to be completed and documented before the Feasibility Study is approved.

5.4.2 Proposed Review Plan

The Corps would prepare a study-specific Review Plan at the start of the Feasibility Study. This Review Plan would outline the levels and types of review required for the report, and identify PDT members, assigned reviewers, and expected costs for the review. The review plan would be coordinated with the ECO-PCX, which would coordinate the efforts of the review team. The review plan would be included in the Project Management Plan and would be posted to the District website for public review.

Development of the Review Plan would be fully coordinated with NWD and ECO-PCX to ensure it meets all requirements of EC 1165-2-209. The Review Plan for the Feasibility Study would be approved by the NWD Commander, after coordination and review by the ECO-PCX.

5.4.3 Other Internal Review Requirements

Cost Engineering Directory of Expertise

The ECO-PCX coordinates with the Cost Engineering Directory of Expertise, located in the Walla Walla District, to conduct reviews of cost estimates, construction schedules, and contingencies included in all decision documents requiring Congressional authorization. A review of this type would be conducted for the Feasibility Study.

Model Approval

In 2003, the Corps established a Models Improvement Program to assess the state of planning models in the Corps, and to make recommendations to ensure that high quality models and tools are available to support informed decisions on Federal investments. The main objective of the Models Improvement Program is to carry out "a process to review, improve, and validate analytical tools and models for U.S. Army Corps of Engineers Civil Works business programs." Model certification is mandatory, and is guided by EC 1105-2-407. Projects that require IEPR are also required to have an external review of any planning models used to measure outputs or aid in making decisions.

5.5 Public and Agency Review

Following the internal and independent peer review steps described above, the Feasibility Study would undergo an extensive public and agency review to allow for input by all interested stakeholders. The public and agency review would be a major part of the authorization and decision process for the Feasibility Study, and is discussed in detail in Section 7 of this Plan of Study.

6.0 PHASE 1 TECHNICAL STUDIES

Per the AMIP, Phase 1 would consist of 2-year technical studies covering the aquatic ecosystem, hydrology, engineering, economic, and other issues related to potential breaching of the lower Snake River dams. The formulation of a civil works project must provide a safe, efficient, reliable, and cost-effective design in the most feasible environmentally sustainable manner. Deconstruction of a dam is an extremely complex project, and all necessary factors may not be known at the outset. As a result, the various Phase I studies outlined below may be modified as the full scope of the decommissioning process is realized.

A high level of coordination and review would need to take place between all of the Phase 1 studies, particularly the biological, engineering, and hydrologic studies.

6.1 Aquatic Ecosystem Studies

The aquatic ecosystem studies in Phase I would examine ESA-listed salmonids and other fish species potentially affected by dam breaching.

6.1.1 Snake River ESA-Listed Anadromous Salmonids

This section discusses Snake River anadromous salmonids listed on the ESA, first by reviewing baseline conditions then by looking at potential effects from dam breaching. It considers both juvenile and adult salmonid life stages, as well as other factors such as water quality changes, avian predation, piscivorous fish predation, and climate change. It concludes with a discussion of possible methods for maintaining fish passage during breaching and a brief consideration of effects on the one fish hatchery in the area.

Baseline Conditions

A large amount of work has been conducted to improve the survival of Snake River anadromous salmonids listed under the ESA. Physical and operational improvements including juvenile bypass systems, surface collection devices, and spill have improved the survival of out-migrating ESA-listed juvenile salmonids at hydropower facilities.

Survival of upstream-migrating adult salmonids is generally high in the lower Snake River. Escapement (the proportion of adults successfully passing the dams) is estimated at more than 99 percent for spring-summer Chinook salmon, ≥96 percent for fall Chinook salmon, and more than 96 percent for steelhead (Keefer et al.

2005), leaving very little room for improvements in escapement rates. Some adult salmonids are known to fall back through spillways at Snake River hydroelectric facilities after successfully ascending the fish ladders, however; this "fallback" occurrence is known to cause fish injury, death, and migration delays (Boggs et al. 2004). Existing information on the survival of upstream migrants could be used to estimate the potential for improving adult spring-summer Chinook salmon, fall Chinook salmon, and steelhead escapement on the lower Snake River.

Although sockeye salmon ascend the lower Columbia River relatively quickly (Quinn et al. 1997), the escapement of adult sockeye salmon in the Snake River is estimated to be very low above Lower Granite Dam (Naughton et al. 2005).

Water temperature is an important factor in salmonid survival. Elevated water temperatures are known to slow adult upstream migrations (Keefer et al. 2004; Keefer et al. 2008) and reduce the survival of outmigrating juvenile salmonids (Connor et al. 2003). Summer releases of water from storage reservoirs are currently used to increase discharge and cool peak summer water temperatures in the lower Snake River to improve salmonid survival.

Breaching Effects Analysis

The breaching of the lower Snake River dams would create a 140-mile stretch of free-flowing river and could have biologically significant effects on both juvenile and adult salmonids. If the AMIP biological triggers are tripped, resulting in beginning the technical studies, consideration of all breaching impacts would occur. For instance, the process of removing the Snake River dams could reduce survival of juvenile and adult salmonids in the short term. Consequently, for dam removal to be successful, it would be critical to carefully plan for the protection of the remaining wild stocks during the dam removal process.

Life-Cycle Modeling

An anadromous fish life-cycle and dam breach model is currently under development, and is scheduled for completion by December 2012. The Corps will work with NOAA Fisheries and other regional stakeholders to develop and test the modules for dam breaching scenarios that will allow incremental analysis of dam breaching. The modeling will use the regional NOAA Fisheries' Comprehensive Passage (COMPASS) model as the base, and add modules to evaluate: 1) dam breach scenarios of the four lower Snake River dams; 2) interim operations that have the least effect on fish between the Early Warning Indicator and Significant Decline triggers; and 3) effects throughout the de-construction and post-breach phases to assess the survival of all listed salmon stocks.

The following discussion addresses key aspects of fish passage and survival that will be incorporated into the modeling effort.

Water Quality Changes The 2002 Feasibility Study documented an extensive evaluation of sediment, total dissolved solids, and turbidity maximum concentrations and durations upon stress and mortality across affected salmon stock life stages that would result from breaching multiple dams. It used literature review and sediment transport and resuspension modeling correlated with a literature review of salmonid life-stage effects to produce this evaluation. The 2002 Feasibility Study also included an evaluation of the chemical contaminants found in Snake River sediments and their potential effects on salmonids and other aquatic organisms. Prior to dam breaching, there should be a similar follow-up study to examine quantities and concentrations of the inorganic and organic contaminants of concern. Potential effects on salmonids from sediment and contaminant resuspension should be incorporated into the life-cycle model.

The removal of lower Snake River dams could increase summer peak temperatures in the river during low-flow years (Corps 2002). Predictive models used for the 2002 Feasibility Study suggest a free-flowing lower Snake River would heat and cool faster than does the impounded (i.e., dammed) river. Under current system operations, water stored behind Dworshak Dam on the Clearwater River is used to augment flows in the

lower Snake River. Late-summer releases of cool water from Dworshak are used specifically to provide cooling in the lower Snake River. Changes in Snake River temperatures following dam removal might lead to changes in the timing and volume of flow augmentation releases from Dworshak Dam. Such changes could affect the development and life history of wild spawning salmonids in the lower Snake and Clearwater Rivers. Modeling the effect of post-dam removal flow augmentation patterns on salmonids would be necessary. Similar modeling efforts were conducted to predict changes in lower Snake River temperatures for the 2002 Feasibility Study. The proposed effort would primarily focus on the effect of altered flow augmentation on all life stages of Clearwater River stocks.

Effects on Juvenile Fall Chinook Salmon The removal of lower Snake River dams could improve juvenile fall Chinook salmon survival by eliminating direct losses at hydropower facilities, improving in-stream rearing conditions, increasing water velocity, reducing the impact of accumulative effects, and improving water quality. The impounded Snake River has slower water velocity, limited shallow water habitat, and elevated water temperatures compared to the pre-dam free-flowing river (Tiffan et al. 2009). Survival of migrating salmonids decreases with reduced water velocity, warmer water temperatures, and increased water transparency (Smith et al. 2003). Dam removal would create warmer conditions for emergence (the departure of fry from the incubation gravel into the water column) and rearing in the mainstem river, likely

increasing wild fall Chinook growth rates that should result in earlier outmigration (Connor et al. 2002).

As a result of degraded spawning habitat, altered flow regimes, and elevated water temperatures, juvenile fall Chinook in the Snake River have altered life histories compared to what they had prior to dam construction (Connor et al. 2002; Connor et al. 2005). The effect of dam removal on fall Chinook that overwinter in reservoirs rather than outmigrating during late summer (known as reservoir-type fall Chinook) may be substantial due to habitat loss. Reservoir-type fall Chinook currently account for an estimated 41 percent of adult wild fall Chinook salmon and 51 percent of adult hatchery fall Chinook salmon (Connor et al. 2005).

The lower Snake River reservoirs currently provide overwintering habitat used by reservoir-type fall Chinook juveniles. Determining the consequence of removing this existing habitat is highly speculative. Modeling the potential effect of reduced overwintering habitat on the survival of reservoir-type fall Chinook would be an important component of evaluating the costs and benefits of dam removal. Three response scenarios are possible for the reservoir-type fall Chinook: 1) they would outmigrate as subyearlings, 2) they would overwinter within pools formed in the free-flowing lower Snake River, or 3) they would overwinter within Lake Wallula above McNary Dam, on the Columbia River. Deriving actual survival rates for each scenario would not be feasible, because these responses could not be tested prior to breaching. Consequently, using the best available science to estimate adult returns of reservoir-type fall Chinook for each scenario would be important to determining the feasibility of stock survival prior to successful natural spawning.

Effects on Juvenile Sockeye Salmon The small size of Snake River sockeye salmon at the time of out-migration has hampered research using traditional technology to monitor their survival and habitat use. As a result, very little is known about the survival and habitat use of sockeye salmon in the lower Snake River. It is assumed that sockeye quickly migrate through the lower Snake River and would not be adversely affected by the removal of lower Snake River dams. By comparing the smolt passage index of sockeye salmon with that of a species that does have a diverse life history in the lower Snake River, such as fall Chinook salmon, it is clear that sockeye salmon migrate during a short window and are unlikely to be dependent on reservoir habitat in the lower Snake River.

Effects on Juvenile Spring-Summer Chinook Salmon and Steelhead Juvenile spring-summer Chinook salmon and steelhead rear within tributaries and are not likely to be directly affected by dam removal prior to out-migration (Chapman et al. 1991). The physical removal of dam structures would eliminate dam-related mortality, but it is likely to lower the survival of salmonid stocks due to potential water quality and passage hazards during the removal process. Estimating the type, severity, and duration of physical hazards that would be encountered during the dam removal process would be important to determining the impacts of dam removal on remaining fish stocks. To identify the potential impacts of dam removal, it would be necessary to determine the potential effect on salmonids based on the estimated water quality parameters. The impact of water quality on migrating salmonids should be estimated for multiple water quality scenarios (including extreme scenarios) and modeled over a 20-year period beginning with the initiation of dam removal efforts. Predicting the effect of increased sediment on the survival of out-migrating salmonids would be highly subjective and dependent on discharge post-dam removal. Similar methods can be applied to all species of outmigrating salmonids.

Effects from Avian Predation The effect of avian predators on juvenile salmonids during and after dam removal is unknown. The breaching of all four dams would reduce the surface area of the lower Snake River from approximately 33,000 acres to 19,000 acres, which would concentrate salmonids and potentially increase encounter rates with predators. Caspian terns (Sterna caspia), double-crested cormorants (Phalacrocorax auritus), and gulls (Larus californicus, L. delawarensis, and L.glaucescens X L. occidentailis) are effective predators in impounded river systems and have a significant impact on salmonids in the Columbia River Basin (Antolos et al.

2005). Caspian terns and cormorants are also effective predators in free-flowing river systems and would likely continue to have an effect on juvenile salmonids. However, gulls are opportunistic feeders that would likely have a reduced impact in a free-flowing river. For example, the gull diet consists of less than 15 percent salmonids at inland sites (Collins et al. 2002).

The effect of terns on salmonids in the lower Snake River may be increased post-dam removal by a greater availability of island nesting habitat for terns. Currently, very little nesting habitat exists on the lower Snake River. High nesting densities in the mid-Columbia River suggest that nesting habitat is a limiting factor in colony expansion (Antolos et al. 2004). This theory could be explored by mapping available and occupied nesting habitat in the Columbia Basin.

Cormorants are believed to be effective predators in free-flowing rivers and do not require specialized habitat for nesting. Although the Snake River Basin has very sparse tree cover or nesting structure, the available habitat is suitable for cormorants. The islands and vegetation that are likely to establish in riparian areas created by dam removals would likely favor cormorant nesting. Predicting the available nesting habitat post-dam removal would be necessary to estimate the potential impact of cormorants. Studies related to the effects of avian predation on salmonids in the Columbia basin are ongoing. The results of those studies will inform the effort that may be necessary to further evaluate effects of avian predation if and when the Feasibility Study is initiated.

Effects from Piscivorous Fish Predation Juvenile salmonids are negatively impacted by both native (northern pikeminnow, Ptychocheilus oregonensis) and non-native piscivorous fish (catfish, Ictalurus punctatus; walleye, Stizostedion vitreum; smallmouth bass, Micropterus dolomieui) in the lower Snake River. The impact of piscivorous fish has been studied in the Snake River Basin (Naughton et al. 2004), but size-based predation risk dynamics may have changed with the continued immigration of invasive predators such as walleye. Changes in size-based predation risk related to the introduction of invasive predators have been documented on the Yakima River (Fritts and Pearsons 2006).

Unlike the situation for many other non-native species, smallmouth bass have higher densities in free-flowing portions of the Snake River than in impounded sections (Naughton et al. 2004). Consequently, it is possible that the consumption of salmonids by non-native species in the lower Snake River could increase with the removal of dams. Information currently exists comparing the effect of some piscivorous fish in free-flowing and impounded sections of the Snake River. The Corps would use the most current predation information available to assess the predation changes associated with dam breaching.

The short-term effect of dam breaching on resident fish includes stranding, the effects of higher sediment loads and turbidity, increased predation, and decreased macroinvertebrates. Of these short-term effects, the potential for increased predation on juvenile salmonids is one that may require further study. Rapid drawdown will confine predators and prey to a smaller area and may substantially increase predation for a short period. The Corps would use data from the 2002 Feasibility Study to evaluate these effects.

Effects on Adult Salmonids Although dam removal could improve upstream passage of spring-summer Chinook salmon, fall Chinook salmon and steelhead upstream passage improvements are unlikely to have a biologically significant effect on returning adults. Existing information on the survival of upstream migrants could be used to estimate the potential for improving adult spring-summer Chinook salmon, fall Chinook salmon, and steelhead escapement on the lower Snake River.

There is insufficient evidence to accurately predict the potential effect of lower Snake River dam passage on adult sockeye salmon. Passive integrated transponder (PIT) tagging of juvenile sockeye salmon is currently being done, and the adult sockeye from these studies will be returning in future years. The PIT-tagged adults can be monitored as they pass through the hydro system. This will provide additional information on adult passage timing and survival, which will assist in the effects on sockeye passing through the system.

One of the perceived benefits of dam breaching is the restoration of in-stream spawning habitat. Dam construction altered mainstem conditions and shifted spawning to colder, less productive tributaries (Connor et al. 2002). It is likely that removal activities and unstable sediment would reduce the spawning success of fall Chinook in the mainstem during dam removal and prior to sediment stabilization post-removal. Currently, very little natural spawning (approximately 20 redds per year) occurs in the lower Snake River (Dauble et al. 1999; Mueller 2008). Redd surveys were conducted below the lower Snake River dams from 1993 to 1997; spawning was detected below Lower Granite, Lower Monumental, and Ice Harbor Dams, accounting for between 5 and 12 percent of total mainstem spawning (Dauble et al. 1999). During fall 2008, a similar survey was conducted, and 15 redds in the tailraces of Lower Granite and Lower Monumental Dams were detected (Mueller 2008).

Predicting the stability of sediments and inferring how instability could affect mainstem spawning success would be a key factor in determining the period required for successful natural spawning to occur in the lower Snake River. It is possible that unstable sediments causing turbidity and a shifting river channel could smother or strand redds for decades after dam removal is complete. To predict the immediate impacts and future benefits of dam removal, it would be beneficial to model sediment stability (see discussion in Section 6.2.3) in relation to known spawning habitat criteria (Dauble et al. 1999; Groves and Chandler 1999). One of the uncertainties of dam breaching is the amount of time it will take for water quality and sediment stability to improve. By combining known spawning/rearing criteria and the extreme scenarios derived from sediment transport modeling efforts, it may be possible to predict the time required to restore lower Snake River fall Chinook spawning habitat. Estimating the time required to restore in-stream

habitat would be essential for determining the effect of dam removal on fall Chinook salmon.

Potential Effect of Global Climate Change on Salmonids The effect of global climate change would be an important consideration of this study. If climate change results in a significant impact on the salmonid production capability of the Snake River Basin, anticipated salmonid survival benefits from removing the lower Snake River dams might have a greatly reduced effect on salmonid recovery. Predicted increases in air temperature could result in reduced snowpack (Barnett et al. 2004). One possible consequence is that reduced snowpack could shift some discharge from the summer to the winter (Stewart et al. 2004), and reduced the amount of stored water available to augment stream flows during migration periods. Altered environmental conditions caused by climate change could impact multiple life stages of salmonids (Payne et al. 2004) and have a detrimental effect on already stressed salmon stocks. Climate change has the potential to result in mean salmonid abundance declines of 20 to 50 percent (Crozier et al. 2007).

The parameters affecting the production of salmonids are well known, and salmonid production could be evaluated using predicted water quality and quantity parameters that might result from climate change. Predicted water conditions would be updated at the time the study is initiated based on the best available science, and consistent with results from other studies of the basin related to climate change. The resulting model would predict the natural and hatchery production capability of the Snake River Basin based on the water quality tolerance of salmonids under multiple climate change scenarios.

Fish Passage During Breaching

Any potential dam breaching action must not interrupt the passage of fish up and down the Snake River during its implementation. This section outlines the possible strategies for maintaining fish passage, first for adult upstream migrating salmonids and then for downstream migrating juveniles.

Adult Upstream Passage The 2002 Feasibility Study considered two options for maintaining upstream adult passage during drawdown and breaching. The first option was to modify fish entrance and exit locations and fish ladders so that fish passage could continue at each project during drawdown and breaching. The second option was to construct fish traps at Ice Harbor and Little Goose Dams, collect the upstream-migrating adults, and transport the anesthetized adults by truck to an appropriate discharge point above the next upstream dam during each drawdown season. The study evaluation recommended the trap-and-haul option as the better of the two options. The decision was based in part on the uncertainty of sediment loads in the river and the difficulty in achieving effective fish ladder modifications.

It should be expected that the extra handling involved with trap-and-haul operations and studies would lead to some mortality or reduced fitness. This effect would represent additional risk to the stocks if the fish being handled were already at very low abundance.

Juvenile Downstream Passage There is great uncertainty about the sediment loads and river conditions fish might experience during drawdown and breaching. Extremely unfavorable conditions might pose such a hazard that juvenile fish would need to be collected upstream of the impacted river sections and transported downstream to a point where river conditions are deemed adequate for survival.

Hatchery Program

The only fish hatchery that would be directly affected by lower Snake River dam removal is the Lyons Ferry Hatchery complex. Lyons Ferry Hatchery production includes steelhead, Chinook salmon, and trout for release into the Snake River Basin. Like most hatcheries, the Lyons Ferry Hatchery complex uses well water for fish production and would have no biological impacts related to dam breaching. Some operations-related changes would be necessary to maintain hatchery production.

6.1.2 ESA-Listed Bull Trout

Bull trout (Salvelinus confluentus) occur in tributaries to the lower Snake and Columbia Rivers; however, their use of the mainstem lower Snake River is not well understood. Individuals from populations of bull trout in the Walla Walla River and Tucannon River drainages have been documented entering the Snake and Columbia River (referred to as mainstem rivers). There are ongoing studies attempting to document habitat use patterns of bull trout that do enter the mainstem rivers, as well as quantifying the number of bull trout using those mainstem habitats.

It does appear that some bull trout overwinter in mainstem rivers. The greatest impact of dam breaching on bull trout would likely be high sediment loads, because these may have negative effects on the migratory component of bull trout that overwinter and migrate in mainstem rivers. However, because bull trout occur at low densities in the mainstem habitats, it would be difficult to assess how many would be impacted and what those impacts would be.

6.1.3 Pacific Lamprey

The Pacific lamprey is a native anadromous fish species that coexists with anadromous salmonids throughout the reach of the Snake River Basin accessible to them. Historically, the geographic distribution of Pacific lamprey coincided with that of salmon. Indian tribes harvested lamprey at several locations in the Snake River Basin. Very little run size information is available for lamprey. The Corps began counting lamprey at the adult fish ladders at Bonneville Dam in 1938, but discontinued the counts after 1969. Run sizes were highly variable, with annual variability in the timing of the runs and run-peaks, as well as in total numbers. Recent observations indicate that runs have declined substantially since completion of the mainstem dams in the Columbia and Snake Rivers. Lamprey returns averaged 108,500 from 1938 to 1969. In 1993, a total index count of 22,366 was estimated. The Corps resumed lamprey counts in 2000, and highly variable total numbers are still reflected in the counts (see table below).

Because Pacific lamprey are not listed under the ESA,

Year	Adult Pacific Lamprey Passage Index (window counts only)				
	BON	IHR	LMO	LGO	LGR
2009	8,622	57	58	34	12
2008	14,562	264	145	104	61
2007	19,304	290	138	72	34
2006	38,941	277	175	125	35
2005	26,667	461	222	213	42
2004	61,780	805	194	243	122
2003	117,035	1,702	476	660	282
2002	100,476	1,127	284	365	138
2001	27,947	203	59	104	27
2000	19,002	315	94	71	28

2000–2009 Annual Adult Lamprey Daytime Window Counts

Note: Bonneville (BON), Ice Harbor (IHR), Lower Monumental (LMO), Little Goose (LGO), and Lower Granite (LGR) Dams.

very little work has been done by the Corps regarding passage success at lower Snake River dams and the associated reservoirs. The majority of work done on lamprey passage has taken place at dams on the Columbia River. In 1994, the Pacific Lamprey Passage Studies Program was initiated, with the majority of work focused on modifications to fish ladders specifically designed for lamprey passage.

In May 2008, an MOA between the Action Agencies, the Accord Treaty Tribes (Umatilla, Warm Springs, and Yakama), and the Columbia River Inter-Tribal Fish Commission addressed actions to protect Pacific lamprey. The Corps was tasked with collaboration with the tribes and USFWS to develop a 10-year lamprey plan, and identify specific actions to improve lamprey passage and survival. Actions relevant to the lower Snake River dams include ladder entrance modifications for all dams; implementation is scheduled between 2014 and 2017.

The Corps has sampled shallow-water habitat for benthic macroinvertebrates and sediment size and distribution since the late 1980s. During this period, one juvenile lamprey was detected on Beckwith Bar (Little Goose Reservoir) in 1995 in a macroinvertebrate dredge sample. Despite thousands of samples collected in shallow-water habitat, no other observations have been made.

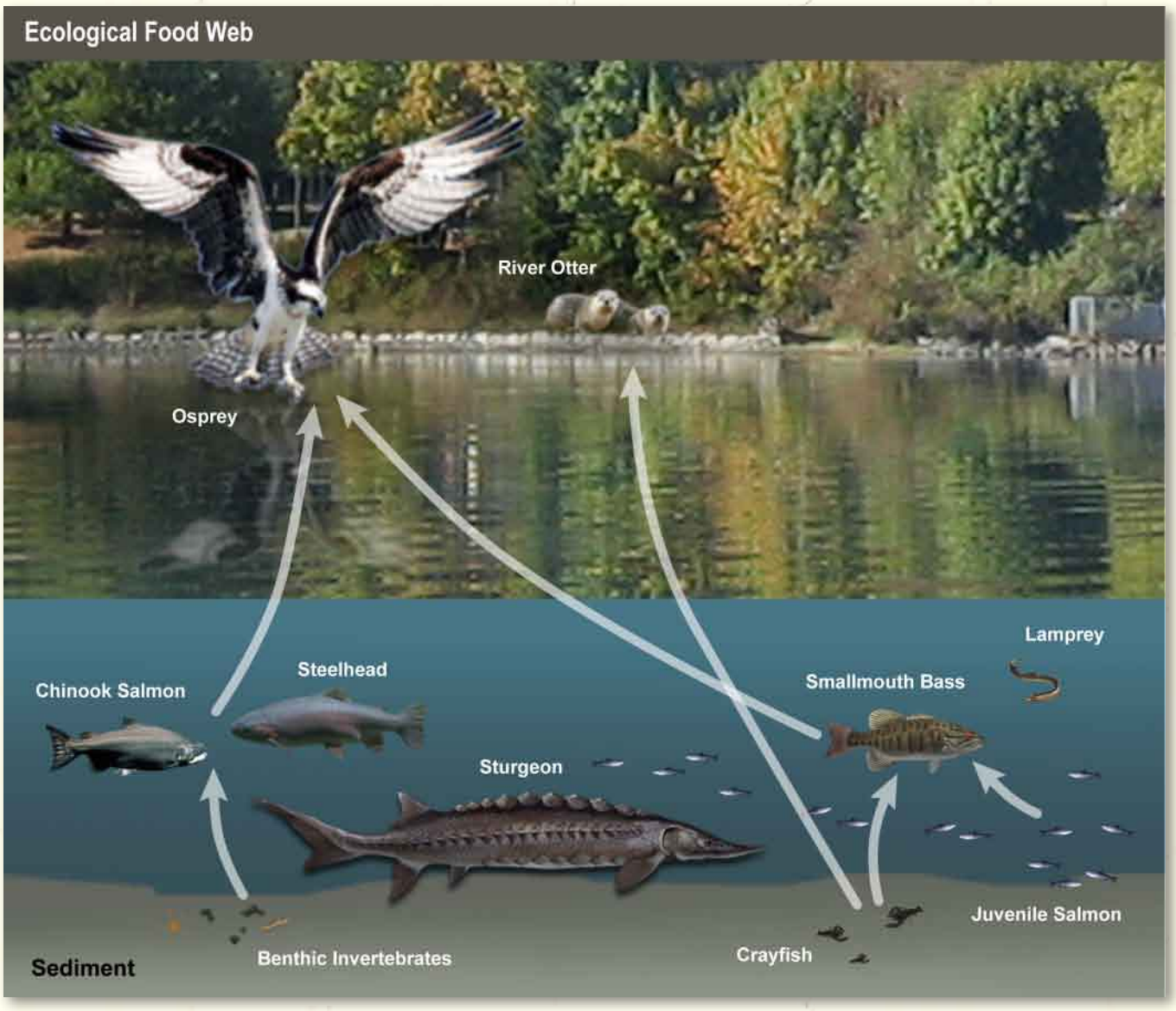
As part of the PSMP, the 2010 contract to characterize shallow water habitat is charged with sampling for the presence of lamprey using specific deep water sampling methodology. Twelve habitat sites that span the entire lower Snake River were selected based on their use by juvenile salmonids, specifically fall Chinook. This work will begin in June 2010. It will evaluate use over all seasons, and results will be available in January 2012.

Another evaluation being done under the auspices of the PSMP project is taking sediment cores from the Snake River, from the confluence of the Clearwater and Snake River, to Silcott Island in Lower Granite Reservoir. The cores will be taken as part of a sediment transport modeling study, and they will be examined for all life stages of lamprey. This study will take place in spring 2010, with results available in December 2011.

The long-term goal of lamprey proponents in the region is to develop a large-scale lamprey sampling plan in the large rivers. The intent of the sampling plan is to better understand where lamprey go once they leave tributaries to migrate toward the ocean, as well as their upstream migration behavior when they return as adults to spawning grounds.

6.1.4 Resident Fish

The potential short-term effects of dam breaching on resident fish include stranding, the effects of higher



sediment loads and turbidity, increased predation, and decreased macroinvertebrates.

Studies to assess long-term impacts to resident fish communities and abundance were completed for the 2002 Feasibility Study, which predicted an overall increase in native resident species and a decrease in non-native species following dam removal.

6.1.5 Other Organisms/Overall Aquatic Ecosystem

The existing food web in the lower Snake River is largely governed by the deep, open water (or pelagic) environment, with a smaller contribution from the near-shore (or littoral) region. Water temperature, available nutrients, light, and hydraulic conditions are some of the main regulators of the phytoplankton (microscopic plants that are the primary producers in the system). Zooplankton (tiny invertebrate animals that float freely throughout the seas and other bodies of water) compose the main phytoplankton consumers and they, in turn, are consumed by plankton-feeding fish. Aquatic insects are of lesser importance in the current system, and are a food source for bottom-feeding fish.

If the current aquatic ecosystem is transformed to a riverine environment, the main components of the primary and secondary productivity would shift to the littoral (shoreline) regions. The benthic algae (algae attached to the river bottom) would represent the base of the food chain and become an important food

source for zooplankton, benthic animals (e.g., crayfish, amphipods, oligochaetes), aquatic insects, and fish that consume benthic animals. In a riverine environment, aquatic macrophytes would also become more important as shelter areas for insects and fish, provide bank stability, and promote nutrient recycling.

Effects of Sediment and Turbidity on the Aquatic Ecosystem

As noted earlier, the 2002 Feasibility Study documented an extensive evaluation of sediment, total dissolved solids, and turbidity maximum concentrations and durations upon stress and mortality across affected salmon stock life stages as a consequence of breaching multiple dams. Many model-based studies of breaching actions across the United States and internationally (e.g., England and Japan) have occurred since 2002. Geological attributes and other geographical variables can be quite significant in influencing or driving breaching action outputs. To date, no breach has been considered for a dam with a hydraulic head (measure of water pressure above a geodetic datum) as deep as that required for the lower Snake River dams. However, the database of completed breaches and studies would be screened for geographic similarities. It would then be incorporated into a current evaluation of turbidity changes as they relate to sources of salmonid mortality.

Effects of Contaminants in Sediment on the Aquatic Ecosystem

Contaminants of concern found in sediment sampling in the lower Snake River were dioxin toxic equivalent (TEQ), total dichlorodiphenyltrichloroethane (DDT), manganese, and sediment-bound nutrients (Feasibility Report/EIS 2002). An analysis of the organic chemical constituents dioxin TEQ and total DDT showed that neither would exceed sediment quality criteria with dam breaching. Inorganic manganese would not exceed health safety levels; however, there would be odor, taste, and aesthetic concerns in the lower Snake River and the Columbia River upstream of McNary Dam.

Prior to dam breaching, there should be a follow-up study similar to what was done in 2002 to examine quantities and concentrations of the inorganic and organic contaminants of concern.

6.2 Hydrologic Studies

Hydrologic and hydraulic studies facilitate project engineering and the evaluation of economic and environmental impacts of alternatives. These studies are required to determine the functional design requirements of water resource projects, as well as establish basic design criteria.

This section describes the appropriate studies for hydrologic analysis, channel stability assessment, sediment transport modeling, water quality assessment and other elements related to an evaluation of the removal of the four lower Snake River dams. Elements common to many hydrologic engineering reconnaissance studies include: 1) hydrologic engineering study objectives; 2) definition of the study area for hydrologic engineering analysis; 3) description of available information; 4) definition of existing flood hazard conditions; 5) definition of existing and expected with-project conditions; and 6) an initial project management plan for feasibility phase study. In addition, the studies involving water discharge, channel morphology and sediment yield would need to account for the expected future effects of climate change.

The Corps currently has no defined methodology in place for hydrologic evaluations of dam removal. This study plan adapts methodology in the Corps' hydrologic engineering guidance with recent developments by the general community of practice for dam removal engineering.

6.2.1 Hydrology

Hydrologic analysis defines the magnitude, timing, and variability of water discharge in the defined study area, which in this case would include the lower Snake River and McNary Reservoir on the Columbia River. It examines the meteorology, climate, and runoff characteristics of tributary watersheds. This analysis is necessary for an evaluation of channel capacity and sediment transport within the open lower Snake River channel.

The change from a run-of-river reservoir operation to a natural-channel flow requires a re-analysis of basic hydrologic characteristics and criteria, emphasizing timing and variability of inflows from tributary basins, peak rates of discharge, stage variability, channel velocities, and the propagation of flood waves.

Sediment transport rates in open channel systems are dependent on the duration and magnitude of high discharges. A complete re-analysis of the hydrologic characteristics of the lower Snake River is warranted to avoid propagation of hydrologic errors through subsequent sediment and channel evolution analyses.

Many of the studies necessary to thoroughly analyze dam removal on the lower Snake River have already been done or are in process under the auspices of the PSMP. Comprehensive watershed runoff and channel routing models have been developed; however, data gaps remain, and include the following:

- Extensive meteorological and stream discharge data for the Snake River Basin has not been compiled in a form directly useable in hydrologic modeling.
- No database of storm events has been assembled in a way that is useful for runoff modeling and routing.
- Runoff characteristics and parameters (infiltration, curve number, unit hydrographs) of the tributary basis are poorly understood, and have not been documented in hydrologic studies.
- Few stage-discharge measurements exist to calibrate hydraulic models of natural channel flows in the Snake and Clearwater Rivers.
- Groundwater geology of the study region is complex, and groundwater inflows to the lower Snake River have not been adequately evaluated.

Hydrology data are essential for other elements of the study, and must be completed during Phase 1. The following tasks are recommended:

- Review and summarize past hydrologic studies and design memoranda.
- Compile and summarize meteorological data for the Snake River Basin.
- Compile and summarize stream discharge data and water temperature data for the Snake and Clearwater Rivers, as well as other tributaries.
- Compile from appropriate regional sources a local meteorological dataset and rainfall frequencies for the lower Snake River project areas.

- Summarize existing reports on the effects of climate change on Snake River Basin water resources and incorporate those results into hydrologic forecasts used in the model analysis
- Characterize stormwater and wastewater effluent discharges from the cities of Lewiston and Clarkston and the Potlatch Corporation plant at Lewiston.
- Compute updated flood-frequency curves and flow duration statistics for the lower Snake River at each junction of the tributaries.
- Develop hydrologic models of tributary basins not already modeled (i.e., Palouse and Tucannon River Basins).
- Develop meteorological scenarios for representative conditions and calibration events for model simulations.
- Determine the Probable Maximum Flood and Standard Project Flood discharges for each study reach.
- Develop discharge time series for flood and sediment transport simulation.

6.2.2 Channel Investigations

Channel Hydraulic and Hydrodynamic Modeling

Flow conditions in the lower Snake River would alter drastically after dam removal. Because there is no prototype channel available to test and observe, atypical conditions that would develop during the drawdown must be simulated. For example, extreme events and environmental flows must be simulated in the lower Snake River to determine the flood and beneficial use impacts of dam removal. Both one- and multi-dimensional models would be used to analyze varied river and flow conditions, and a full range of alternatives and configurations would be modeled.

To successfully model the lower Snake River conditions, the following data gaps must be filled:

- A comprehensive, high-resolution bathymetric survey of the lower Snake River and the McNary Reservoir must be completed.
- Hydraulic resistances of below water reservoir and channel surfaces need to be characterized for transitory and natural river flow conditions.
- Discharge and velocity measurements are needed for model calibration in the open reaches of the reservoir.

Hydraulic and hydrodynamic models are essential for the sediment transport and channel evolution elements of the hydrologic analysis and, therefore, must be completed in Phase 1. Tasks to be accomplished during Phase 1 include:

- Compile, review, and summarize existing hydraulic models of the lower Snake River and the McNary Reservoir.
- Compile and describe survey control information for study reaches.
- Compile and summarize existing flow and velocity measures for study reaches.
- Develop a high-resolution digital bathymetric dataset of the lower Snake River and the McNary Reservoir by conducting a multi-beam echo-sounding hydroacoustic survey.
- Acquire water surface elevation measurements and acoustic Doppler discharge-velocity measurements for model calibration at selected locations within the study reaches.
- Develop a description of physical characteristics of the study reaches, and assemble a modeling dataset of bathymetry, structural features, and hydraulic resistance.
- Using input from the region, develop initial sediment modeling scenarios.
- Develop one-dimensional, georeferenced hydraulic models of all study reaches for existing, transitional, and natural river conditions.
- Develop two-dimensional, georeferenced hydrodynamic models of special interest segments (e.g., McNary Reservoir and the confluence of the Snake and Clearwater Rivers).
- Calibrate the models with available data.
- Develop final modeling scenarios.
- Produce water surface profiles for further analysis.
- Develop hydraulic model documentation reports.

Channel Stability and Evolution

Channel stability is defined by the temporal change in the prevailing width, depth, longitudinal profile, and planform pattern of a channel because of an inequality between the supply and removal of sediment. Channel stability assessments are usually performed to establish the physical properties of an equilibrium channel for design and restoration work. Geomorphic assessment is the means to apply the principles of channel stability and evolution to the engineering and management of rivers.

Dam removal on the lower Snake River would change the flow regime from a relatively deep impounded channel to an open, natural-channel flow. The sediment regime would change from almost no bed material load to a relatively high equilibrium sediment load. It is also certain that accumulated sediments would remobilize, and the channel would adjust to a new equilibrium morphology.

The data required for a geomorphic assessment would be acquired through other pieces of the hydrological assessment. The following tasks must be performed to achieve an effective geomorphic assessment, which would be completed during Phase 1:

- Assemble existing data.
- Define current channel forms and sediment features.
- Define historical channel forms through an analysis of aerial photography and historical channel surveys.
- Perform geomorphic analysis.
- Classify stream reaches, and assess stability status at reach scale.
- Predict the effects of climate change on the channel morphology of the lower Snake River
- Predict channel response and morphological evolution to dam removal.
- Define and quantify objectives for the post-breach channels.
- Integrate results of geomorphic analysis into the engineering design.
- Select hydrodynamic sediment transport equations and equilibrium relations appropriate to the river and conditions.
- Design stable channel dimensions at the breach locations that mimic natural channel forms.
- Use sediment transport models matched to the alluvial setting that incorporate existing geologic and artificial controls to predict morphological response

Snake River Basin Sediment Concepts		
Extensive steep terrain	=>	landslide potential (sediment source)
Terrain + land cover + precipitation	=>	high basin-wide sediment yield
Steep tributaries	=>	large capacity to move sediment

of the channel system to altered flow and sediment load conditions.

- Use geomorphic analysis and sediment transport models to evaluate alternative dam removal strategies and sediment management plans, and develop preliminary designs of the channel sections at the breach locations.
- Use geomorphic analysis, sediment transport models, and pier scour methods to evaluate scour at structures that would remain in the reformed river channel.
- Use geomorphic analysis, sediment transport models, and stability analysis to evaluate the impact of river adjustment on the Lewiston levee system.
- Integrate environmental features effectively into morphological and engineering aspects of the final project.
- Evaluate maintenance requirements and optimize the design.
- Consider and propose the scope of post-project appraisal and monitoring regime necessary to evaluate project performance.
- Prepare reports for the geomorphic and channel stability analyses.

6.2.3 Sediment

Watershed Sediment Yield

Sediment yield analysis defines the rate, timing, and sources of sediment delivered by the watershed to downstream sources. An estimation of sediment yield is necessary to characterize unmeasured sediment inflows to the lower Snake River system.

Sediment yield would be evaluated for selected portions of the Snake River Basin. Mean annual rates and seasonal rates of sediment load would be estimated for tributaries.

Other than ongoing work for the PSMP, there have been no recent estimates of sediment yield for the lower Snake River Basin. Most of the data required for the sediment yield analysis would be acquired in other elements of the hydrological assessment for the Feasibility Study. Sediment loads for the Columbia River above Richland, the Yakima River, and the Walla Walla River remain to be determined to support analysis of sediment-related effects downstream of the lower Snake River projects.

To accurately perform a sediment yield analysis, it is necessary to accomplish the following tasks:

- Estimate sediment yield in the tributary basins.
- Estimate seasonal distribution and mean annual sediment loads for lower Snake River tributaries.
- Review existing information, and estimate seasonal and annual sediment loads from the Columbia River above Richland, the Yakima River, and the Walla Walla River to the McNary Reservoir.

Sediment Characterization and Quality

Breaching would result in free-flowing river reaches and former reservoir bottoms that would become vulnerable to erosion by higher water velocities and runoff events. This would result in sediment movement. Sediment, in the form of turbidity, has the potential to affect primary and secondary productivity, while some amounts of formerly unavailable nutrients

Landslide near Lewiston, ID

Logging road and landslide (Clearwater National Forest)

Upstream channel erosion (Pataha Creek)

may be released into the water column. In addition, sediment contamination may occur in some areas, and drawdown conditions may cause these contaminants to be re-suspended along with the sediment, and then be redistributed in the Snake and Columbia Rivers.

Reservoir sediments have been characterized in previous studies. Most of these investigations were linked to the Corps' dredging authorities and projects, and focused predominantly on the area around the confluence of the Snake and Clearwater Rivers.

A considerable amount of new sampling would be necessary throughout the lower Snake River to characterize the sediments and fully understand the redistribution of these sediments under drawdown conditions. This sampling effort would have to follow protocols set forth in the most recent version of the Regional Sediment Evaluation Framework for the Pacific Northwest. These guidelines include sampling frequency recommendations, methods, current chemicals of concern, and elutriate testing triggers, and place a greater emphasis on bioaccumulation and toxicity testing than has occurred in the past.

The results of the chemical and biological sediment tests would be evaluated in two steps. In the first step, the results would be compared to data from previous lower Snake River studies to identify any trends. Additionally, the data would be compared to peer-reviewed literature and the predicted concentrations of total suspended solids in the system following breaching (this is the approach that was followed in the 2002 Feasibility Study). During the second step, the sediment chemistry and elutriate data would be merged with the most recent sediment transport model results. This effort would provide an estimate of sediment redistribution that was not completed as part of the previous study and take into greater consideration the amount of exposure resident and anadromous fish may experience to chemicals of concern.

Sediment Transport Modeling

The removal of a dam substantially changes the way the water's energy is expended along the river. Energy is now consumed by power production, lockage, and controlled dissipation. After dam removal, energy would be spent on turbulence and sediment remobilization in the recovering river channel. The task of evaluating the exact physical response of a large river system to the removal of a dam is extremely complex, but should include the following: 1) defining the discharge and sediment inflow regimes;

2) evaluating bed erosion and sediment transport rates; 3) simulating bed mobility; 4) predicting short- and long-term channel adjustment, including the possibility of sediment and/or discharge conditions that exceed the level of channel stability; and 5) characterizing the uncertainty of these channel adjustments.

Over the past nearly 60 years, approximately 115 million cubic meters (150 million cubic yards) of sediment have been deposited upstream of the four lower Snake River dams, and much fine sediment has accumulated in Lower Granite Reservoir, the Palouse River mouth, and other locations. If the dams were removed, a portion of this accumulated sediment would remobilize.

Field studies and modeling work are in progress under the PSMP for parts of the Snake River Basin. These would be extended and augmented to evaluate the impacts of dam removal. The bathymetry surveys, sediment load measurements, bed sediment coring, and sediment transport modeling for the PSMP would be directly applicable to the dam removal study. The Walla Walla District maintains an ongoing program to measure sediment ranges throughout the lower Snake River system. Electronic instruments that continually track sediment load were installed and are operated by the USGS as part of the PSMP. In addition, sediment analysis was done for the removal of Lewiston Dam, the 1992 drawdown of the Lower Granite pool, and the 2002 Feasibility Study. However, despite a good level of available information, data gaps do exist. To fill these gaps, it would be necessary to accomplish the following tasks:

- Provide more detailed bathymetry through a multi-beam echo-sounding survey. With the exception of the Lower Granite pool, the bathymetry of the lower Snake River is defined only by sediment range cross sections and short segments of high-resolution bathymetry near the dams.
- Resurvey all (approximately 300) sediment range cross sections so that an up-to-date comparison can be made with historical cross sections, and provide a check on the multi-beam echo-sounding bathymetry survey.
- Characterize sediment load data for tributaries other than the Clearwater and Palouse Rivers.
- Characterize the thickness, spatial variability, and grain-size distribution of the accumulated and original bed sediments throughout the lower Snake River, the upstream reaches of the Clearwater River, and the McNary Reservoir. The exception is the Lower Granite Reservoir bed, which is being characterized through the PSMP.
- Evaluate the stability and erosion resistance of below water bank and channel slopes.
- Characterize the frequency and strength of turbidity currents in the McNary Reservoir.

Field work, synthesis of existing data, and modeling and analysis work would need to be completed during Phase 1. To adequately model and analyze sediment transport in the lower Snake River, it would be necessary to accomplish the following tasks:

- Develop a digital cross-section database of historical sediment ranges and conditions surveys.
- Develop a database of existing sediment load data.
- Compile information on past dredging operations

Sediment Remobilization

Dam breaching could result in significant movement of sediments. It is estimated that 50 to 75 million cy of existing sediments may be eroded and moved downstream.

and volumes in the lower Snake and Clearwater Rivers, and the McNary Reservoir.

- Compile information on past navigation shoaling for the lower Snake River and the Columbia River below McNary Dam.
- Review and summarize previous studies of sediment transport in the lower Snake River.
- Review and summarize studies and findings from similar investigations on other rivers.
- Perform single-beam hydroacoustic survey of the 304 established sediment ranges throughout the study reaches.
- Acquire underwater sediment cores at the historical sediment range cross sections (except at Lower Granite) and special interest areas.
- Perform a subbottom profiling survey of the lower Snake River reservoirs, McNary Reservoir, and the accessible reaches of the Clearwater and Snake Rivers to inventory the accumulated sediments and characterize the original bed material.
- Measure the erodibility of underwater fine-grained sediment deposits with the Corps' High Shear Stress Flume Mobile Laboratory (SEDflume).
- Measure suspended and bed sediment load on the Snake, Clearwater, and Palouse Rivers if not continued for the PSMP, and begin the same measurements on the Tucannon River.
- Develop a description of physical characteristics of the study reaches, and assemble a modeling dataset of bathymetry and sediment parameters.
- Develop one-dimensional sediment models of the lower Snake River and McNary Reservoirs for the study of short- and long-term bed adjustment.
- Develop two-dimensional sediment transport and particle tracking models of special interest areas in the lower Snake River and the McNary Reservoir.
- Develop a draft sediment transport modeling report for ATR.
- Develop final sediment transport report.

McNary Reservoir Evaluation

The McNary Reservoir (Lake Wallula) would potentially receive large quantities of sediment and floating debris as the lower Snake River channel reformed during and after dam removal. Even after the channel recovered, the full natural sediment and debris loads of the lower Snake River would continue to accumulate in the McNary Reservoir. The effect of initial and persistent sediment loads and potential transport mechanisms, such as turbidity currents, on McNary Lock and Dam must be evaluated to predict the useful life of the reservoir and determine if dam operations must be controlled. The effect of increased sedimentation on the flood capacity of the Tri-Cities levee system must also be evaluated, as should potential ice loads on McNary Dam.

To accurately evaluate the consequences of dam breaching on the McNary Reservoir, information on debris loads must be compiled. Other data required for the assessment will be gathered through other pieces of the hydrological assessment and the PSMP.

Tasks that must be performed in Phase 1 include the following:

- Determine current storage elevation curve for the McNary Reservoir.
- Estimate the rate of sediment accumulation.
- Estimate the useful life of the reservoir.
- Evaluate the short- and long-term impacts on the flood capacity of the Tri-Cities levee system.
- Describe and characterize sediment impacts on dam operations.
- Evaluate possible sediment management or bypass options.
- Assemble information about debris loads, and characterize impacts to McNary Dam.
- Evaluate potential ice load impacts on McNary Dam.

6.2.4 Water Quality

Water temperatures in the lower Snake River are affected by seasonal and weather conditions; natural inflow; upstream storage project releases; and the surface area, volume, and configuration of the run-of-river reservoirs themselves. Reservoir temperatures have the potential to affect primary and secondary productivity, the growth rates of juvenile anadromous and resident fish, and the feeding rates of resident fish predators. Greater spatiotemporal temperature data are available, and a more robust model has been developed. This model can be used to enhance understanding of the temperature dynamics that would occur during and after dam breaching, and how those temperatures would compare to the Washington State water quality standards.

Water temperatures have been modeled previously using one-dimensional models (i.e., Water Quality for River-Reservoir Systems [WQRRS], River Basin Model – Region 10 [RBM-10], and Modular Aquatic Simulation System 1D [MASS1]). The WQRRS model developed for the 2002 Feasibility Study indicated that water temperatures during low-flow years in the lower Snake River could reach higher summer peaks under natural river conditions than under the existing impounded river conditions. The RBM-10 model developed by EPA found a greater likelihood that, without Dworshak augmentation, water temperatures in the lower Snake River would more frequently exceed the 68°F (20°C) benchmark with the dams in place than with the dams removed. Exceedances would still occur with flow augmentation, but to a lesser extent. The MASS1 modeling effort completed by Pacific Northwest Laboratory found that the primary difference between the current and natural river condition scenarios was that the reservoirs decrease water temperature variability, but shift the annual thermal cycle. However, due to uncertainties in the simulation model, the authors concluded that the results showed only small differences between the current and natural river regimes.

Since the previous studies were completed in the 1990s, the CE-QUAL-W2 model has been implemented in the lower Snake River for the purpose of predicting temperature changes in that system resulting from cold water releases from Dworshak Reservoir (the primary emphasis has been the Lower Granite Dam tailwater). Additional vertical temperature strings have also been installed in the forebays of each dam that transmit real-time hourly data year-round to the Corp Water Management System database. This laterally averaged two-dimensional model can, with some modifications, be used to quantify in-river water temperatures during and after dam breaching throughout the lower Snake River Basin. Modifications to the CE-QUAL-W2 model, decisions regarding specific model runs to perform, and completion of those runs would be completed during one year of engineering data analysis. Work on the water quality modeling would need to be coordinated among technical experts within the region.

6.3 Engineering Studies

The Feasibility Study would require a number of studies analyzing engineering issues related to dam breaching and its effects. These would include techniques for conducting the dam breaching itself and modifications to other ancillary structures or operations related to the dams. Pricing, schedule, and risk would also need to be evaluated, as outlined in this section.

6.3.1 Core Breaching Functions

Embankment Removal (Excavation Plan)

In the 2002 Feasibility Study, the Corps put extensive study into the requirements for breaching the four lower Snake River dams, including excavation of existing embankments and constructing levees to channel water around the concrete dam structures. In that study, the Corps developed a step-by-step process for excavation, and identified areas for stockpiling the excavated material. Plans developed for the previous dam breaching scenario (breaching earthen embankments and mothballing the concrete structures) included drawings, excavation plans, material quantities, and equipment needs. The Corps still considers these plans to be applicable to that scenario of dam breaching, with the exception of the items noted below.

Current Photograph of Lower Granite Dam

Site Condition During Construction of Lower Granite Dam That May Be Similar to the Breached Condition

An area not adequately addressed in the 2002 Feasibility Study was wet material handling. This study component would include developing methods for stockpiling wet material, driving on wet material, and similar concerns that would be part of the excavation process.

If an alternate method for breaching is recommended, the Corps would develop comparable plans to support the recommendation, including soil testing and surveys at the proposed work site, bedrock mapping, topographic mapping, investigation and location of coffer cell locations (left over from dam construction), and a plan for stockpiling and handling wet material.

There is a possibility that breaching of any of the dams but Lower Granite Dam (the most upstream dam), in particular, may result in an uncontrolled collapse of the embankment prior to complete excavation in a controlled breach. It is also possible that heavy equipment would not be able to work on the embankment materials during an excavation of the embankment. If the clay core is saturated as the lateral support is removed, the slope might fail and result in an uncontrolled release of the remaining reservoir. This same saturated material may make for a working surface that would not support heavy equipment during excavation of the embankment.

To address these issues, each embankment would be explored and a study group would be formed to address the stability and excavation concerns. A series of 12 exploration drill holes would be drilled into each embankment core and the material would be tested for material type, moisture content, in-place density, and other applicable engineering characteristics. A study group would be formed consisting of a dam breach expert and soils engineers with technical experience in slope stability and excavation techniques. This group would assess the adequacy of the breach design and determine if it is technically feasible to breach the embankment. Should the existing design for a controlled breach prove unsafe, then the group would address other approaches to removing the embankments.

Rock Sources

Rock riprap is used at many locations along the lower Snake River projects to protect and stabilize constructed features such as embankments and bridges. The 2002 Feasibility Study identified sites where rock riprap protection might be needed and provided an estimate of the amount and size of the rock required. The study estimated that the drawdown of the four lower Snake River reservoirs would require about 750,000 cubic meters (1 million cubic yards) of riprap material for protection of embankments, drainage modifications, bridge abutments, channel construction, and general slope stability and erosion protection. Material meeting the size and gradation requirements, ranging from 0.3 meter (1 foot) to 0.8 meters (2.5 feet), is generally available from existing quarry sites in the Lower Granite Reservoir and other potential sites in the Ice Harbor and Lower Monumental Reservoirs. Based on experience and the general practice of quarry development within the Lower Granite Reservoir area, about two and one-half times as much material must be processed and can be used for riprap. Quantity estimates for cost purposes would be developed during the Feasibility Phase. Specific locations of quarries would likely take place during development of plans and specifications.

Slope Stabilization

A thorough study was performed to identify embankments that are above the reservoir level. The amount of instability that can be expected for these structures is estimated; however, steep slopes and existing submerged embankments are difficult to quantify. Another area that is difficult to estimate is silt buildup in the reservoir that would be unstable after drawdown and continue to erode as the river changed course and cut through these silt beds.

Damage to the existing embankments can occur in two ways. The primary concern for instability is due to the proposed rapid drawdown of the reservoir water surface. The rapid lowering of the water surface elevation would initiate displacement of the embankments and slopes by sliding and settlement (2002 Feasibility Study, Appendix D, Annex F). Embankment or slope damage could also

occur by undermining from river erosion of the slope or embankment toe.

The Feasibility Study would require a review of the information that is available on existing dam removal and stability within the reservoir. After data review, additional visual surveys would be accomplished to determine areas where new or modified construction has taken place that may be affected by rapid drawdown. A conceptual plan would be developed to address any unstable areas to ensure there is no danger to the public or loss of vital public assets.

Further analysis of the topography and photographs of the channel prior to dam construction would be performed to identify and document any probable unstable slopes after drawdown that were not identified in the 2002 Feasibility Study.

6.3.2 Schedule/Risk/Cost Engineering

Pricing, schedules, and risks associated with dam breaching were evaluated in the 2002 Feasibility Study. This effort related to a wide variety of contractual activities, features, studies, demolition, and construction activities, as well as temporary fish support systems and features required during dam removal. These 2002 studies would need to be re-evaluated and updated in a future Feasibility Study. This would also include the evaluation of costs related to newly discovered elements, activities, and features when costs have not been previously identified or captured.

A wide range of planned modifications and mitigative actions would be necessary as a result of reservoir drawdown. They would be integral parts of the drawdown implementation plan and would include a wide variety of temporary and permanent construction actions. The construction costs presented in a Feasibility Study would be developed by the Walla Walla District Cost Engineering Branch Directory of Expertise. The costs would be based on the scope of work, assumptions, and methodology presented in the engineering studies. The following paragraphs summarize specific details concerning the basis of costs for each of the engineering efforts and the cost

summary tables for each effort. The comprehensive, detailed cost estimates would be developed using the Corps' Micro-Computer Aided Cost Estimating System (MCACES, specifically, the latest version of the M2 software on file with the Walla Walla District Cost Engineering Branch of the Corps).

Components of construction include the following five cost elements: labor, permanent materials, construction equipment, subcontracts, and contractor's expendable supplies. The key ingredient in determining the cost of each of these elements is productivity of the work force and the construction equipment used to perform the various work activities. Productivity rates for individual and specific construction activities, whether temporary or permanent, would be selected to reflect local weather, site conditions, work week hours, craft experience and availability, appropriate construction techniques, schedule sequencing, and experience gained on previous construction projects.

The Feasibility Study would require the completion of a formal cost and schedule risk analysis (CSRA), in accordance with ER 1110-2-1150, ER 1110-2-1302, and ETL 1110-2-573. This includes the performance of risk studies both during the alternative formulation and evaluation phase, as well as development of the recommended National Economic Development (NED) and/or Locally Preferred Plans (LPP) for each of the four lower Snake River dams. The CSRA process would include information gathering and risk identification processes, risk model development, cost estimating and scheduling market research, and performance of quantitative risk analysis using the Monte Carlo simulation technique. Each site would require its own risk analysis process, due to the differing nature of each project location, construction and infrastructure, schedule, and breach feasibility level. The CSRA effort would include coordinating and facilitating risk identification meetings; formulating project risk registers and qualitative analysis; developing quantitative risk study models specific to each project site; collecting and studying market and schedule trends, tendencies, and scenarios for each identified risk; completing Monte Carlo simulation and preparing appurtenant result data and reports; recommending contingency and management reserve levels per project; recommending financial and time management risk reduction measures; and drafting formal financial and time management risk assessment reports to be included in the main report appendices.

6.4 Economic Studies – National Economic Development

The Corps would conduct economic studies that fully evaluate the alternatives for dam breaching. These analyses would be included in the Feasibility Study as a general summary in the main report; an appendix would document the full analysis.

The analysis would conform to the guidelines established by the U.S. Water Resources Council in the publication Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, as well as Corps ER 1105-2-100. This guidance recommends that the evaluation and display of the effects of proposed alternatives be organized into four accounts: NED, Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects. These accounts are described below. The Corps regulation requires documentation of the analysis of NED and Environmental Quality (also known as National Ecosystem Restoration [NER]). For the Feasibility Study, the NED technical analysis would take place during Phase 1. The analysis of effects within the framework of the other three accounts would be conducted in conjunction with the NEPA process in Phase 2.

The Feasibility Study would be based on using the NED as the governing economic analysis to determine which alternatives should be considered for recommendation. The NED Plan displays changes in the economic value of the national output of goods and services, and measures economic efficiency at a national level. It does not measure economic gains or losses of a region.

Beneficial effects measured under the NED account may include increases in the economic value of the national

output of goods and services under actual or simulated market prices, the willingness of users to pay for the goods or services, net income associated with these changes, cost of the most likely alternative, the value associated with the use of unemployed or underemployed labor, and the value of output resulting from external economies caused by the proposed alternative. Adverse effects measured are the opportunity costs of resources used in implementing the plan.

The components of the NED analysis to be conducted during Phase 1 are described below. Discussion of efforts relating to Environmental Quality, Regional Economic Development, and Other Social Effects is included in Section 7.1.

Hydropower The effects of dam breaching on the power system would need to be analyzed during the Feasibility Study. This would include both a power system analysis and a hydropower replacement analysis.

The Corps would work with the Bonneville Power Administration to develop a power system analysis (an NED element) that would measure economic costs associated with changes in hydropower production at the four lower Snake River dams. Because the power generated by the four lower Snake River dams is marketed across the entire west coast, the scope of the analysis would include impacts to that geographic area. The analysis would include enough detail to identify costs to BPA and its ratepayers. This effort would include analysis of power values as the system is currently operated, effects of the various alternatives on power generation, effects of different water conditions on generation, and power reliability and capacity. The analysis would report how changes in hydropower generation may affect other energy types, and the effects of alternate energy types on the environment and the market. A price analysis would measure economic effects on the power market.

A hydropower replacement analysis (another NED element) would examine alternative power generating resources to replace the energy, capacity, and ancillary services that the lower Snake River dams currently provide to both the power system (e.g., power reserves, the ability to follow changes in loads, and regulation of generation) and the transmission system (e.g., voltage support for system stability and reliability). This effort would examine (1) costs associated with using replacement resources to fill all of these needs; (2) what it would take to implement alternative energy resources; and (3) the environmental impacts of alternative energy resources, such as carbon emissions from gas-fired power plants.

Navigation An analysis of impacts to navigation on the Snake River was conducted as part of the 2002 study, which quantified the direct economic effects of disruption of the barging system currently in place. As part of the current study, the Corps would update the results of that study to current pricing indices.

Recreation As part of the 2002 Feasibility Study, the Corps conducted a complete analysis of effects of dam breaching on recreation. The results of that study would be updated to current pricing indices.

Irrigation and Water Supply Economic impacts of dam breaching to irrigation and water supply facilities and operations was evaluated in the 2002 study. If and when the Feasibility study is implemented, the Corps would update the results of the previous study to current pricing indices.

Commercial Fishing The Corps conducted an evaluation of the effects of dam breaching to commercial fishing in the 2002 study. The results of that evaluation would be updated to current price indices for the current study.

6.5 Geographic Information Systems

Breaching the four lower Snake River dams would have large-scale regional effects on a wide variety of economic, environmental, and hydrologic subject matters. Given current geospatial technologies aptitude for data management, analysis, and visualization, Geographic Information Systems (GIS) would be indispensable in the development, assessment, and evaluation of technical study alternatives, as well as restoration and long-term monitoring. The development of a comprehensive geospatial data management plan for a detailed study would require extensive effort given the numerous and complex investigations required in the development of a decision document. Specifically, detailed needs assessments would be conducted to determine the appropriate application of geospatial technologies with each functional business area. The results of the assessments would then aid in the development of a concise geospatial data management and analysis plan.

7.0 PHASE 2 STUDY AND AUTHORIZATION DECISION PROCESS

The technical studies conducted during Phase 1 would be used by salmon policy leaders at the national level to make a decision whether the Corps would move forward with an overall evaluation study and NEPA compliance process. This second phase of the study process would include technical studies and plans needed to support the public decision process for the Feasibility Study or for implementation of the decision. Phase 2 also would include all actions needed for compliance with the applicable environmental laws, and for the public process through which the NEPA document would be reviewed.

7.1 Phase 2 Technical Efforts

If the technical studies conducted during Phase 1 show that dam breaching is a reasonable alternative to address the decline of Snake River salmonid species, the Corps would move into the second phase of the study process. Section 7.1 summarizes the hydrologic, engineering, biological, economic, environmental and related studies and plans that would be performed during Phase 2 of the Feasibility Study.

7.1.1 Hydrologic and Related Studies

The special conditions presented by dam removal would require modification of the existing Water Control Plans. Many other items must also be addressed, including:

- Annual operation of Dworshak Reservoir for juvenile and adult fish
- Fish passage concerns, both upstream and downstream
- Navigation challenges on the Columbia River presented by the removal of Snake River dams (potential increase in dredging operations)
- Modification of Supervisory Control and Data Acquisition (SCADA) systems and stream gaging, both throughout and following the dam removal process

Deviations to existing Water Control Plans may be used in lieu of creating new plans, as necessary, depending on the length of time required for dam removal. It may be necessary to prepare Water Control Plans for retired dams, depending on the expected effects of probable maximum floods on any remaining portions of the dams that might be left in place.

To accommodate the changing conditions of the river system, Emergency Action Plans would also need to be modified throughout the dam removal process, as necessary.

7.1.2 Economic Analysis

As discussed in Section 6.4, the Feasibility Study would use the NED analysis as the primary economic analysis measure relative to which alternatives should be considered for recommendation. The Feasibility Study would consider the benefits and adverse effects associated with all four accounts established by U.S. Water Resources Council, including Environmental Quality, RED, and Other Social Effects, prior to selection of a recommended plan. Analyses for the latter three accounts would be conducted using current policy and guidance at the time the Feasibility Study is undertaken.

Environmental Quality (National Ecosystem Restoration)

The environmental quality analysis displays non-monetary, qualitative effects on ecological, cultural, and aesthetic resources, including the positive and adverse effects of the proposed action. Beneficial and adverse effects addressed in the Environmental Quality account include changes in ecological, aesthetic, and cultural attributes of natural and cultural resources.

An environmental quality analysis would include an incremental cost analysis to measure the environmental outputs against the costs. With the cost-effective (CE) analysis, incremental cost analysis (ICA) would be completed that shows the best-buy solutions. A best buy is designated by those cost-effective plans that have the greatest increase in output or benefit for the least increase in cost. Both the CE/ICA and best-buy analysis would be completed using the Corps model IWR Plan. The plan that reasonably maximizes environmental benefits related to costs is known as the NER Plan.

Because of the challenge of dealing with non-monetized benefits, the concept of significance of outputs plays an important role in ecosystem restoration evaluation. Along with information from CE/ICA and information about acceptability, completeness, and effectiveness, information on the significance of ecosystem outputs would be used to determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended.

Regional Economic Development

The RED analysis shows changes in the distribution of regional economic activity such as income and employment associated with the proposed plan. The Feasibility Study would model effects to the Lower Snake Region identified in Section 4.2, essentially Lewiston, Idaho, to Pasco, Washington. Other regional effects, such as an analysis of effects to power supply and rates, would be modeled at a state level.

Other Social Effects

The Other Social Effects analyses would portray the effects of the proposed plans on social aspects such as community, health and safety, displacement, energy conservation, loss of life, and social justice issues.

7.1.3 Biological Analyses – Terrestrial Ecosystem Effects

Wildlife

Birds

The lower Snake River is used as a minor flyway and wintering area for various species of ducks and geese. Some nesting by ducks and geese also occurs on New York Island and in backwater areas. Ring-necked pheasants, California quail, chukar, and doves also occur along the river, especially near intensively managed Habitat Management Units (HMUs). A variety of non-game birds can also be found along the

river. Killdeer, sandpipers, gulls, swallows, hawks, owls, eagles, osprey, and numerous songbirds are present. Birds are not likely to be directly affected by removing the dams.

Mammals

Big Game Both mule and white-tailed deer can be found along the lower Snake River. Deer use the reservoirs as a watering source in some locations. Upon dam breaching, some of the river would become inaccessible for that purpose.

Furbearers Beaver, muskrats, mink, coyotes, and raccoons are common along the river. River otter are also present in some locations. Dens are often located along the shoreline. Effects to furbearers from dam removal are expected and would be identified through updating information from the 2002 Feasibility Study.

Non-Game Species A variety of non-game species exists along the lower Snake River. Small species such as mice, voles, shrews, and bats can be found along the shoreline. Dam removal would not directly affect non-game species, and no further study is recommended.

Reptiles and Amphibians

Sixteen species of amphibians and reptiles have been documented in the study area, with two additional species likely there due to the presence of suitable habitat and documented presence in the vicinity. Amphibians and reptiles use a variety of habitats along the lower Snake River. Emergent wetlands and riparian areas are especially important to amphibians, and some amphibians could be adversely affected by dam breaching.

Vegetation

Riparian

Prior to construction of the dams, there were approximately 5,200 acres of riparian vegetation along the lower Snake River. This included forb areas composed of species such as teasel, curly dock, and water hemlock; shrubland, represented by hawthorn, chokecherry, currant, and blackberry; scrub-shrub dominated by coyote and other willows; and forested areas dominated by black cottonwood and white alder. Much of this vegetation was found in discontinuous stringers along the main river, at the bottom of the canyon. Today less riparian habitat exists (approximately 2,100 acres).

Habitat Management Units

The Corps manages 54 HMUs along the lower Snake River. These HMUs were established to compensate for lost wildlife habitat due to reservoir impoundments behind the Snake River dams. Under the Lower Snake River Fish and Wildlife Compensation Plan, 30 areas were purchased and set aside for wildlife habitat mitigation. Most of the HMUs are non-irrigated, but 10 HMUs have irrigation systems either supplied by surface water intakes in the river or by groundwater wells. Approximately 960 acres are irrigated.

The irrigated HMUs include one or more wells or pumping stations for water supply. There are currently 8 HMUs being irrigated by 11 surface water pumping plants and 2 HMUs being irrigated by well-supplied water. The table below identifies which HMUs are currently irrigated and would require water supply modifications if dam breaching were to occur.

HMU	Water Supply Source
Big Flat	Pump Stations
Lost Island	Pump Stations
Hollebeke	Pump Station
Skookum	Pump Station
Fifty-five Mile	Pump Station
Ridpath	Ground Water Well
New York Bar	Pump Station
Swift Bar	Pump Station
John Henley	Ground Water Well
Chief Timothy	Pump Stations

Irrigated HMUs along the Snake River

The major effect of drawdown on the HMUs would be the disruption of the existing irrigation systems. The lower river water surface would render the river intake pumping systems inoperable and significantly affect the water wells. No further site-specific evaluation is necessary. An overall evaluation of the HMU program following dam removal would be undertaken in conjunction with the Feasibility Study.

Invasive Plants

If dam breaching were implemented, approximately 14,000 acres that are currently inundated would be exposed and in need of revegetation. These barren areas would be extremely susceptible to invasion by noxious weeds. A shoreline revegetation plan was compiled for the 2002 Feasibility Study (Appendix D, Annex K). In addition to this plan, the Corps would explore options for controlling noxious weeds after dam breaching.

Implementation Planning

Lower Snake River Fish and Wildlife Compensation Plan

The Lower Snake River Fish and Wildlife Compensation Plan has been implemented since the 1970s to mitigate losses to fish and wildlife along the lower Snake River from dam construction. To this end, fish hatcheries were built, a game bird stocking program was started, habitat was improved, and land was purchased. A large portion of the Compensation Plan focuses on compensation for lost riparian habitat.

Restoration Plan

The Corps produced a Restoration Plan in the 2002 Feasibility Study. This Restoration Plan assumed breaching of the earthen embankments of the four lower Snake River dams, and estimated the amount of seeding and planting needed per reservoir location to restore native vegetative communities. The 2002 Restoration Plan estimated a 10-year effort for effective vegetation re-establishment.

The Feasibility Study would build on the Restoration Plan produced in 2002. The details of the future Restoration Plan would be dependent on the final alternative selected and the potential configuration of proposed breaching. Where the 2002 Restoration Plan included only vegetative re-establishment, a future Restoration Plan might include in-water habitat features (e.g., constructed pools, riffles, and log jams) to optimize the benefits of habitat that might be created by breaching the lower Snake River dams. A real estate analysis to determine the amount and status of

exposed property (previously inundated) would need to be completed prior to investment in a Restoration Plan. An adequate Restoration Plan would require research, monitoring, and evaluation coordinated with state and regional interests.

Monitoring and Adaptive Management

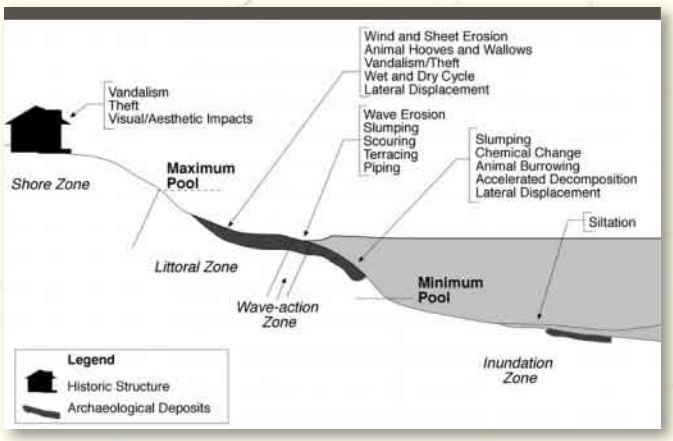
A Monitoring and Adaptive Management Plan would be developed. Adaptive management prescribes an iterative management process wherein management activities can be changed in relation to their efficacy in restoring or maintaining an ecological system in some desired range of conditions. The adaptive management process would benefit from the active participation of regional stakeholders.

The Corps would use an adaptive management strategy supported by monitoring. Future decisions would then be adapted based on those monitoring results. The adaptive management would focus on short-term (0 to 5 years) and mid-term (5 to 10 years) management actions and system responses.

It is difficult to predict exactly how the river system would respond to dam breaching. Management actions such as in-stream habitat improvements and extra revegetation efforts could become necessary. The sequence of dam removal is also unknown at this time. Monitoring and adaptive management would be used to help reduce environmental impacts as dam removal progresses.

7.1.4 Cultural Resources

Any ground-disturbing action or building/structure alteration that would potentially occur in association with the technical studies undertaken for the Feasibility Study, including testing, construction actions, or modification of the dams for dam breaching studies, would require a National Historic Preservation Act (NHPA) Section 106 compliance review. The Walla Walla District cultural resources team would interface with technical teams from States and Tribes during initiation of all technical studies to start the Section 106 compliance process. Completion of field investigations and reporting is a prerequisite for consultation. Section



106 consultation includes a mandatory 30-day review process with tribes and the State and Tribal Historic Preservation Offices. All comments received must be addressed prior to initiation of ground-disturbing activities.

Identify and Evaluate Cultural Resources and Historic Properties

Cultural resource baseline information would be collected for inclusion in Feasibility Study documents. A literature review would be completed to compile, describe, and display all known cultural resources and historic properties in the study area, including traditional cultural properties (sites of religious or cultural significance). This baseline information would include text and graphic displays defining the location and condition of known cultural resources and historic properties. Additional information gathered about each resource and/or property would include, but would not be limited to, the status of National Register of Historic Places (NRHP) eligibility determinations, site elevation, and depth and extent of cultural deposits. One or more of the lower Snake River dams might be 50 or more years old at the time of a possible breaching, and therefore potentially eligible for the NRHP.

Determine Effects on Cultural Resources and Historic Properties

The Corps would identify high-probability areas for unknown cultural resources and all areas of probable impact for all four lower Snake River projects. Sites, resources, and buildings/structures would be identified

on a GIS mapping database with associated site information. The probable effects of the proposed project on cultural resources and historic properties would be presented. A determination of effect finding for each cultural resource and historic property would be completed. The finding would be based on current information, predictions about water elevation changes, and future actions. Evaluations of cultural resources would be completed, as appropriate, and mitigation of adverse impacts would be proposed. Information generated would be compiled in a report. The Walla Walla District would consult with affected tribes and the State and Tribal Historic Preservation Offices using the generated reports and documents. Any adverse effect determinations would be mitigated and treatment/protection plans developed in consultation with State and Tribal Historic Preservation Offices. Mitigation and/or protection measures would be addressed in a MOA.

Protection Plans for Cultural Resource Sites

A Protection Plan for significant cultural resources would be developed. This plan would include the protection of sites during construction and evacuation of the reservoirs, following the evacuation process, and could include restoration activities. Activities in the plan may involve law enforcement actions, construction of barriers, or excavation and removal of historic material from known sites. Work would include long-term planning for curation of collections and compliance with all applicable laws. The Protection Plan would be coordinated with local tribes and the State and Tribal Historic Preservation Offices, as required.

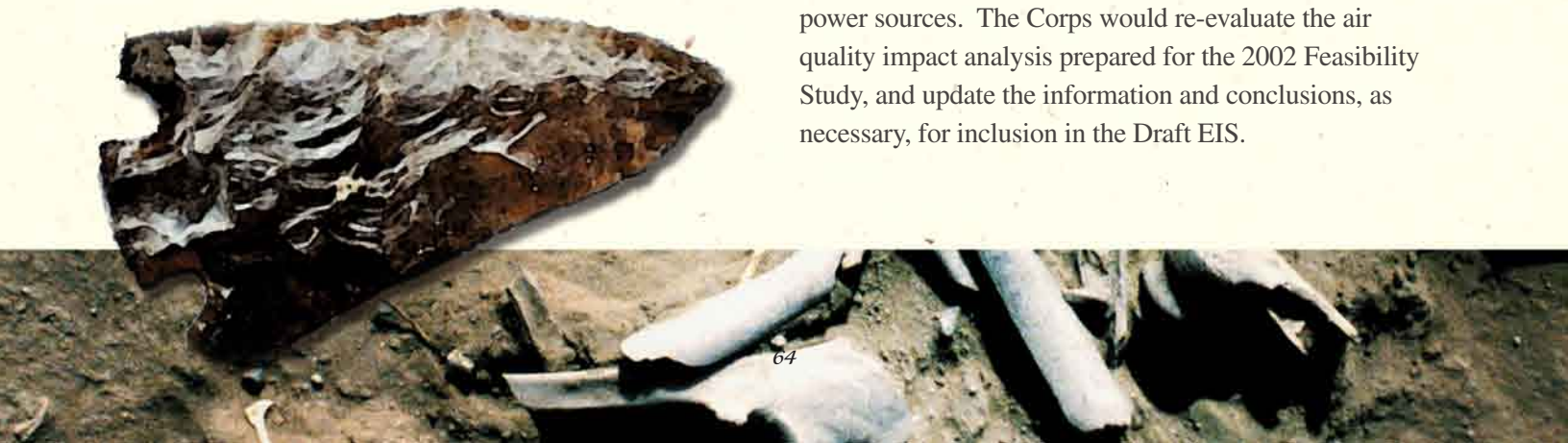
Archaeological Monitoring Plan

A Monitoring Plan would be developed to define the timing and duration of archaeological monitoring actions to be conducted during the dewatering of each reservoir. The Monitoring Plan would establish when monitoring would take place and the applicable documentation and reporting procedures. The Monitoring Plan would also address the procedures, consultation actions, and reporting processes to be completed in the event human remains, burials, or cemeteries are exposed during construction or dewatering activities in each of the four existing reservoirs.

7.1.5 Other Environmental Studies

Air Quality

Dam breaching would affect local and regional air quality through several avenues, including emissions from equipment used in dam removal, fugitive dust from about 14,000 acres of previously inundated land that would be exposed, emissions from alternate transportation modes, and emissions from alternate power sources. The Corps would re-evaluate the air quality impact analysis prepared for the 2002 Feasibility Study, and update the information and conclusions, as necessary, for inclusion in the Draft EIS.



Aesthetics

Dam breaching would affect the aesthetics of the lower Snake River canyon. The Corps would re-evaluate the aesthetics impact analysis prepared for the 2002 Feasibility Study, and update the information and conclusions, as necessary, for inclusion in the Draft EIS.

7.1.6 Real Estate

A Real Estate Plan would be developed for the Feasibility Study. For each alternative, the Real Estate Plan would include a gross appraisal. Real estate issues to be addressed include the following:

- Land disposition
- Reserved rights
- Leases, out-grants, and easements
- Pump stations and appurtenances
- Wells, utility crossings, and effluent lines

A Real Estate Plan was developed for the 2002 Feasibility Study that outlined procedures and considerations. Historical information about acquisition in the 2002 Real Estate Plan is still accurate and applicable. Information related to land disposals would be updated. Information concerning the number and type of leases, easements, and out-grants would be updated, and impacts considered, in the alternative evaluation.

7.2 Environmental Compliance

Breaching the four lower Snake River dams would require coordination with appropriate agencies, special interest groups, and the general public, and compliance with applicable environmental laws and regulations for construction of structural components and operational modifications. Compliance requirements include the NEPA, Clean Water Act, ESA, FWCA, Pacific Northwest Electric Power Planning and Conservation Act, and various cultural resources laws.

Compliance activities would be required for all construction actions, including protection and restoration activities, modifications to operation of the Columbia and Snake River system, regional alterations to electrical power generation, and modifications to the navigation systems and transportation systems.

Key Laws for Environmental Compliance

- National Environmental Policy Act (NEPA)
- Endangered Species Act (ESA)
- Clean Water Act
- Clean Air Act
- Fish and Wildlife Coordination Act (FWCA)
- National Historic Preservation Act (NHPA)
- Archaeological Resources Protection Act (ARPA)
- Native American Graves Protection and Repatriation Act (NAGPRA)
- American Indian Religious Freedom Act (AIRFA)
- Pacific Northwest Electric Power Planning and Conservation Act

7.2.1 National Environmental Policy Act of 1969

Federal agencies are required by NEPA to integrate environmental values into their decision making processes by considering the environmental impacts of proposed actions and reasonable alternatives to those actions. The NEPA coverage for this project would likely include development of an EIS. The following paragraphs describe the typical process the Corps would follow for preparing an EIS.

Early in the NEPA process, the Corps, as the lead agency, would determine whether to extend invitations to other Federal and state agencies and tribes to participate in the study as cooperating agencies. Upon request by the Corps, any other Federal agency with jurisdiction by law is to be a cooperating agency unless other program commitments preclude their involvement. Also, an agency may request the Corps to designate that agency as a cooperating agency. Cooperating agencies participate in scoping, develop information, prepare environmental analyses, and provide staff support.

Prepare Notice of Intent

The NOI is an official announcement, in writing, declared after the decision is made to prepare an EIS. The NOI appears in the Federal Register, states the purpose and need of the proposed action, describes (if known) all practical alternatives, and refers to pertinent laws, agency missions, and other environmental documents that might influence the range of alternatives. The NOI would also summarize the proposed scoping process, including (if known) the date and time of the initial public scoping meeting(s).

The Corps would prepare a draft NOI and circulate it for internal and Action Agency review. The Corps would then incorporate comments and submit the final NOI for publication in the Federal Register.

Perform Scoping

Scoping is the crucial start of the NEPA process. Scoping is used to determine the range of actions, impacts, and alternatives to be considered in the EIS. It involves public participation and meetings in and around the project impact area. Scoping for this study would be conducted through several means, using in-house personnel and capabilities. The Walla Walla District would mail scoping letters to a distribution list, inviting comments on the scope of the EIS and participation in scoping meetings. Public scoping meetings would be held at several locations in the region. Technical scoping meetings would be held with stakeholders such as ports, tribes, railroads, and local governments. The Corps would collect all of the comments generated through the scoping process, and summarize them in a scoping report.

Prepare Draft EIS

Information gathered from the scoping process and hydrological, biological, and engineering studies would be utilized to develop a preliminary Draft EIS for internal review and ATR, and a final Draft EIS for public and agency review. The Draft EIS would include a description of the existing environment, a description of alternatives, analysis of impacts of the viable alternatives, identification of the preferred alternative, discussion of necessary mitigation, and status of compliance with all Federal laws. The Corps would file the Draft EIS with EPA, and distribute the Draft EIS to the established mailing list for public and agency review. The Corps would also post the Draft EIS on its website. The Corps estimates it would take about 2 years to prepare the Draft EIS, go through the internal reviews, and file the Draft EIS with EPA.

Respond to Public Comments on Draft EIS

The Draft EIS would be released for a minimum 45-day public review period. The review period would begin on the date EPA publishes the Notice of Availability of the Draft EIS in the Federal Register in its list of weekly receipts. Another set of public meetings would be held in the region to present the findings in the Draft EIS and take public comment. Questions and comments collected during the review, and the Corps' responses to the comments, would be placed in an appendix of the Final EIS.

Prepare Final EIS

The Corps would prepare the Final EIS, based on information and comments received during the review of the Draft EIS and the other associated environmental reviews. Changes would be made in the EIS to incorporate comments on the Draft EIS, as appropriate, address valid and/or significant issues raised, and evaluate any new information. The Corps would develop a preliminary Final EIS for internal review and a Final EIS for public and agency review. The Corps estimates it would take about 1 year from the date of the Draft EIS Notice of Availability to complete the Final EIS. All other associated environmental reviews should be complete and incorporated into the Final EIS prior to filing with EPA. The Corps would file the Final EIS with EPA, and distribute the Final EIS to the established mailing list for a 30-day waiting period, during which the public and agencies may submit comments. The waiting period would begin on the date EPA publishes the Notice of Availability of the Final EIS in the Federal Register in its list of weekly receipts. The Corps would also post the Final EIS on its website.

Another set of public meetings would be held in the region, at the same locations as the meetings on the Draft EIS, to present the findings in the Final EIS and take public comment.

Prepare Record of Decision

The final step in the NEPA process is the preparation and signing of a ROD. The ROD explains the final decision made and summarizes the action to be taken, along with all mitigating requirements. The ROD includes comments received on the Final EIS, responses to those comments, issues still not resolved, and identification of how those issues would be resolved. The Corps would develop a draft ROD for internal review. The Corps would distribute the signed ROD to the mailing list, and post the signed ROD on its website.

7.2.2 Clean Water Act

Actions identified in the EIS would likely require compliance with Sections 401, 402, and 404 of the Clean Water Act. Section 401 requires an applicant for a Federal permit involving in-water discharge to obtain certification from the applicable state that the discharge meets state water quality standards. Section 402 regulates the discharge of pollutants into waterways through the National Pollutant Discharge Elimination System (NPDES). These discharges include point source, non-point source, and stormwater. Section 404 requires a permit for the discharge of dredged or fill material into navigable waterways. The Corps does not issue itself permits; therefore, for civil works actions, the Corps prepares an analysis of the discharge, but does not obtain a permit.

Prepare Section 404(b)(1) Evaluation

Discharge of fill material below the ordinary high water mark associated with construction activities and operational changes requires evaluation under Section 404 of the Clean Water Act. The preferred alternative would likely include placement of fill material in water. The Corps would need to prepare a Section 404(b)(1) evaluation for the preferred alternative to address the impacts to water quality and the aquatic environment from placing any fill material. This evaluation would become an appendix to the Draft EIS.

Request Section 401 Water Quality Certification

If an action includes activities subject to Section 404, the action is also subject to Section 401. Because the preferred action would likely require review under Section 404, the Corps would need to request Section 401 water quality certification from the appropriate state agencies (Idaho Department of Environmental Quality and/or Washington Department of Ecology). The Corps would also issue a Public Notice advising all interested parties of the project, and soliciting comments and information necessary to evaluate the probable impact of the discharge. Normally, the review period for the notice is 30 days. This review period would be concurrent with the review period for the Draft EIS; however, the state agencies can have up to 1 year to respond to the Corps' request for 401 certification, although normally they respond within 2 to 6 months.

Request Section 402 NPDES Permit

Activities connected to any preferred alternative involving dam breaching may be subject to the stormwater provisions of Section 402. If deconstruction activities would disturb more than 1 acre of land and there is the possibility that stormwater from that disturbed area could enter surface water, the action would likely be subject to Section 402 and require an NPDES permit. The Corps would likely request NPDES permits at this time rather than requiring construction contractors to obtain the permit. The Corps would need to prepare an NOI and a Stormwater Pollution Prevention Plan, which would be included in the Draft EIS.

There is also the possibility that the dewatering of almost 14,000 acres of submerged shoreline may require an NPDES stormwater permit, because all of this land would be subject to stormwater runoff until soil stabilization measures were implemented. The Corps would contact EPA to determine whether an NPDES permit would be needed. If a permit were needed, the Corps would need to prepare an NOI and a Stormwater Pollution Prevention Plan, which would be included in the Draft EIS.

7.2.3 Endangered Species Act

The ESA establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants, as well as the habitat upon which they depend. Section 7(a) of the ESA requires Federal agencies to consult with USFWS and NOAA Fisheries, 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 would consult with both USFWS and NOAA Fisheries regarding the effects of the preferred alternative on listed species or their critical habitat.

Prepare Biological Assessment

The Corps would likely need to prepare a BA for the implementation of the preferred plan, including all construction and operational changes necessary to modify the FCRPS hydropower system. The Corps would obtain a current list of all potentially affected species from USFWS and NOAA Fisheries. In the BA, the Corps would evaluate the effects of the preferred plan on those species and would include the results of the fish life-cycle model being developed by NOAA Fisheries for this effort. The BA would be included in the Draft EIS.

Initiate Consultation

The Corps would initiate Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation with NOAA Fisheries for all actions identified in the preferred plan or as a result of implementation of the preferred plan. The Corps would also need to initiate Section 7 Formal Consultation with USFWS for all actions in the preferred plan. The USFWS and NOAA Fisheries, in consultation with the Corps, would make a jeopardy and critical habitat determination. Formal Consultation normally takes about 6 months to conclude, beginning with the date

USFWS and NOAA Fisheries receive the BA from the Corps, and ending when USFWS and NOAA Fisheries issue their respective BiOps. The BiOps would be included in the Final EIS.

7.2.4 Fish and Wildlife Coordination Act

The FWCA requires consultation with USFWS and the appropriate state wildlife agency 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 potential damage to wildlife and the mitigation measures that should be taken. The USFWS may provide a Planning Aid Report that: 1) provides the Corps with a description of the fish and wildlife resources that exist in, and are influenced by, the action; 2) identifies potential impacts to fish and wildlife that could occur from the proposed actions; 3) identifies significant data gaps and study need that the Corps needs to address in preparation of the study; and 4) identifies Federally listed threatened, endangered, and candidate species that could be impacted by the preferred alternative. An FWCA Report, as required under Section 2(b) of the Act, outlining the USFWS position on the proposed plan, would then be provided.

As part of this effort, USFWS would need to consider the effects of the preferred alternative on the Lower Snake River Fish and Wildlife Compensation Plan, which provides compensation for fish and wildlife losses associated with the four lower Snake River reservoirs and was developed in compliance with the FWCA.

The Corps would develop and negotiate a scope of work, schedule, and budget for participation by the USFWS pursuant to the interagency cooperative agreement. The Corps and USFWS would review and evaluate the product at the completion of each task under the scope of work. The Coordination Act Report would be included in the Final EIS.

7.2.5 Cultural Resources Compliance

Actions identified in the EIS would likely require compliance with several cultural resources protection laws including the NHPA, the Archaeological Resources Protection Act (ARPA), the Native American Graves Protection and Repatriation Act (NAGPRA), and the American Indian Religious Freedom Act (AIRFA), which are all discussed further below.

National Historic Preservation Act

The NHPA (16 United States Code 470) established the Federal policy of protecting historic properties in coordination with state and local governments. It authorized the Secretary of the Interior to expand and maintain an NRHP and determine the criteria of eligibility for listing with the Register. Amendments to Section 101 of the NHPA in 1992 explicitly allowed properties of traditional religious and cultural importance to be eligible for inclusion in the NRHP. Section 106 of the NHPA requires that a Federal agency consider the effects of agency undertakings on properties included in the NRHP or that may be eligible for inclusion in the NRHP, prior to approval of the undertaking. The process is designed to integrate preservation concerns with the needs of Federal undertakings. Study and consultation activities to be undertaken for Section 106 compliance were described previously in Section 7.1.5.

Archaeological Resources Protection Act

The ARPA supplements the 1906 Antiquities Act, and applies mainly to Federal land-managing agencies. It prohibits the excavation or removal of archaeological resources from Federal or Indian lands without a permit from the land manager. The ARPA imposes prohibitions on looting and vandalism, levies stiffer penalties for such activities than were in place previously, and prohibits interstate trafficking in cultural remains recovered from Federal lands. Finally, the ARPA furthers the cooperative protection of archaeological resources nationwide by Federal authorities, private individuals, and professional organizations.

Native American Graves Protection and Repatriation Act

The NAGPRA establishes the rights of Native American groups to human remains and associated

cultural objects recovered from Federal or Indian lands. It also establishes procedures and consultation requirements for intentional excavation or accidental discovery of Native American remains on Federal or tribal lands.

American Indian Religious Freedom Act

The AIRFA protects the rights of Native American people to believe, express, and exercise their traditional religions. It requires review (in consultation with Native American leaders) of Federal agency policies and programs to determine changes necessary to protect and preserve religious and cultural practices of Native Americans.

7.2.6 Other Applicable Environmental Laws, Regulations, and Executive Orders

Other applicable environmental laws, regulations, and EOs would be addressed in the EIS, as follows:

- EO 12898 Environmental Justice
- EO 11988 Flood Plain Management
- EO 11990 Wetlands Protection
- Farmland Protection Policy Act
- Wild and Scenic Rivers Act
- Council on Environmental Quality Memorandum of August 11, 1990, Analysis of Impacts on Prime or Unique Agricultural Lands
- Land and Water Conservation Fund Act

7.3 Public Involvement Plan in Conjunction with NEPA Process

The Corps would develop a public outreach plan to guide public involvement activities throughout the entire study. There are two primary objectives of this plan: 1) to ensure public participation and inclusion of a full range of public values into the planning and NEPA process; and 2) to inform the public regarding the output and results of the study. The public outreach plan would include a website, newsletters/fact sheets, open houses, workshops, public meetings, hearings, maintaining mailing lists, and responding to inquiries/ comments.

7.3.1 Develop and Maintain Mailing List

The Corps would develop a mailing list of all interested and applicable parties and periodically update the list for use throughout the planning and NEPA process. The list would include Federal and state agencies; Federal, state, and local government offices; Federal, state, and local elected officials; stakeholders; tribes; organizations and interest groups; and interested public that have attended meetings or submitted inquiries.

7.3.2 Perform Outreach to Agencies, Tribes, and Other Stakeholders

The Corps would perform public outreach during all phases of the study. Technical workshops could be held during the technical

analysis phase to gather data and information on various subjects. At least three series of public meetings would be held as part of the NEPA process.

7.3.3 Conduct Scoping Meetings/Workshops

The Corps would conduct public scoping meetings at the beginning of the EIS portion of the study.

7.3.4 Conduct Interim Status Meetings

The Corps may decide to have interim status meetings during preparation of the technical analyses and the Draft and Final EIS. These meetings could focus on specific subjects or the Feasibility Study as a whole. The meetings could be held in some or all of the same locations as the scoping or public meetings for the Draft EIS.

7.3.5 Conduct Public Meetings/Hearings on Draft EIS

The Corps would conduct public meetings after the Draft EIS is distributed for public and agency review. These meetings could be informational, with the Corps answering questions and taking comments from the public; they could be public hearings where formal testimony is accepted; or they could be a combination of both.

7.3.6 Conduct Final Public Meetings on Final EIS

The Corps would conduct public meetings after the Final EIS is distributed for review. As with the meetings on the Draft EIS, these could be information meetings, public hearings, or a combination of both.

7.3.7 Website Maintenance and Preparation/ Distribution of Fact Sheets

The Corps would maintain a website for the study as a means of distributing information regarding the study and the NEPA process. The Corps would use the website to post notices for the scoping meetings and meetings on the Draft and Final EIS. Documents prepared as part of the NEPA process (i.e., the NOI, scoping summary, Draft EIS, Final EIS, and ROD) would also be posted on the website.

The Corps would prepare a series of fact sheets during the study process. The Corps would distribute these via U.S. mail, e-mail, and posting on the website.

Public Meetings

The Corps would conduct public meetings after the Final EIS is distributed for review. As with the meetings on the Draft EIS, these could be information meetings, public hearings, or a combination of both.

8.0 REGIONAL REVIEW AND COORDINATION

The Corps recognizes that coordination with regional stakeholders is a critical part of the decision process on breaching the four lower Snake River dams. Regional cooperation shaped this Plan of Study. This study plan was coordinated with the Action Agencies, Federal Caucus (made up of other federal agencies in the region), and the RIOG, made up of state, tribal, and regional cooperators. These groups all reviewed the draft Plan of Study, and provided comments. Many of the comments received were incorporated into this document. If and when a trigger is tripped and it is determined that it is necessary to initiate studies for breaching the four lower Snake River dams, all of these regional cooperators would be engaged for their input and assistance in the process, as would many other stakeholders throughout the region.

8.1 Communication Plan

The Corps, and any cooperating agencies, would develop a Communication Plan to guide public involvement activities that support the Feasibility Study. As discussed in Section 7, NEPA requires scoping and public review. In addition to scoping meetings, the Corps would conduct stakeholder meetings and workshops to raise awareness and understanding of the issues, and provide opportunities for dialogue and involvement. The Corps may use a combination of the following types of formats to meet this objective:

- Information meetings
- Formal public meetings and hearings
- Workshops
- Briefings
- Tours
- Speaking engagements
- Electronic platforms (website, blogs, social networking sites)
- Mailing list
- Newsletters
- News releases
- Media broadcasts

The audience for these outreach efforts may include the following:

- Elected officials
- State and Federal agencies
- Affected tribes
- General public
- Academia
- Media

8.2 Regional Implementation Oversight Group

The RIOG is a policy working group made up of regional entities. The working group has collaborated on policy issues over the life of the BiOp remand, and the Corps will continue to work with the RIOG as the Corps works through issues associated with the FCRPS BiOp. The Corps would coordinate the Feasibility Study analysis and recommendations with the RIOG using regular meetings over the life of the Feasibility Study.

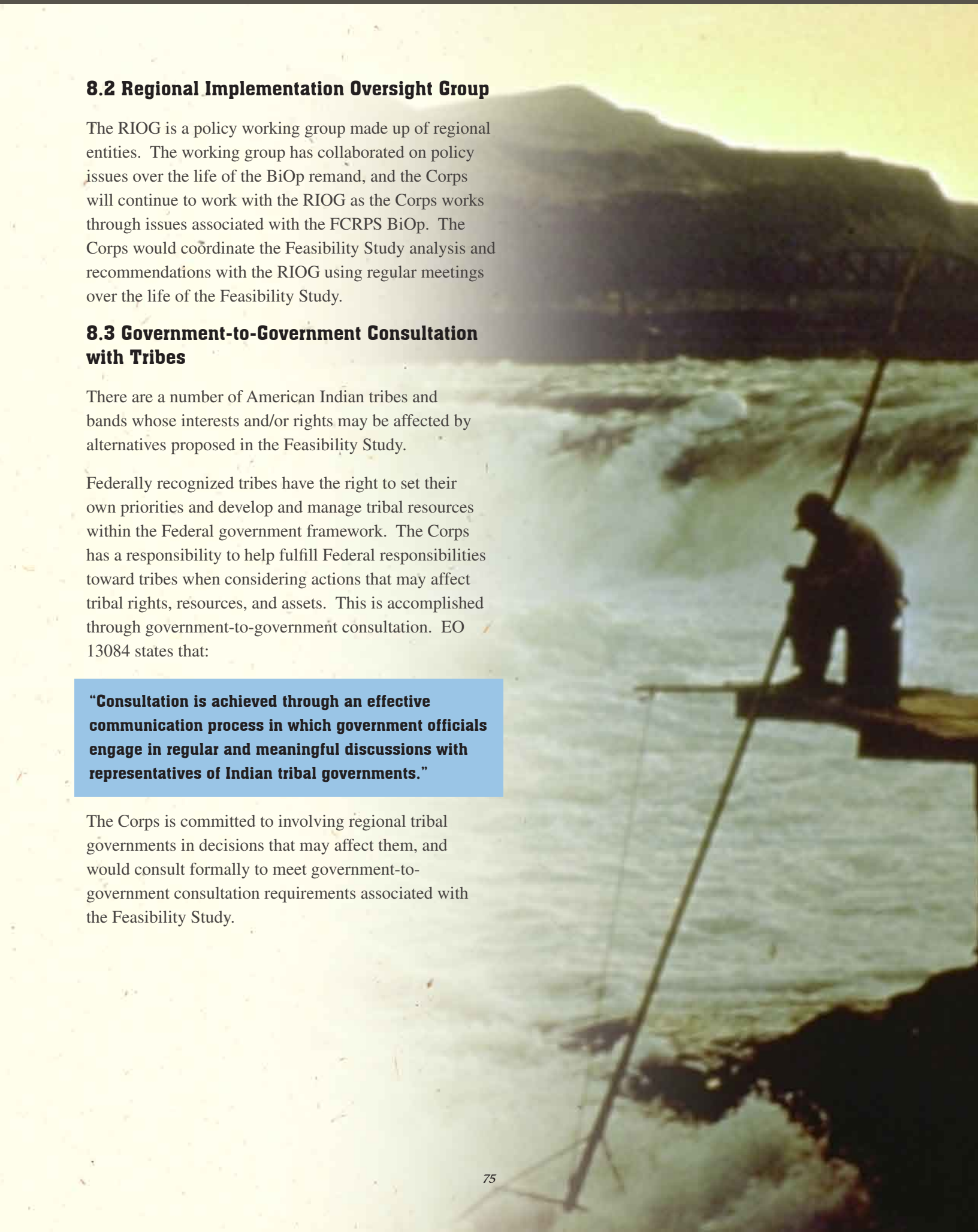
8.3 Government-to-Government Consultation with Tribes

There are a number of American Indian tribes and bands whose interests and/or rights may be affected by alternatives proposed in the Feasibility Study.

Federally recognized tribes have the right to set their own priorities and develop and manage tribal resources within the Federal government framework. The Corps has a responsibility to help fulfill Federal responsibilities toward tribes when considering actions that may affect tribal rights, resources, and assets. This is accomplished through government-to-government consultation. EO 13084 states that:

"Consultation is achieved through an effective communication process in which government officials engage in regular and meaningful discussions with representatives of Indian tribal governments."

The Corps is committed to involving regional tribal governments in decisions that may affect them, and would consult formally to meet government-to-government consultation requirements associated with the Feasibility Study.



9.0 FEASIBILITY STUDY COST ESTIMATE

The Corps prepared a Feasibility Study cost estimate that reflects fiscal year 2010 price levels, and is intended for informational purposes. The preliminary estimate indicates an expected total cost of approximately $19.8 million. This cost estimate includes a 35 percent contingency for risk and uncertainty. Details of the cost estimate are included in Appendix A. The cost estimate will be revised and updated to current price levels upon initiation of the Feasibility Study. The cost estimate may also be adjusted in the future to reflect any changes in scope that may result from data and technical innovation or new available information.

10.0 FEASIBILITY STUDY SCHEDULE

The Feasibility Study schedule reflects commitments made in the AMIP to conduct technical studies and analyses that will determine the necessity of proceeding with a decision process in the first 2 years, and following with a 3 year public decision process/NEPA process. A representative schedule for the Feasibility Study is provided in Appendix B. The specific dates in the representative schedule are intended only to give the reader an idea of activity durations and predecessors. Execution of, and adherence to, this schedule is dependent on receipt of full project funding at the start of the project.

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Appendix A

Feasibility Study Cost Estimate

			GS-15	GS-14	GS-13	GS-12	GS-11	GS-9	GS-8	GS-7					
FAC. COST OF CAP. :	0.00%														
SRE:	0.00%	'current approx hourly rate FY-10:	$50.00	$45.00	$40.00	$35.00	$30.00	$25.00	$20.00	$15.00		UNIT	1	18.00	
OH:	0.00%	FACTORED RATE (W/ OH):	120.00	110.00	100.00	90.00	80.00	70.00	60.00	50.00		RATE:	LS	$/DAY	
Contingency:	35.00%										ITEM TOTALS				
			LABOR (HOURS)								HOURS	DOLLARS		DIRECT COST ITEMS	(DOLLARS)	ITEM TOTALS
Phase I Technical Studies	Estimated pages	0									0	$0		$7,350,000	$0	#REF!
Aquatic Ecosystem Studies					150	560	300									
Hydrology			24	56	40	72	72	16								
Channel Hydraulic and Hydrodynamic Modeling		0	7		392	296	296	59						$2,100,000.00		
Sediment Transport Modeling for Dam Removal			6	40	618		316	32						$1,400,000.00		
Channel Stability and Evaluation			1		120		80	4								
Sediment Transport Modeling for Dam Removal					24		8	1								
McNary Reservoir Evaluation		0			32		24	3								
Water Quality Modeling			2		86	429		114						$1,000,000.00		
Cimate Change Impact					48		24	3								
Sediment Characterization and Quality			6		1700	1000		40						$1,500,000.00		
Engineering Studies		0	68	80												
Excavation Plan			6		200	404		41						$600,000.00		
Schedule/Costs/Risk			40		1250	1040		104								
Qualitative Review - Dam Removal Alternatives			20	64	1248	1664	832	166								
Economoic Studies	RESERVED	0														
Power Analysis						200	200									
GIS/Data Management						160										
		0														
Phase 2 Study and Authorization Decision Process																
Feasibility Study Process																
Plan Formulation		0		100	3000	2000	800									
Corps' Review Process		0			560	500	48			160				$750,000.00		
Public and Agency Review		0			160	320										
Phase 2 Technical Efforts		0														
Hydrologic & Related Studies		0														
Engineering Plans		0														
Economic Analysis		0				480										
Biological Analyses - Terrestrial Ecosystem Effects		0			275	370										
Cultural Resources		0				200								$40,000.00		
Other Environmental Studies		0														
Real Estate					220	400	1600			80						
Environmental Compliance		0														
National Environmental Policy Act of 1969		0			488	2000								$1,100,000.00		
Clean Water Act		0			6	54										
Endangered Species Act		0			8	66										
Fish and Wildlife Coordination Act		0			16	120										
Cultural Resources Compliance		0			22	162										
Other Applicable Environmental Laws, Regs, & Exec Orders		0			2	16										
Public Involvement Plan (in conjunction with NEPA process)		0			160	160										
Regional Review and Coordination																
Communication Plan		0			90											
Regional Implementation Oversight Group		0			100											
Government to Government Consultation with Tribes		0			240											
Meetings		0			320	200										
	CATEGORY TOTALS		180	340	11575	12873	4600	583	0	240	30391		CATEGORY TOTALS	$7,350,000	$0	$7,350,000
			$9,000	$15,300	$463,000	$450,555	$138,000	$14,575	$0	$3,600		$1,094,030				

PROJECT TOTALS:

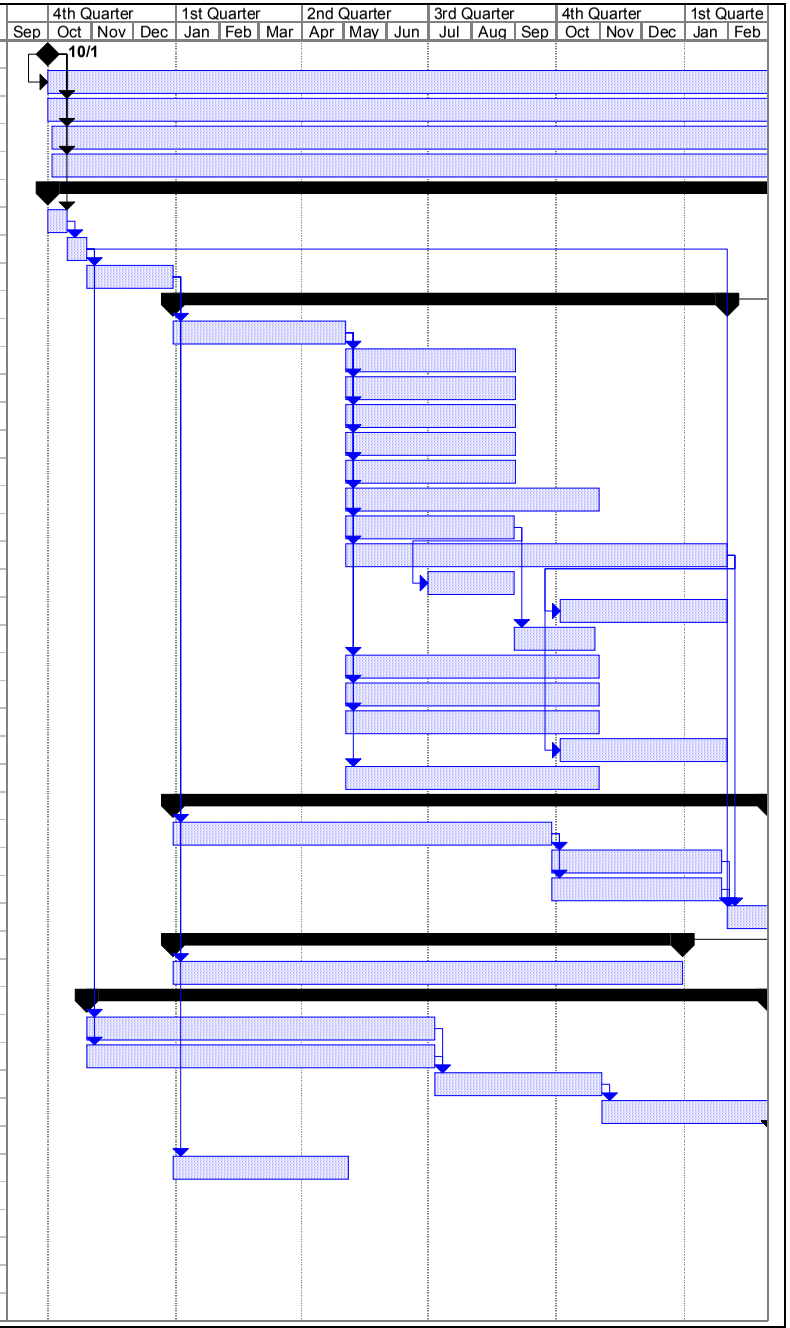
Labor :

Labor Cost (Incl.Profit):		**$1,094,030**
Total Labor:		**$1,094,030**
Direct Costs:		
Materials / Supplies and Other Exp.:		**$7,350,000**
Subtotal:		**$8,444,030**
Contingency @	**35.00%**	**$2,955,411**
Total Direct Costs:		**$18,749,441**
Total Costs:		**$19,843,471**

Appendix B

Feasibility Study Schedule

ID	Task Name	Duration	Start	Finish
1	Dam Breach Plan of Study - Initiate	0 days	Fri 10/1/10	Fri 10/1/10
2	Program and Project Management	1305 days	Fri 10/1/10	Thu 10/1/15
3	Regional Coordination	1305 days	Fri 10/1/10	Thu 10/1/15
4	Technical Coordination	1300 days	Mon 10/4/10	Fri 9/25/15
5	Coordination with RIOG	1300 days	Mon 10/4/10	Fri 9/25/15
6	**Phase 1 - Technical Studies**	**522 days**	**Fri 10/1/10**	**Mon 10/1/12**
7	Identify Problems & Opportunities	10 days	Fri 10/1/10	Thu 10/14/10
8	Develop Planning Objectives and Constraints	10 days	Fri 10/15/10	Thu 10/28/10
9	Determine Future Hydrologic Condition with Climate Change	44 days	Fri 10/29/10	Wed 12/29/10
10	**Hydrologic Studies**	**284 days**	**Thu 12/30/10**	**Tue 1/31/12**
11	Data Gathering (past studies, meteorological data, stream discharge, etc)	88 days	Thu 12/30/10	Mon 5/2/11
12	Compute flood-frequency curves & flow duration stats	88 days	Tue 5/3/11	Thu 9/1/11
13	Develop hydrologic models of tributary basins not included in PSMP	88 days	Tue 5/3/11	Thu 9/1/11
14	Develop meteorological scenarios for representative conditions and calibrate ev	88 days	Tue 5/3/11	Thu 9/1/11
15	Determine Probable Maximum Flood	88 days	Tue 5/3/11	Thu 9/1/11
16	Develop discharge time series for flood & sediment transport simulation	88 days	Tue 5/3/11	Thu 9/1/11
17	Water Management	130 days	Tue 5/3/11	Mon 10/31/11
18	Channel Hydraulic and Hydrodynamic Modeling	87 days	Tue 5/3/11	Wed 8/31/11
19	Sediment Transport Modeling for Dam Removal	196 days	Tue 5/3/11	Tue 1/31/12
20	Channel Stability and Evolution	44 days	Fri 7/1/11	Wed 8/31/11
21	Watershed Sediment Yield	86 days	Tue 10/4/11	Tue 1/31/12
22	McNary Reservoir Evaluation	42 days	Thu 9/1/11	Fri 10/28/11
23	Water Quality Modeling	130 days	Tue 5/3/11	Mon 10/31/11
24	Temperature	130 days	Tue 5/3/11	Mon 10/31/11
25	Aquatic Food Web Modeling	130 days	Tue 5/3/11	Mon 10/31/11
26	Sediment Characterization and Quality	86 days	Tue 10/4/11	Tue 1/31/12
27	Global Climate Change Report	130 days	Tue 5/3/11	Mon 10/31/11
28	**Engineering Studies**	**306 days**	**Thu 12/30/10**	**Thu 3/1/12**
29	Excavation Plan	194 days	Thu 12/30/10	Tue 9/27/11
30	Slope Stabilization	88 days	Wed 9/28/11	Fri 1/27/12
31	Rock Sources	88 days	Wed 9/28/11	Fri 1/27/12
32	Schedule/Risk Cost Engineering	22 days	Wed 2/1/12	Thu 3/1/12
33	**Economic Analysis**	**262 days**	**Thu 12/30/10**	**Fri 12/30/11**
34	Power System Analysis	262 days	Thu 12/30/10	Fri 12/30/11
35	**Biological Analysis Studies**	**350 days**	**Fri 10/29/10**	**Thu 3/1/12**
36	Aquatic Resources	178 days	Fri 10/29/10	Tue 7/5/11
37	Habitat Evaluations	178 days	Fri 10/29/10	Tue 7/5/11
38	Short Term Requirements and Consequences	86 days	Wed 7/6/11	Wed 11/2/11
39	Long Term Requirements and Consequences	86 days	Thu 11/3/11	Thu 3/1/12
40	Summary Recommendation Report	21 days	Fri 3/2/12	Fri 3/30/12
41	Model Approval	90 days	Thu 12/30/10	Wed 5/4/11
42	Agency Technical Review	43 days	Mon 4/2/12	Wed 5/30/12
43	Independent External Peer Review	88 days	Thu 5/31/12	Mon 10/1/12
44				
45	**Recommendation to Administration**	0 days	Mon 10/1/12	Mon 10/1/12
46				



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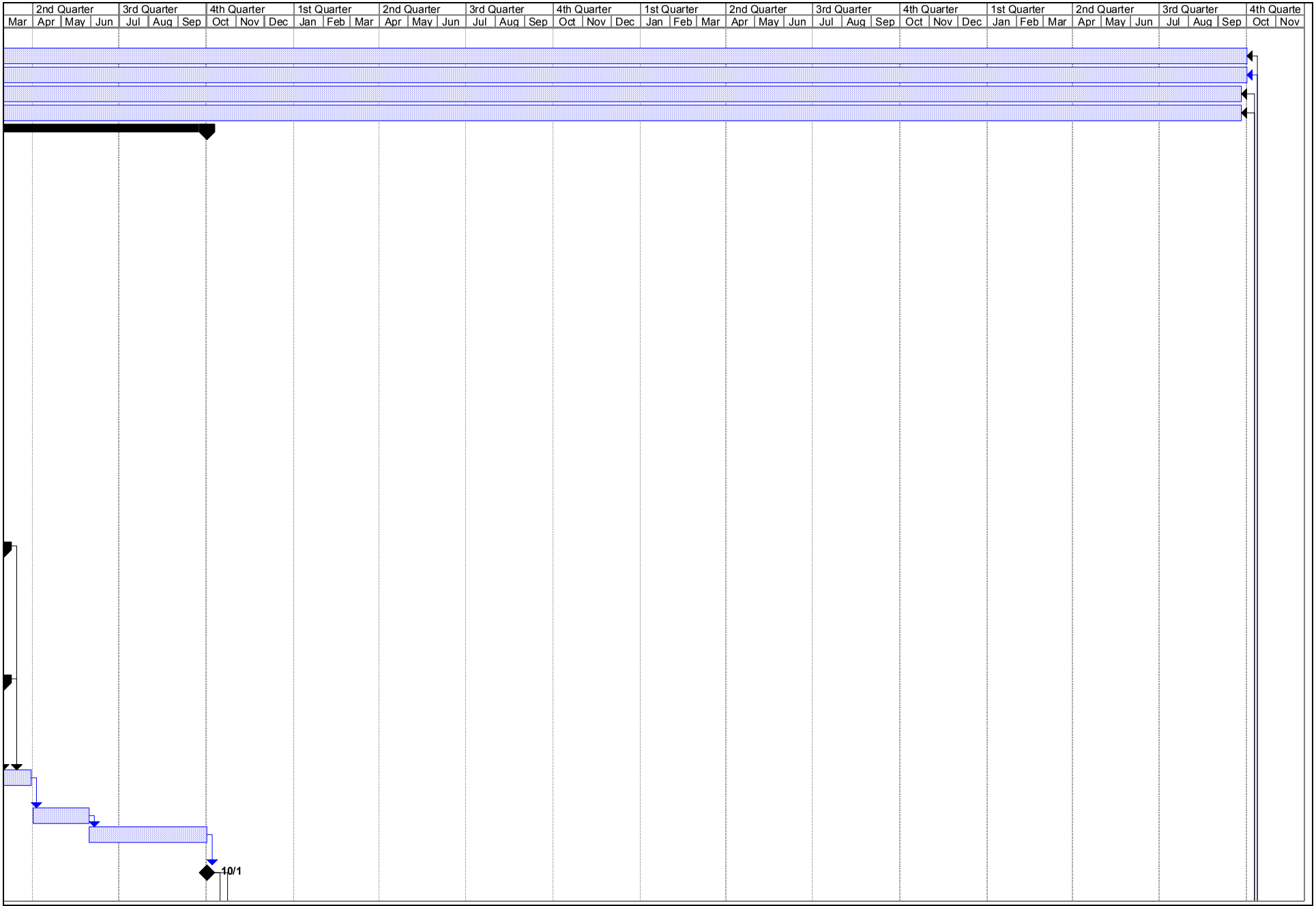

Project: Draft AMIP Schedule March 2
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Task | Progress | Summary | External Tasks | Split

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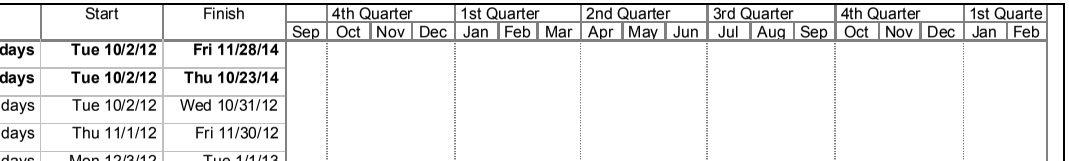
ID	Task Name	Duration	Start	Finish
47	**Phase 2 - Public Policy Decision Process**	**564 days**	**Tue 10/2/12**	**Fri 11/28/14**
48	**Feasibility Report**	**538 days**	**Tue 10/2/12**	**Thu 10/23/14**
49	Confirm Problems & Opportunities	22 days	Tue 10/2/12	Wed 10/31/12
50	Confirm Alternatives	22 days	Thu 11/1/12	Fri 11/30/12
51	Confirm Evaluation Criteria	22 days	Mon 12/3/12	Tue 1/1/13
52	Describe Alternatives (10% level)	110 days	Wed 1/2/13	Tue 6/4/13
53	Determine Benefits	88 days	Thu 4/4/13	Mon 8/5/13
54	Preliminary Screening	56 days	Tue 8/6/13	Tue 10/22/13
55	Cost Effectiveness Analysis	44 days	Wed 10/23/13	Mon 12/23/13
56	Real Estate - Alternative Evaluation	45 days	Wed 6/5/13	Tue 8/6/13
57	Trade-Off Analysis	45 days	Tue 12/24/13	Mon 2/24/14
58	Second Evaluation of Alternatives	22 days	Tue 2/25/14	Wed 3/26/14
59	Selection of Preferred Alternative	45 days	Thu 3/27/14	Wed 5/28/14
60	Finalize Real-estate Plan	44 days	Thu 5/29/14	Tue 7/29/14
61	Finalize Engineering Appendices	44 days	Thu 5/29/14	Tue 7/29/14
62	Finalize MCACES Estimate	22 days	Thu 5/29/14	Fri 6/27/14
63	System of Accounts	22 days	Mon 6/30/14	Tue 7/29/14
64	Cost Risk Analysis	22 days	Wed 7/30/14	Thu 8/28/14
65	Finalize Draft Report	40 days	Fri 8/29/14	Thu 10/23/14
66	**NEPA**	**44 days**	**Thu 11/1/12**	**Tue 1/1/13**
67	Notice of Intent	22 days	Thu 11/1/12	Fri 11/30/12
68	Scoping	22 days	Mon 12/3/12	Tue 1/1/13
69	**Prepare Draft EIS**	**498 days**	**Wed 1/2/13**	**Fri 11/28/14**
70	Determine Environmental Consequences	198 days	Wed 1/2/13	Fri 10/4/13
71	Fish & Wildlife Coordination Act	198 days	Tue 6/4/13	Thu 3/6/14
72	Clean Water Act	132 days	Thu 5/29/14	Fri 11/28/14
73	Prepare Section 404(b)1 evaluation	132 days	Thu 5/29/14	Fri 11/28/14
74	Section 401 Certification	132 days	Thu 5/29/14	Fri 11/28/14
75	Section 402 NPDES Permit	132 days	Thu 5/29/14	Fri 11/28/14
76	Section 7 Consultation	132 days	Thu 5/29/14	Fri 11/28/14
77	Section 106 Consultation	132 days	Thu 5/29/14	Fri 11/28/14
78	**Technical, Public and Policy Reviews**	**215 days**	**Mon 12/1/14**	**Fri 9/25/15**
79	Agency Technical Review	65 days	Mon 12/1/14	Fri 2/27/15
80	Policy Review	60 days	Mon 3/2/15	Fri 5/22/15
81	Public Review of Draft Final FS/EIS	90 days	Mon 5/25/15	Fri 9/25/15
82	Independent External Peer Review	130 days	Mon 3/2/15	Fri 8/28/15
83				
84	**Decision Feasibility Report/EIS**	0 days	Fri 9/25/15	Fri 9/25/15
85				
86	**Draft Record of Decision**	4 days	Mon 9/28/15	Thu 10/1/15



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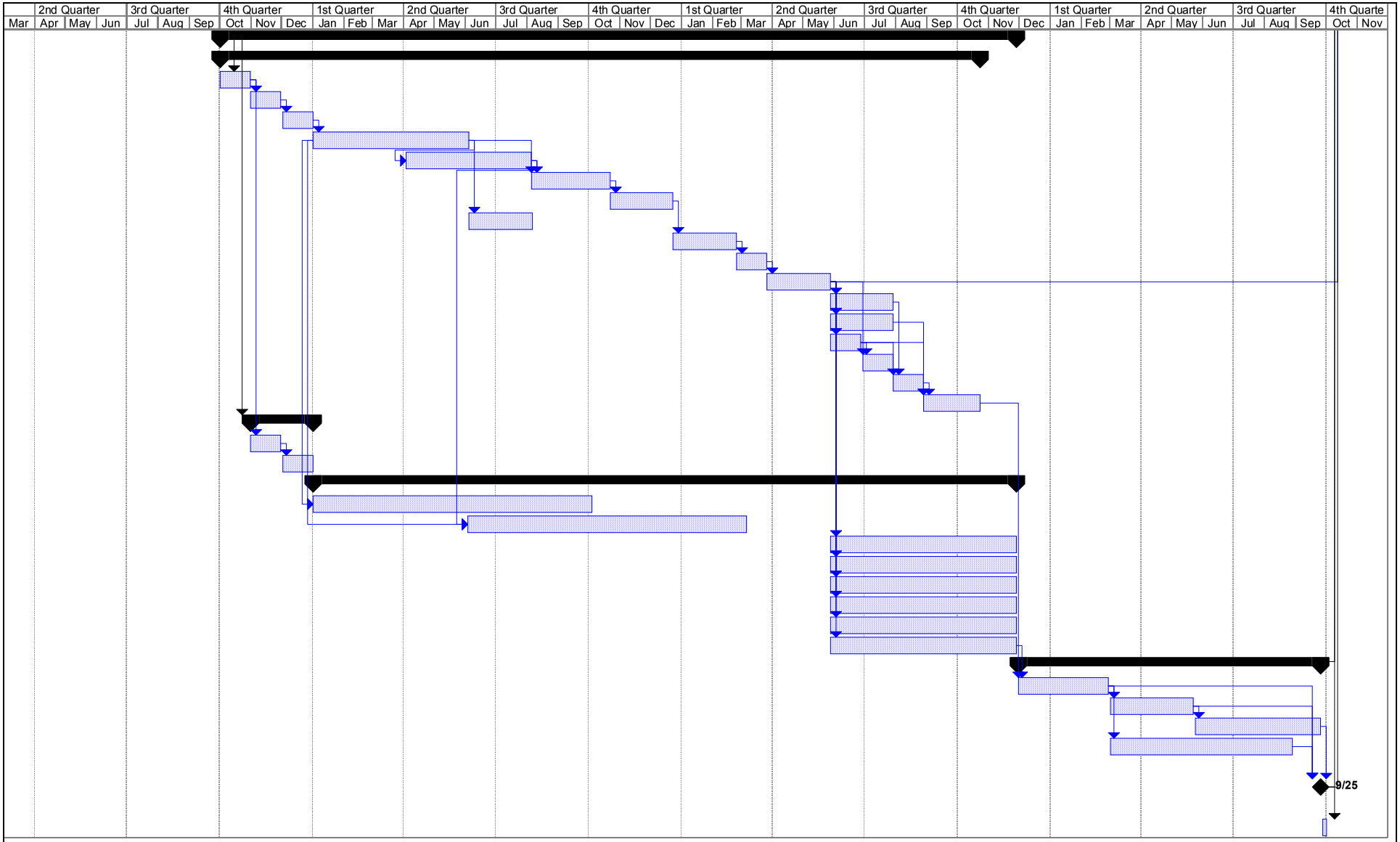
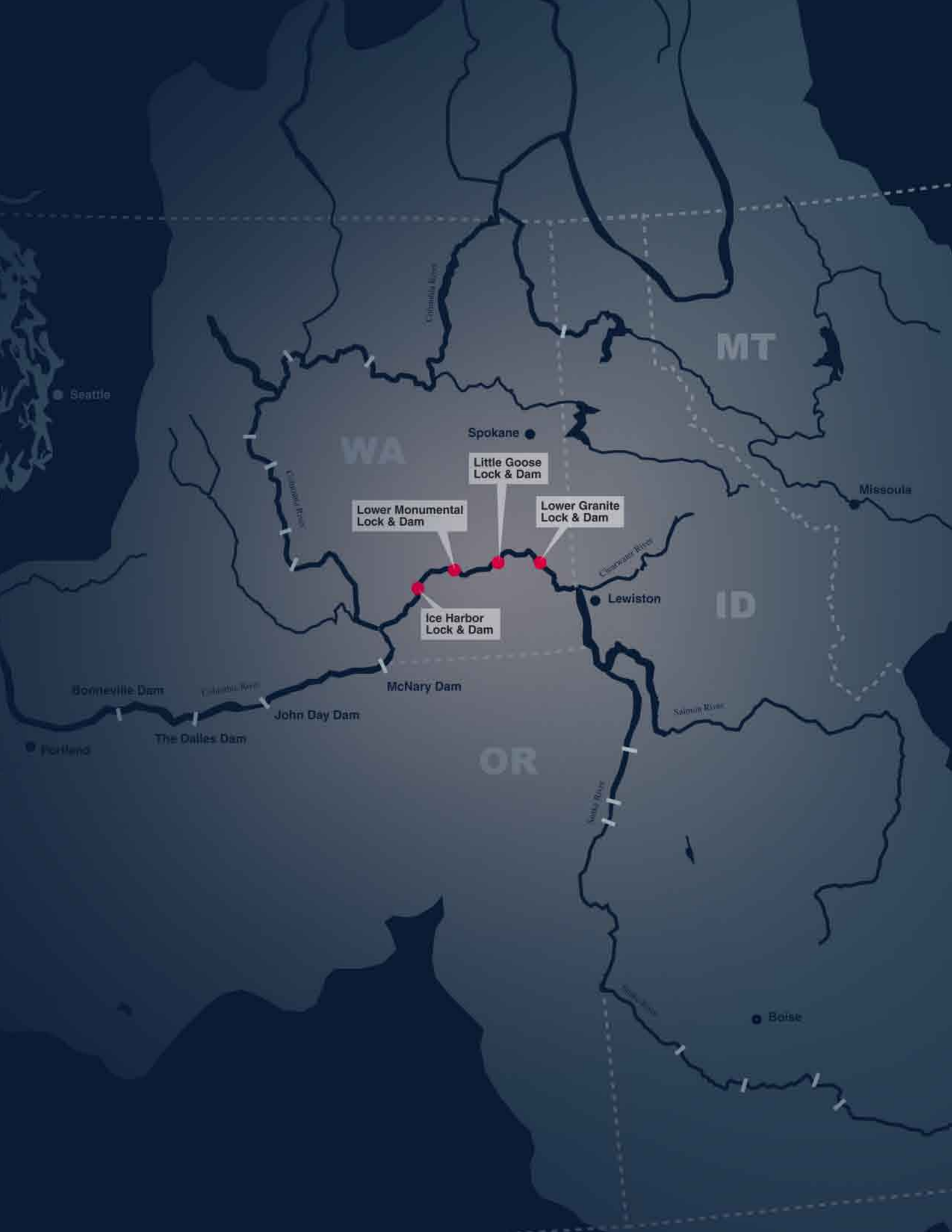


Project: Draft AMIP Schedule March 2
Date: Wed 3/24/10

Task | Progress | Summary | External Tasks | Split

Split | Milestone | Project Summary | External MileTask


MT
WA
OR
ID
Seattle
Spokane
Missoula
Lewiston
Boise
Portland
Columbia River
Snake River
Clearwater River
Salmon River
Little Goose Lock & Dam
Lower Monumental Lock & Dam
Lower Granite Lock & Dam
Ice Harbor Lock & Dam
McNary Dam
John Day Dam
The Dalles Dam
Bonneville Dam