Columbia River System Operation Review

Final Environmental Impact Statement

Appendix H

Navigation

BONNEVILLE POWER ADMINISTRATION

US Army Corps of Engineers
North Pacific Division

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DOE/EIS-0170

November 1995

PUBLIC INVOLVEMENT IN THE SOR PROCESS

The Bureau of Reclamation, Corps of Engineers, and Bonneville Power Administration wish to thank those who reviewed the Columbia River System Operation Review (SOR) Draft EIS and appendices for their comments. Your comments have provided valuable public, agency, and tribal input to the SOR NEPA process. Throughout the SOR, we have made a continuing effort to keep the public informed and involved.

Fourteen public scoping meetings were held in 1990. A series of public roundtables was conducted in November 1991 to provide an update on the status of SOR studies. The lead agencies went back to most of the 14 communities in 1992 with 10 initial system operating strategies developed from the screening process. From those meetings and other consultations, seven SOS alternatives (with options) were developed and subjected to full–scale analysis. The analysis results were presented in the Draft EIS released in July 1994. The lead agencies also developed alternatives for the other proposed SOR actions, including a Columbia River Regional Forum for assisting in the determination of future SOSs, Pacific Northwest Coordination Agreement alternatives for power coordination, and Canadian Entitlement Allocation Agreements alternatives. A series of nine public meetings was held in September and October 1994 to present the Draft EIS and appendices and solicit public input on the SOR. The lead agencies received 282 formal written comments. Your comments have been used to revise and shape the alternatives presented in the Final EIS.

Regular newsletters on the progress of the SOR have been issued. Since 1990, 20 issues of *Streamline* have been sent to individuals, agencies, organizations, and tribes in the region on a mailing list of over 5,000. Several special publications explaining various aspects of the study have also been prepared and mailed to those on the mailing list. Those include:

- The Columbia River: A System Under Stress
- The Columbia River System: The Inside Story
- Screening Analysis: A Summary
- Screening Analysis: Volumes 1 and 2
- Power System Coordination: A Guide to the Pacific Northwest Coordination Agreement
- Modeling the System: How Computers are Used in Columbia River Planning
- Daily/Hourly Hydrosystem Operation: How the Columbia River System Responds to Short–Term Needs

Copies of these documents, the Final EIS, and other appendices can be obtained from any of the lead agencies, or from libraries in your area.

Your questions and comments on these documents should be addressed to:

SOR Interagency Team
P .O. Box 2988
Portland, OR 97208–2988

PREFACE: SETTING THE STAGE FOR THE SYSTEM OPERATION REVIEW

WHAT IS THE SOR AND WHY IS IT BEING CONDUCTED?

The Columbia River System is a vast and complex combination of Federal and non–Federal facilities used for many purposes including power production, irrigation, navigation, flood control, recreation, fish and wildlife habitat and municipal and industrial water supply. Each river use competes for the limited water resources in the Columbia River Basin.

To date, responsibility for managing these river uses has been shared by a number of Federal, state, and local agencies. Operation of the Federal Columbia River system is the responsibility of the Bureau of Reclamation (Reclamation), Corps of Engineers (Corps) and Bonneville Power Administration (BPA).

The System Operation Review (SOR) is a study and environmental compliance process being used by the three Federal agencies to analyze future operations of the system and river use issues. The goal of the SOR is to achieve a coordinated system operation strategy for the river that better meets the needs of all river users. The SOR began in early 1990, prior to the filing of petitions for endangered status for several salmon species under the Endangered Species Act.

The comprehensive review of Columbia River operations encompassed by the SOR was prompted by the need for Federal decisions to (1) develop a coordinated system operating strategy (SOS) for managing the multiple uses of the system into the 21st century; (2) provide interested parties with a continuing and increased long–term role in system planning (Columbia River Regional Forum); (3) renegotiate and renew the Pacific Northwest Coordination Agreement (PNCA), a contractual arrangement among the region's major hydroelectric–generating utilities and affected Federal agencies to provide for coordinated power generation on the Columbia River system; and (4) renew or develop new Canadian Entitlement Allocation Agreements (contracts that divide Canada's share of Columbia River Treaty downstream power benefits and obligations among three participating public utility districts and BPA). The review provides the environmental analysis required by the National Environmental Policy Act (NEPA).

This technical appendix addresses only the effects of alternative system operating strategies for managing the Columbia River system. The environmental impact statement (EIS) itself and some of the other appendices present analyses of the alternative approaches to the other three decisions considered as part of the SOR.

WHO IS CONDUCTING THE SOR?

The SOR is a joint project of Reclamation, the Corps, and BPA—the three agencies that share responsibility and legal authority for managing the Federal Columbia River System. The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and National Park Service (NPS), as agencies with both jurisdiction and expertise with regard to some aspects of the SOR, are cooperating agencies. They contribute information, analysis, and recommendations where appropriate. The U.S. Forest Service (USFS) was also a cooperating agency, but asked to be removed from that role in 1994 after assessing its role and the press of other activities.

HOW IS THE SOR BEING CONDUCTED?

The system operating strategies analyzed in the SOR could have significant environmental impacts. The study team developed a three–stage process—scoping, screening, and full–scale analysis of the strategies—to address the many issues relevant to the SOR.

At the core of the analysis are 10 work groups. The work groups include members of the lead and cooperating agencies, state and local government agencies, representatives of Indian tribes, and members of the public. Each of these work groups has a single river use (resource) to consider.

Early in the process during the screening phase, the 10 work groups were asked to develop an alternative for project and system operations that would provide the greatest benefit to their river use, and one or more alternatives that, while not ideal, would provide an acceptable environment for their river use. Some groups responded with alternatives that were evaluated in this early phase and, to some extent, influenced the alternatives evaluated in the Draft and Final EIS. Additional alternatives came from scoping for the SOR and from other institutional sources within the region. The screening analysis studied 90 system operation alternatives.

Other work groups were subsequently formed to provide projectwide analysis, such as economics, river operation simulation, and public involvement.

The three–phase analysis process is described briefly below.

- **Scoping/Pilot Study**—After holding public meetings in 14 cities around the region, and coordinating with local, state, and Federal agencies and Indian tribes, the lead agencies established the geographic and jurisdictional scope of the study and defined the issues that would drive the EIS. The geographic area for the study is the Columbia River Basin (Figure P–1). The jurisdictional scope of the SOR encompasses the 14 Federal projects on the Columbia and lower Snake Rivers that are operated by the Corps and Reclamation and coordinated for hydropower under the PNCA. BPA markets the power produced at these facilities. A pilot study examining three alternatives in four river resource areas was completed to test the decision analysis method proposed for use in the SOR.
- **Screening**—Work groups, involving regional experts and Federal agency staff, were created for 10 resource areas and several support functions. The work groups developed computer screening models and applied them to the 90 alternatives identified during screening. They compared the impacts to a baseline operating year—1992—and ranked each alternative according to its impact on their resource or river use. The lead agencies reviewed the results with the public in a series of regional meetings in September 1992.
- **Full–Scale Analysis**—Based on public comment received on the screening results, the study team sorted, categorized, and blended the alternatives into seven basic types of operating strategies. These alternative strategies, which have multiple options, were then subjected to detailed impact analysis. Twenty–one possible options were evaluated. Results and tradeoffs for each resource or river use were discussed in separate technical appendices and summarized in the Draft EIS. Public review and comment on the Draft EIS was conducted during the summer and fall of 1994. The lead agencies adjusted the alternatives based on the comments, eliminating a few options and substituting new options, and reevaluated them during the past 8 months. Results are summarized in the Final EIS.

Alternatives for the Pacific Northwest Coordination Agreement (PNCA), the Columbia River Regional Forum (Forum), and the Canadian Entitlement Allocation Agreements (CEAA) did not use the three–stage process described above. The environmental impacts from the PNCA and CEAA were not significant and there were no anticipated impacts from the Regional Forum. The procedures used to analyze alternatives for these actions are described in their respective technical appendices.

For detailed information on alternatives presented in the Draft EIS, refer to that document and its appendices.

WHAT SOS ALTERNATIVES ARE CONSIDERED IN THE FINAL EIS?

Seven alternative System Operating Strategies (SOS) were considered in the Draft EIS. Each of the seven SOSs contained several options bringing the total number of alternatives considered to 21. Based on review of the Draft EIS and corresponding adjustments, the agencies have identified 7 operating strategies that are evaluated in this Final EIS. Accounting for options, a total of 13 alternatives is now under consideration. Six of the alternatives remain unchanged from the specific options considered in the Draft EIS. One is a revision to a previously considered alternative, and the rest represent replacement or new alternatives. The basic categories of SOSs and the numbering convention remains the same as was used in the Draft EIS. However, because some of the alternatives have been dropped, the numbering of the final SOSs are not consecutive. There is one new SOS category, Settlement Discussion Alternatives, which is labeled SOS 9 and replaces the SOS 7 category. This category of alternatives arose as a consequence of litigation on the 1993 Biological Opinion and ESA Consultation for 1995.

The 13 system operating strategies for the Federal Columbia River system that are analyzed for the Final EIS are:

SOS 1a Pre Salmon Summit Operation represents operations as they existed from around 1983 through the 1990–91 operating year, prior to the ESA listing of three species of salmon as endangered or threatened.

SOS 1b Optimum Load–Following Operation represents operations as they existed prior to changes resulting from the Regional Act. It attempts to optimize the load–following capability of the system within certain constraints of reservoir operation.

SOS 2c Current Operation/No–Action Alternative represents an operation consistent with that specified in the Corps of Engineers' 1993 Supplemental EIS. It is similar to system operation that occurred in 1992 after three species of salmon were listed under ESA.

SOS 2d [New] 1994–98 Biological Opinion represents the 1994–98 Biological Opinion operation that includes up to 4 MAF flow augmentation on the Columbia, flow targets at McNary and Lower Granite, specific volume releases from Dworshak, Brownlee, and the Upper Snake, meeting sturgeon flows 3 out of 10 years, and operating lower Snake projects at MOP and John Day at MIP.

SOS 4c [Rev.] Stable Storage Operation with Modified Grand Coulee Flood Control attempts to achieve specific monthly elevation targets year round that improve the environmental conditions at storage projects for recreation, resident fish, and wildlife. Integrated Rules Curves (IRCs) at Libby and Hungry Horse are applied.

SOS 5b Natural River Operation draws down the four lower Snake River projects to near river bed levels for four and one–half months during the spring and summer salmon migration period, by assuming new low level outlets are constructed at each project.

SOS 5c [New] Permanent Natural River Operation operates the four lower Snake River projects to near river bed levels year round.

SOS 6b Fixed Drawdown Operation draws down the four lower Snake River projects to near spillway crest levels for four and one–half months during the spring and summer salmon migration period.

SOS 6d Lower Granite Drawdown Operation draws down Lower Granite project only to near spillway crest level for four and one–half months.

SOS 9a [New] Detailed Fishery Operating Plan includes flow targets at The Dalles based on the previous year's end–of–year storage content, specific volumes of releases for the Snake River, the drawdown of Lower Snake River projects to near spillway crest level for four and one–half months, specified spill percentages, and no fish transportation.

SOS 9b [New] Adaptive Management establishes flow targets at McNary and Lower Granite based on runoff forecasts, with specific volumes of releases to meet Lower Granite flow targets and specific spill percentages at run–of–river projects.

SOS 9c [New] Balanced Impacts Operation draws down the four lower Snake River projects near spillway crest levels for two and one–half months during the spring salmon migration period. Refill begins after July 15. This alternative also provides 1994–98 Biological Opinion flow augmentation, integrated rule curve operation at Libby and Hungry Horse, a reduced flow target at Lower Granite due to drawdown, winter drawup at Albeni Falls, and spill to achieve no higher than 120 percent daily average for total dissolved gas.

SOS PA Preferred Alternative represents the operation proposed by NMFS and USFWS in their Biological Opinions for 1995 and future years; this SOS operates the storage projects to meet flood control rule curves in the fall and winter in order to meet spring and summer flow targets for Lower Granite and McNary, and includes summer draft limits for the storage projects.

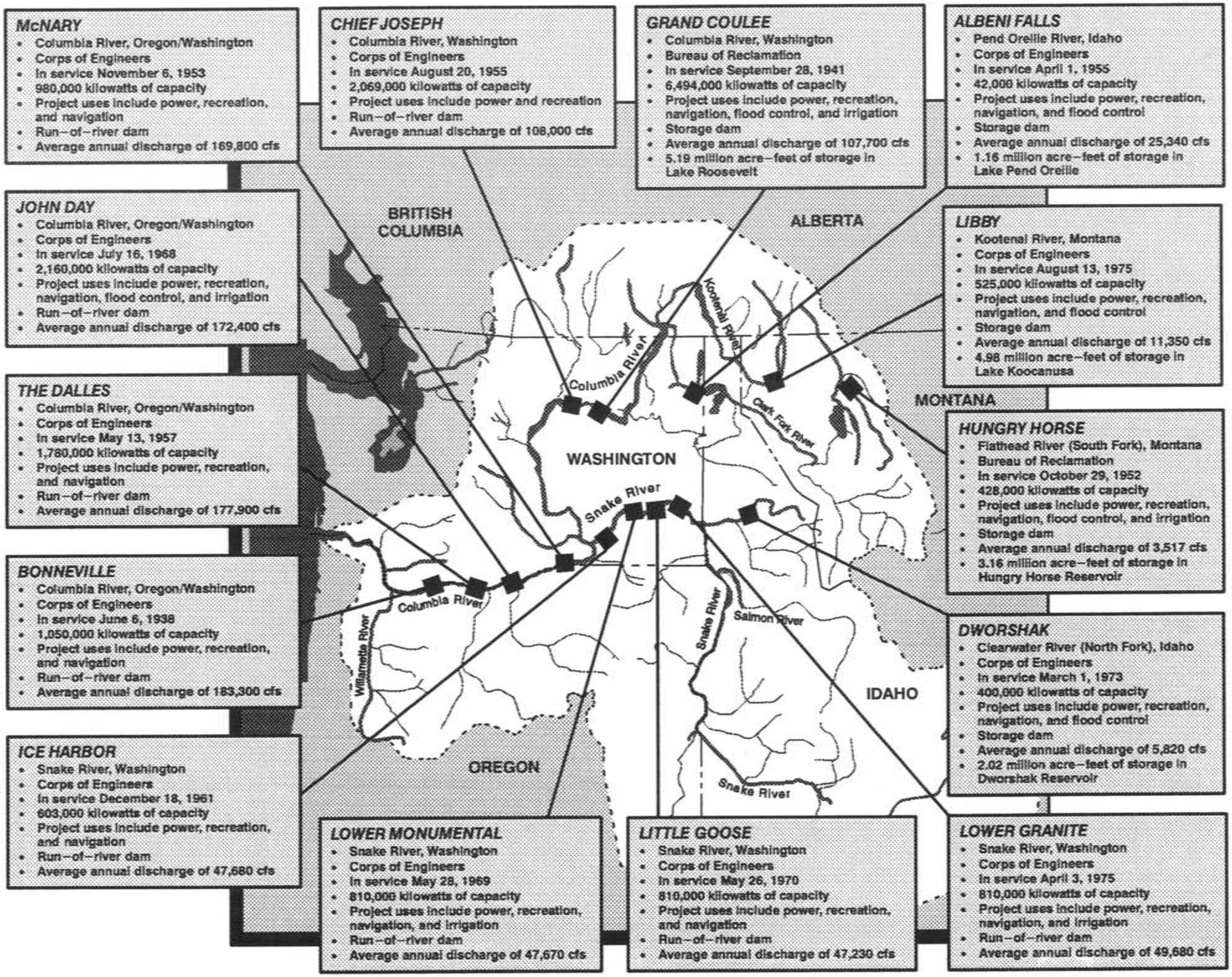
WHAT DO THE TECHNICAL APPENDICES COVER?

This technical appendix is 1 of 20 prepared for the SOR. They are:

A. River Operation Simulation
B. Air Quality
C. Anadromous Fish & Juvenile Fish Transportation
D. Cultural Resources
E. Flood Control
F. Irrigation/Municipal and Industrial Water Supply
G. Land Use and Development
H. Navigation
I. Power
J. Recreation
K. Resident Fish
L. Soils, Geology, and Groundwater
M. Water Quality
N. Wildlife
O. Economic and Social Impacts
P. Canadian Entitlement Allocation Agreements
Q. Columbia River Regional Forum
R. Pacific Northwest Coordination Agreement
S. U. S. Fish and Wildlife Service Coordination Act Report
T. Comments and Responses

Each appendix presents a detailed description of the work group's analysis of alternatives, from the scoping process through full–scale analysis. Several appendices address specific SOR functions (e.g., River Operation Simulation), rather than individual resources, or the institutional alternatives (e.g., PNCA) being considered within the SOR. The technical appendices provide the basis for developing and analyzing alternative system operating strategies in the EIS. The EIS presents an integrated review of the vast wealth of information contained in the appendices, with a focus on key issues and impacts. In addition, the three agencies have prepared a brief summary of the EIS to highlight issues critical to decision makers and the public.

There are many interrelationships among the different resources and river uses, and some of the appendices provide supporting data for analyses presented in other appendices. This Navigation appendix relies on supporting data contained in Appendix A. River Operation Simulation and Appendix O, the Economics and Social Impacts Section. For complete coverage of all aspects of Navigation readers may wish to review these two appendices in concert.



1 million acre feet = 1.234 billion cubic meters
1 cubic foot per second = 0.028 cubic meters per second

Figure P–1. Projects in the System Operation Review.

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CHAPTER 1

NAVIGATION STUDIES SCOPE AND PROCESS

1.1 INTRODUCTION – SCOPE AND PROCESS

The Navigation Technical Appendix presents the analysis of the various System Operation Review (SOR) alternatives in terms of their potential affects on the congressionally authorized navigation system within the Columbia and Snake river waterways. The focus of the study, impacts to the authorized navigation, improvements/developments, reflects on one of the continuing historical missions of the U.S. Army Corps of Engineers: to promote safe commercial navigation of the nation's waterways benefitting the development of commerce within the United States. Fulfillment of this mission resulted in the development and maintenance of ship and barge channels, turning basins, dams and locks, and operation and maintenance activities, such as channel dredging and lock maintenance.

The study and evaluation process involved Scoping, Screening and Full scale evaluation. The Scoping process involved public coordination and *brain storming* by the Navigation Technical Work Group (NTWG), resulting in a narrowed and refined problem domain that aided in focussing the evaluation procedures. During screening two models were developed; one was used to evaluate the effects of the various alternatives on navigation through the Snake River Projects and the other the effects on the Dworshak Pool. Full Scale Analysis was expanded to included a study of effects throughout the system.

1.2 TECHNICAL AND GEOGRAPHIC SCOPE

The Navigation Technical Appendix has a complementary relationship with sections of the Economic and Social Impacts Appendix. The Navigation Technical Appendix discusses the technical assessment of each alternative in terms of the physical impacts of moving commercial vessels through the Columbia and Snake River Federally authorized system ship channels and locks. The Economic Technical Appendix provides an estimate of the costs associated with commodity transport on the navigable waterway. An assessment is made of the economic impact of each alternative on the region, states, counties, ports, and commodity shippers for each operating strategy considered in the SOR process.

The Navigation technical review evaluated all the various alternatives to determine the physical impacts to navigation interests on the Snake and Columbia River system and logging operations using the Dworshak Dam pool. The alternatives incorporate the current operational procedure(s), as defined in System Operating Strategy (SOS) 2c, as its baseline and a set of alternatives that propose a range of operational strategies which would affect pool levels and river flows throughout the Columbia and Snake River system.

The geographical extent of the System Operations Review (SOR) includes the Columbia River Basin from the mouth to its upper reaches in Canada, and its tributaries, including the Snake River and its tributary the Clearwater River. The NTWG focus is on those projects on the Columbia, Snake, and Clearwater Rivers where navigation is one of the Congressionally authorized uses. On the Columbia River, authorized navigation projects provide for the main channel from the mouth to Richland, Washington, and numerous side channels and access channels. On the Snake River, authorized navigation channels provide for a barge channel from McNary Dam through the pool behind Lower Granite Dam. Navigation past the dams is provided by locks at Bonneville, The Dalles, John Day, and McNary on the Columbia River and at Ice Harbor, Lower Monumental, Little Goose, and Lower Granite on the Snake River. Dworshak Reservoir is also included in the analysis of navigation because the project authorization specifically provides for the use of Dworshak Lake for transportation of log rafts from collection points around the lake to a transfer point near the dam. Finally, the potential for impact to two ferry operations on Lake Roosevelt, behind Grand Coulee Dam, was assessed for each proposed SOS. (See Figure 1–2)

1.3 PUBLIC INVOLVEMENT AND SCOPING

1.3.1 Public Involvement

During the scoping meetings held throughout the Columbia and Snake River basins, navigation issues where presented to those in attendance. A limited number of responses concerning navigation matters resulted from these meetings. During the screening and full–scale analysis, public and agency involvement focused on the commercial users and those that operate and maintain the Columbia and Snake River navigation system.

Although a wide variety of users, including commercial fishermen and recreational users, derive a benefit from the safe, regularly maintained waterway, the focus of public involvement and agency coordination was on the commercial users and those that maintain and operate the authorized waterway.

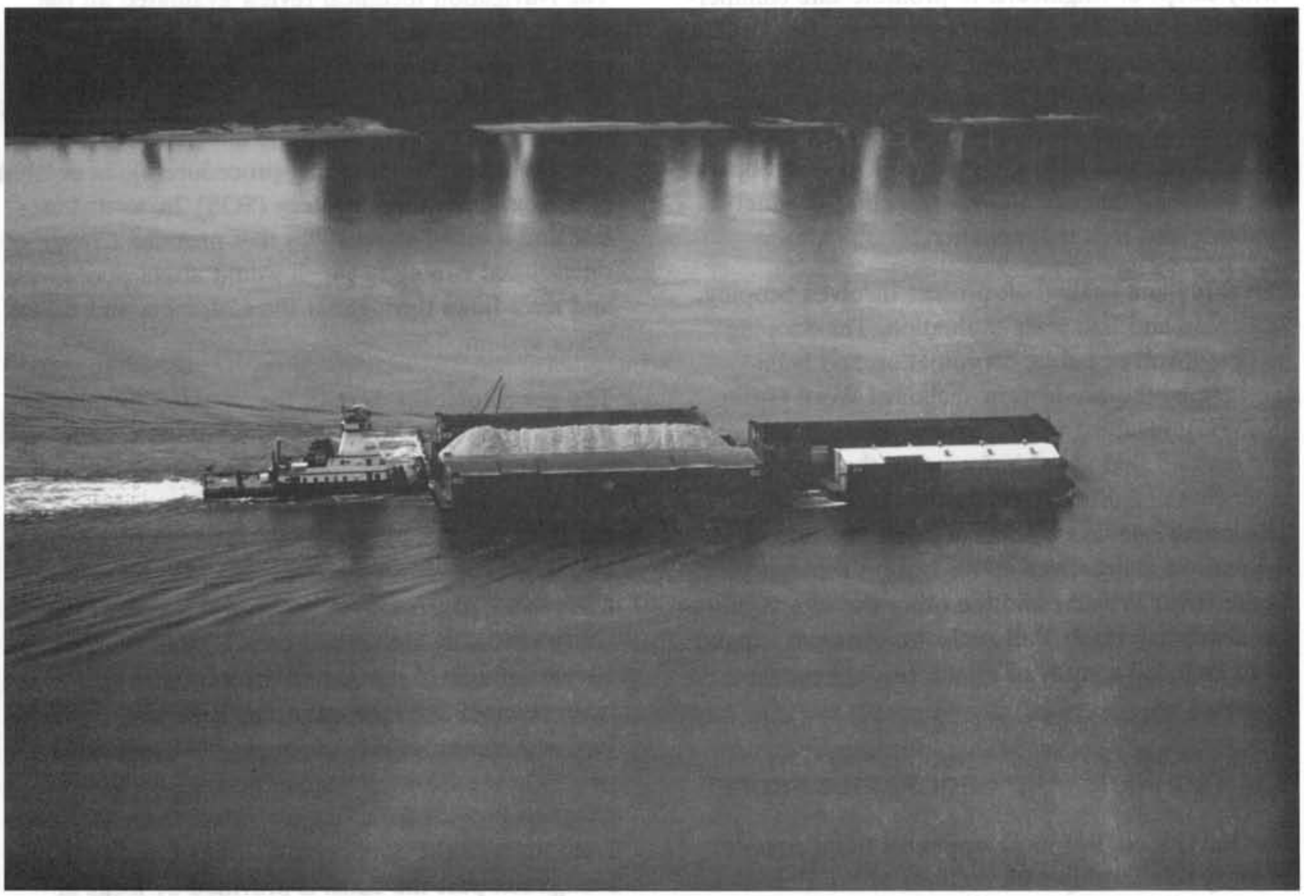

Figure 1–1. Tug and Barge Moving Grain to Portland, Oregon

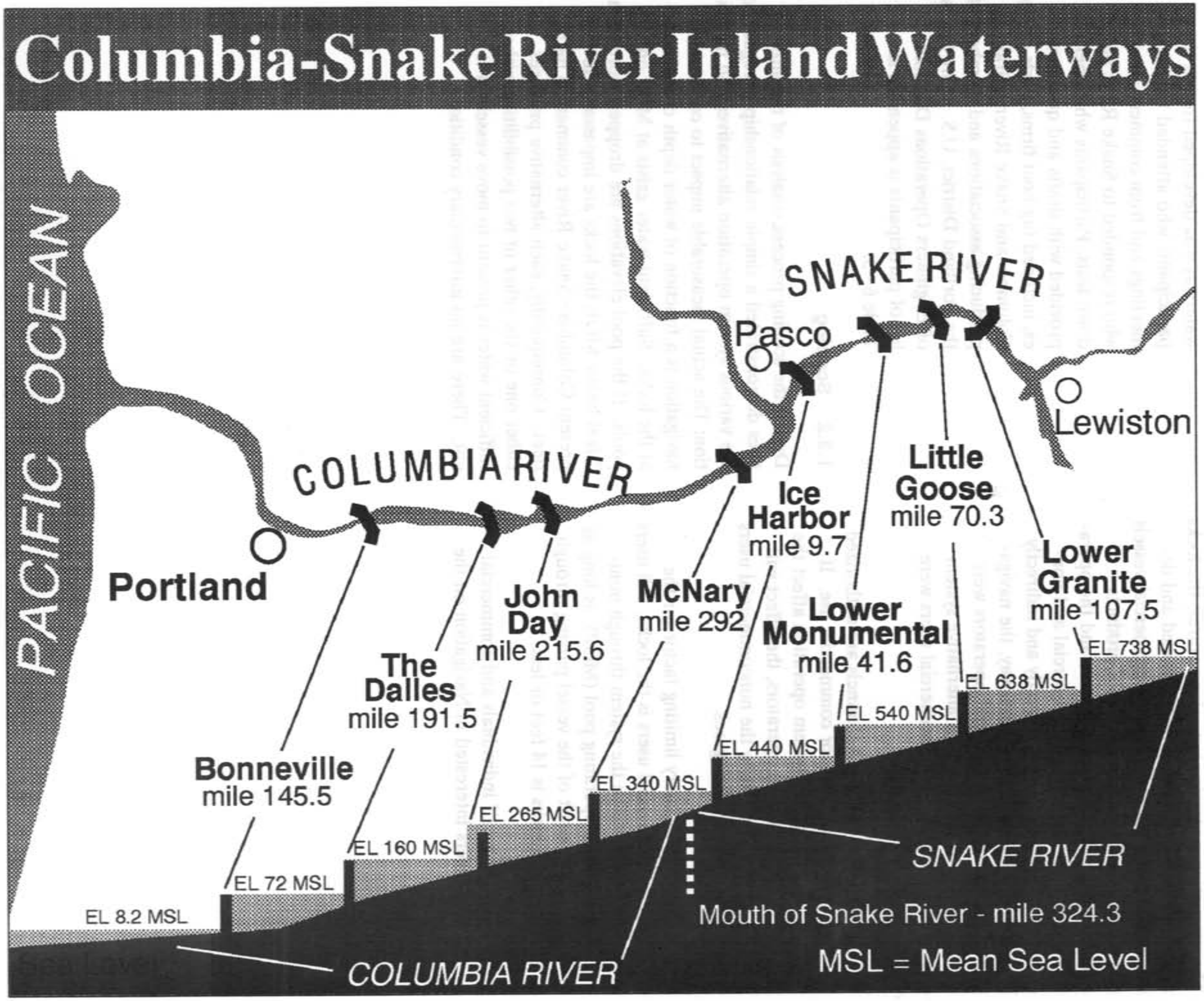

Figure 1–2. Navigation Study Area

The navigation system's physical structures, the locks and navigation channels, were authorized and designed to facilitate the passage of commercial vessels and barges. Although consumers of products shipped by the commercial operators and the operators of smaller vessels (both commercial and non-commercial) are groups who directly and indirectly benefit from the authorized waterway, the navigation requirements of commercial operators were used to measure the effects of alternative system operation strategies. The commercial users were chosen for three reasons:

(1) The locks and channels are authorized by Congress for commercial use. If changes in system operation affect the commercial operators, the effect will also be felt by the noncommercial users to various degrees.

(2) The primary limiting factor for the commercial users is the locks. All users can utilize the system through minimum operating pool (MOP), as long as the draft of the vessel passing through the locks is 14 feet or less.

(3) A list of individuals and commercial users interested in Navigation on the waterway was developed from a list of participants who attended the Scoping meetings and from commercial users who responded to Snake River draw down tests. Participants who where provided with drafts and questionnaires, included tug boat firms, Ports on the Columbia and Snake Rivers; Grain producing associations and members of the Portland District, U.S. Army Corps of Engineers Operations Division. A list of participants is appended as Table 6–3.

1.3.2 Scoping

During the scoping process, analysis of the alternatives demonstrated a simple relationship in regard to the various system operation alternatives and navigation: The actual measurable impact to commercial navigation is a function of water depth over the sills at the locks. Sufficient water exists at MOP on all pools. If the pool elevations are dropped more than 2 feet below MOP, the locks are impassable to the present Columbia–Snake River commercial barge fleet. Consequently, each alternative produces either one or the other of two possibilities: either sufficient water is present to move vessels or it is not. There are no intermediary conditions.

CHAPTER 2

NAVIGATION ON THE COLUMBIA AND SNAKE RIVER WATERS

2.1 GENERAL OVERVIEW OF NAVIGATION

Navigation on the Columbia and Snake Rivers has historically provided an important route of access into and from the interior Columbia and Snake River basins. Recognizing the economic importance of navigation led to early navigation improvements such as the Cascade Locks (1880–1890s), the Jetties at the Mouth of the Columbia River (1880–1890s), Celilo Canal (1890–1900s) and eventually the construction of the dams and locks on the Columbia and Snake Rivers. (Willingham, 1983) As part of its Congressional mandate, the Army Corps of Engineers continues to maintain, enhance and operate the navigational improvements on the Columbia and Snake Rivers waterway for the benefit of all users. As reaffirmed in the Water Resources Development Act 1992 Sec.109, for the "Columbia, Snake, and Clearwater Rivers. (a) Dredging. The Secretary [of the Army] is authorized to maintain navigation access to, and berthing areas at, all currently operating public and private commercial dock facilities associated with or having access to the Federal navigation project on the Columbia, Snake, and Clearwater Rivers from Bonneville Dam to and including Lewiston, Idaho, at a depth commensurate with the Federal navigation project." (Public Law 102–580)

Commercial traffic operates on the Columbia River from its mouth through the Tri–Cities area in Washington. On the Snake River, commercial traffic uses the waterway from its confluence with the Columbia River to Lewiston, Idaho. An authorized use of the Dworshak pool is made by the logging industry where rafts of timber cut from the North Fork of the Clearwater River drainage are towed to transfer areas near the dam. Private and recreational craft operate on the Columbia and Snake Rivers throughout the system.

2.2 STATEMENT OF OPTIMAL CONDITIONS

Optimal conditions for the navigation of the system are those which (a) allow for the use of the channels, navigation locks, and associated facilities at or in excess of their present level of use (b) without increased maintenance costs, (c) or compromised safety of vessels. Since the largest vessels using the waterway above Bonneville Dam are barges used to haul grain, a minimum "optimal condition" is one that allows a vessel with a 14–foot draft to move unimpeded through the locks of the dams on the Columbia and Snake Rivers. Below Bonneville Dam the authorized channel increases in depth, which allows deep draft, ocean going vessels to call on the ports at Portland, Oregon and Vancouver, Washington.

2.3 NAVIGATION CHANNELS AND LOCKS

The Federal government, through the Army Corps of Engineers, operates and maintains the congressionally authorized navigation channels and locks throughout the navigable waterway of the Columbia and Snake Rivers. The channels and locks provide access to the ports, moorage and recreational places along the rivers.

Authorized channels are typically maintained, on a seasonal or as needed basis, by dredging to depths sufficient to maintain authorized depths or depths appropriate to the deepest draft commercial users. Maintenance dredging of access channels to ports and moorages also occurs, but infrequently, on an as needed basis.

2.3.1 Columbia River Projects: Channels and Locks

The Columbia River authorized ship channel begins at the Columbia River entrance, Columbia River Mile (CRM) 4.0 and extends through Tri–Cities area in Washington. Authorization provides for a 40–foot–deep, 600–foot–wide ship channel from the Columbia River Bar to Vancouver, Washington, CRM 105.6. From Vancouver, to the Dalles Dam, the authorized channel is 27 feet deep and 300 feet wide, however, the channel is typically dredged only to 17 feet reflecting the maximum depth required by commercial traffic through this reach of the river. A 14–foot–deep channel 250 feet wide is maintained from The Dalles Dam, through McNary Dam, and up to the various ports in the vicinity of the Tri–Cities, Washington and from the mouth of the Snake River to Lewiston, Idaho.

The locks on the Columbia and Snake River dams lift or lower vessels, on the average, 100 feet above the lock's downstream and/or upstream entrances. Each lock has an operating range determined not only by its hydraulic lift but also by the depth of the sill at the upstream and downstream entrances to the locks. (See Figure 2–1).

The passage of vessels, commercial or recreational, in the Columbia or Snake Rivers is limited by sill depths at the navigation locks. At most of the projects upstream sills are at –15 feet relative to Minimum Operational Pool (MOP). MOP provides the clearance needed for a barge drafting 14 feet, the typical draft of barges operating in the Columbia and Snake River fleet.

Sill depths at Bonneville Dam are different than the locks at upstream projects. The Bonneville (1930) lock has a downstream sill depth of 23 feet at minimum tailwater elevations and an upstream sill depth of 30 feet at the 70 foot (MOP). The new Bonneville navigation lock (1993) has a sill depth of 19 feet at the downstream and upstream entrances to the locks. The locks at The Dalles, John Day and McNary Dams have upstream and downstream sill depths of 15 feet.

2.3.2 Lower Snake River Projects: Channels and Locks

The navigation channel from the confluence of the Snake River with the Columbia to Lewiston, Idaho is authorized to depths of 14 feet and a width of 250 feet. There are lockages at four dams on the Lower Snake River: at Ice Harbor, Lower Monumental, Little Goose and Lower Granite.

2.3.3 Clearwater River: Navigation on Dworshak Project

Commercial log rafting is an authorized use on the Dworshak Reservoir and was one of the justifications for construction of Dworshak Project. Logs cut along the drainage of the North Fork of the Clearwater River are hauled to a number of staging areas, dumped into the pool, assembled into rafts, towed to log dumps near the dam, and hauled by truck to mills. Staging areas have been developed for use at various pool elevations so that timber drops and hauling can be maintained during periods of normal draw down. However, at certain minimum pool elevations this activity must be replaced by trucking when the timber has to roll too far to the pool and becomes susceptible to damage. There are no maintenance activities associated with log rafting on the Dworshak pool, although during periods of significant draw down the pool becomes unusable for log rafting.

2.3.4 Port Facilities

A comprehensive inventory of port facilities on the Columbia and Snake River pools is attached to the back of this appendix, as Exhibit A. The distribution of port terminals by type and pool is summarized in the table.

The number of port facilities on all eight reservoirs totals 54, with 34 on the lower Columbia River (McNary and below) and 20 on the lower Snake River (Lower Granite Reservoir and below). The geographic distribution of port facilities reflects the concentration of shipping activity near Lewiston on the Lower Granite Pool and Pasco on the McNary Pool. Grain terminals are the most common facilities accounting for nearly half of all terminals within the study area, Minimum water depths alongside these facilities range from 10 to 40 feet for active facilities. (*U.S.A.C.E., 1986*)

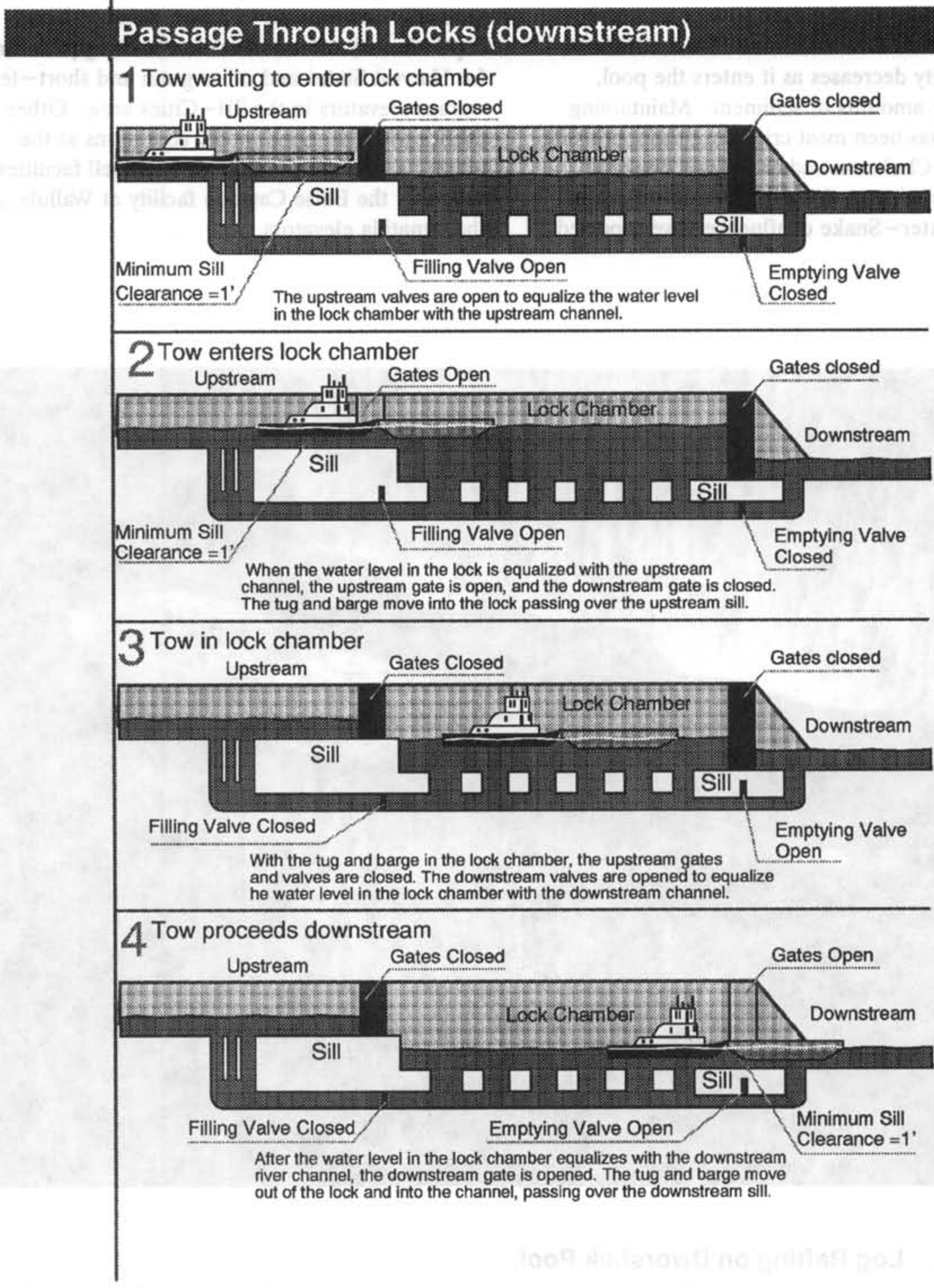

Figure 2–1. Locking Procedure (Downstream)

Port facilities at Clarkston and Lewiston have histories of siltation. Siltation occurs because of the change in river flow as the Snake River enters the pool formed behind Lower Granite Dam. River currents velocity decreases as it enters the pool, dropping large amounts of sediment. Maintaining water depths has been most critical on the south side of the river at Clarkston and to a lesser extent at Lewiston. Facilities on the north bank downstream of the Clearwater–Snake confluence have reported few problems.

On the McNary pool, eddies and other conditions cause marginal water depths at some facilities, especially downstream of Clover Island. These depths have continued to cause docking problems for Harvest States and other grain and short–term storage elevators in the Tri–Cities area. Other facilities with marginal water conditions at the present include the Cargill and Connell facilities at Burbank, the Boise Cascade facility at Wallula, and the Umatilla elevators.

Figure 2–2. Log Rafting on Dworshak Pool

CHAPTER 3

SCREENING PROCESS AND FULL SCALE ANALYSIS

Chapter 3 provides a general overview of the screening process and full scale analysis. It should be noted that the *process in full scale analysis differed in several significant ways from the screening.* The models used to evaluate the effects of the various alternatives on navigation on the Snake River and logging operations on the Dworshak Project were refined from one phase to the next and additional analyses were conducted to substantiate potential impacts identified during screening.

3.1 DEVELOPEMENT OF SCREENING MODELS

The following discussion includes the assumptions that supported the modeling; the value measures used to rank the magnitude of the effects of each screening alternative on the Snake and Clearwater Rivers, a qualitative evaluation noting the consequences related to alternatives which impact navigation, an analysis of the effects on Snake river drawdown alternatives on stage below Bonneville Dam, effects on the ferry operations in Lake Roosevelt, and the physical impacts to facilities in draw down affected reaches of the Snake River.

The purpose of Screening was to determine whether the various system alternatives could be evaluated and their effects on particular operations, values, and activities measured. Screening was the first evaluation of system data. The effects of alternative operations where evaluated at the lower Snake River projects and Dworshak Project. During screening, the NTWG developed and used two models to estimate the costs of alternative transportation of the goods which are presently barged on the lower Snake River and log rafts which are towed on the Dworshak pool. The first model estimated the direct cost of sending by rail or truck goods now barged down the lower Snake River when alternative system operations result in lower pool depths. The second model estimated the costs of trucking logs now rafted on the Dworshak pool when the pool level is drafted below the facilities designed to handle the logs.

Also during screening, other potential problems were identified, but not analyzed. Examples of other potential problems included: (1) navigation impacts of increased spring flows at critical reaches of the Snake River, (2) increased shoal formation in the Snake and Columbia Rivers navigation channels due to increased spring flows, (3) reduced stage below Bonneville Dam due to extreme or extended low releases that would force changes to the movement of deep draft vessels.

3.1.1 Lower Snake River Projects: Screening Analysis

The navigation model developed for screening system alternatives assessed navigation impacts at the four lower Snake River Projects: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor. This model evaluated alternatives based on the observation that commercial navigation operations would be suspended when pools dropped 2 feet below MOP because vessels could not safely access locks. As stated in Chapter 2, the movement of tugs and their various tows through the lock system is an either/or situation; either water elevations are high enough that a tug and fully (or light loaded barge) can pass through or there is not sufficient water for navigation through the lock system.

When navigation is affected by low water alternatives, commodities are shipped by an alternative method, either truck or rail, or not shipped at all. To measure this cost, a value measure, *added transportation costs,* was applied to those alternatives that impacted navigation. This value measure estimated the increased cost of shipping commodities which are typically transported by barge. Impacts to navigation are expressed in dollar values under each alternative.

3.1.1.1 Screening Assumptions for the Evaluation of Snake River Impacts

The following assumptions were made for the purposes of modeling impacts during the initial screening of alternatives:

a. Transportation from the Snake River to Portland occurs year round. Monthly quantities of transported commodities were used for three representative years. The low, average, and high commerce years and associated probabilities used are as follows:

Calendar Year		Probability
Low Yr	1985	.05
Medium Yr	1990	.85
High Yr	1989	.1

b. The costs of transporting goods is likely to vary over time depending on a variety of factors which may include fuel costs, inflation or other unknowns. To account for possible variations in alternative transportation costs, costs were varied through a range of ± 25 percent from a baseline value. The associated probabilities of occurrence are follows:

Low	.05
Medium	.70
High	.25

c. Three commodity groupings: grain; wood products and paper; and wood chips and logs account for over 90 percent of the down stream commercial navigation traffic. The annual tonnage of each of these commodities for each project for the high, average and low commerce years adequately represents commodity transport on the Columbia and Snake Rivers.

d. Commodities shipped by barge are not stored; they are all shipped without delay. The model assumes sufficient numbers of rail cars or trucks to carry the additional volume of commodities and that Portland rail and truck off–loading facilities would be capable of handling the diverted commodities.

e. All commodities either originating in or destined for a pool or a project were treated as though they were shipped from that pool to Portland. This assumption ignores local river traffic, but a review of the 1990 data shows that no significant error is introduced by this assumption. Petroleum products were not included, as they are predominantly an upstream moving commodity, with the largest portion of traffic between Portland and the McNary pool.

f. The lock system operates within a certain range on all the projects under review. Between MOP and 2 feet below, barges would be light loaded resulting in additional tows to move the same quantities. At depths 2 feet and lower than MOP all commodities would be shipped by the next available mode of transportation, either truck or rail.

g. Lower Columbia River Dam Outages or Restrictions: As a result of an early understanding that MOP would be maintained on the McNary, John Day, The Dalles, and the Bonneville pools, the Navigation models used in screening do not account for impacts due to reduced elevations at these projects. If these pools fall below MOP, the impacts to navigation would be substantial, equaling outage impacts on the Snake River plus the cost of alternate transportation to ship commodities by rail or truck past all of these projects.

h. The dams on the navigable portions of the Columbia and Snake Rivers were designed to accommodate and facilitate tug and barge transportation at MOP. Impacts to navigation will occur whenever elevation drops to MOP or below. The locks become impassible to the present fleet when the pool elevation drops just 2 feet below MOP. Several alternatives analyzed during screening also impacted the elevations at lower Columbia River dams. These impacts were not modeled, but would be as great or greater than the Snake River impacts.

3.1.1.2 Value Ranges for Snake River Screening Model

Impacts, evaluated as the total cost of alternate transportation for selected commodities, ranged from none at all to over 31 million dollars, depending on the alternative. Alternatives not requiring draw down below MOP had no measured effect in the screening analysis. The impact of draw down alternative is more or less severe depending on the duration of the draw down and the length of time needed to refill the affected pools. It is important to note that this model was not used in the full scale analysis and results from the full scale analysis are not similar.

3.1.1.3 Qualitative Analysis of the Lower Snake River Screening Results

The screening model measures the severity of an impact by predicting the costs associated with each alternative. Alternatives that leave pools at or above MOP are similar to the baseline alternative: they do not limit navigation, and therefore do not increase the costs of commodity shipments. No impacts are associated with these alternatives.

Alternatives that fall between 2 feet below MOP and MOP would increase navigation costs because barges would need to be light loaded to enter and pass through the lock system. None of the alternatives proposed in screening fell into this category.

Those alternatives that result in pool levels lower than 2 feet below MOP produce severe navigation impacts. These alternatives eliminate the possibility of barging commodities. Trucking or transport by rail is substantially more expensive than barging commodities resulting in increased navigation impacts for those alternatives.

3.1.1.4 IMPACTS: Summary of Results of Initial Screening

LOWER SNAKE RIVER IMPACTS:

(1) Lost grain sales: The screening model assumes that sufficient rail cars, trucks, and off–loading capacity would be available should barge navigation on the lower Snake and Columbia Rivers be curtailed. Insufficient capacity would result in lost grain deals simply because the commodity could not be brought to market. The model can not account for the regional impacts of lost sales.

(2) Upgrading Transportation Infrastructure – Representatives from the transportation agencies of the states of Washington and Oregon have expressed the concern that the highway and rail systems are not physically adequate to handle the large increase in traffic volume should the grain that is normally barged be shipped by an alternate land route. Upgrading the existing road system in the rural areas would require redistribution of transportation funds in both states that could not be fully recovered under existing state or Federal highway revenue allocation formulas. As a result of what is essentially a Federal action, states would be forced to divert transportation funds from other areas, resulting in unmet needs in locations far removed from the Columbia River.

Figure 3–1. Typical Cracking in Whitman County Road 9000 after March 1992 Lower Granite Drawdown Test

(3) Non–movement of Wood Chips – The major hauler of wood chips has indicated that alternatives to barging are not available because the product value is not high enough to justify a more expensive transportation alternative. This would increase the cost of river outages.

(4) Rate Adjustments: The model does not address rate increases that would be necessary during the year to offset fixed expenses during closure windows. The magnitude of the adjustment would depend on the length of the low water forced closures.

(5) Maximum Optimal Flows Exceeded: Two areas on the Snake River the Ice Harbor Cut and below Lower Monumental Dam, were identified as having maximum optimum velocities, above which barge traffic would be impacted. If the flow of the river exceeds 100,000 cfs at the Ice Harbor Cut or 150,000 cfs below Lower Monumental Dam (combined spillway and regulated flow), barge tows must be broken up and moved individually through the reach and then reassembled to pass through the locks. Breaking tows increases the safety hazard in the reach and increases commodity transit time. Added transportation cost associated with high velocities delays is not accounted for in the navigation screening model.

LOWER COLUMBIA RIVER IMPACTS:

(1) Potential Impacts to deep draft navigation: Alternatives which have extended draw down periods (past June 15 of any year) have a likelihood of impacting deep draft navigation below Vancouver, Washington. In these circumstances the refill period for the lower Snake River dams would extend far into the low flow period of the natural hydrograph for the basin and could cause a decrease in river elevations on the lower Columbia River. Present deep draft navigation practices maximize the draft of outbound ships, based on the actual stage of the Columbia River and the tidal cycle. Even small changes in available water depth could have significant impacts. (This result not verified in full scale analysis)

(2) Potential for Increased channel dredging – Flow augmentation scenarios that simulate a freshet condition in the lower Columbia River, below Bonneville dam, will probably increase the formation and severity of shoaling conditions in the navigation channels. Increased dredging would be needed to keep the Columbia River Ship channel clear of shoals. If high flows are immediately followed by low flows (while dams are refilling) the impact on shipping from increased shoaling would be compounded by the loss in water elevation.

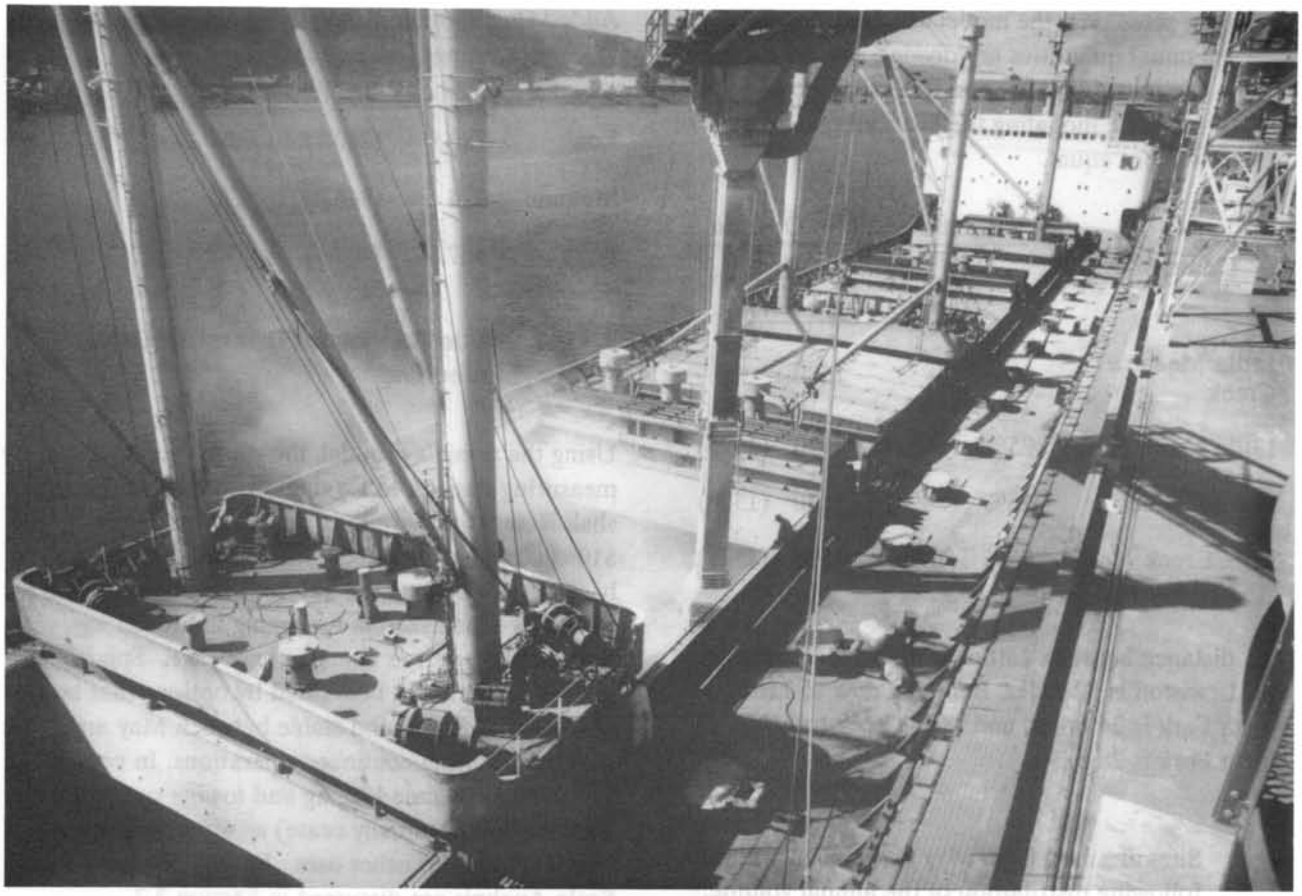

Figure 3–2. Grain vessel being loaded at Port of Portland Terminal 4

A summary of the results from the Screening Analysis are in a separate, two volume SOR publication entitled, *Screening Analysis, Vol. 1, Description and Conclusions*, dated August 1992 and *Screening Analysis, Vol. 2, Impact Results*, dated June 1992.

3.1.2 Dworshak Dam: Screening Analysis

For Dworshak Project, the model developed for Screening evaluated the impacts of log rafting activities on Dworshak Reservoir as a result of alternate system operations. The value measure for the Dworshak screening model was *added transportation costs* for trucking logs to more distant log dumps or all the way to Lewiston when the pool elevation dropped below the lowest dump.

3.1.2.1 Assumptions for the Dworshak Dam Screening Model

a. The annual high and low log quantities, measured in million board feet (mbf), were for 1987 and 1989, respectively. An average year was calculated from the two. The following range of probabilities for each volume condition is used for the analysis.

These assumptions were changed in the Full Scale Analysis. The revised assumptions are also shown.

	Volume (mbf)		Probability	
	Screening/(Full Scale)			
Low Yr	14	(14)	.2	(.1)
Medium Yr	26	(16)	.6	(.8)
High Yr	50	(50)	.2	(.1)

b. In screening, the model assumed that the annual quantities are divided equally between the four dump sites on Dworshak pool. In full scale modeling the distribution of logs was not equal.

Dump Site	Percent of Total		Min Operating Elev (ft)S	
	Screening/(Full Scale)			
Little Meadow Creek	25%	(0)	1580	
Little North Fork	25%	(56%)	1570	(1575)
Benton Creek	25%	(34%)	1570	(1570)
Milk Creek	25%	(10%)	1590	(1585)

The distance between Little North Fork Log Dump and Lewiston is 52 miles, Benton Creek to Little North Fork is 26 miles, and Milk Creek to Little North Fork is 28 miles.

c. Sites are used from May to October, with the following distribution of the annual volume:

Month	Percent of Annual Volume Screening/(Full Scale)	
May	10%	(0%)
June	15%	(15%)
July	25%	(25%)
August	25%	(25%)
September	15%	(25%)
October	10%	(10%)

d. Until the pool elevation drops below 1570, logs are trucked to the nearest usable site on the pool. When the pool elevation falls below 1570 feet, logs are trucked to Lewiston, Idaho. The range of added cost for transporting logs to a different site or to Lewiston is as follows:

	Added Cost ($/mbf/mi.) Screening/(Full Scale)		Probability
Low	280.5	(280.5)	.05
Medium	374	(346.0)	.7
High	467.5	(467.5)	.25

3.1.2.2 Value Ranges for Dworshak Dam Screening

Using the *screening* model, the range of values measuring impacts to logging operations at Dworshak Reservoir operations ranged from minus $106,000 to plus $474,000, when compared to the base case. The negative values indicate that some alternatives analyzed in Screening improved log transport operations over the base case. Specifically, log rafting activities benefitted by options that hold pool elevations full and stable between May and October allowing continued operations. In contrast, under the base case logging and towing operations decline (and eventually cease) as water is drafted from the pool for other uses. Results from the Full Scale Analysis are discussed in Section 3.2.

Figure 3–3. Dworshak Dam Log Dump

3.1.2.3 Qualitative Analysis of the Dworshak Dam Screening Results

Log Storage on Dworshak Pool:

Some temporary storage of logs occurs at the Dworshak log dumps, which the screening model does not account for. As a result, the screening model shows a cost impact associated with even the base case water condition. As this statement applies to nearly all of the alternatives screened, it will not be listed separately in the observations for the Navigation Group.

A summary of the results from the Screening Analysis are in a separate, two volume SOR publication entitled, *Screening Analysis, Vol. 1, Description and Conclusions*, dated August 1992 and *Screening Analysis, Vol. 2, Impact Results*, dated June 1992.

3.2 FULL SCALE ANALYSIS

During full scale analysis, the NTWG looked to verify the significance of issues and concerns identified during screening and to document the physical impacts on navigation of all of the alternatives. Each alternative SOS, including the various modeled options for each, was analyzed to determine whether the SOS/option affected utilization of the locks, caused increased shoaling, high flows, or reduced river elevations below Bonneville Dam. For Dworshak impacts, the model developed during screening was refined by the NTWG with timber industry input and the cost of trucking logs, rather than rafting logs, estimated. Facility owners and operators along the Snake River were asked to qualitatively assess the physical damages that would occur to their facilities during an extended draw down. Some of the results of the NTWG were given to Economics Work Group to further determine the cost and social impact of the alternative.

Snake River Model: Unlike the screening model, the cost of alternate transportation of goods normally barged through the dams on the lower Snake River was generated by a much refined model under a contract administered through the Economics Work Group. Refer to the Economics Appendix for a description of the model and results.

Dworshak Dam: The analysis of impacts on Dworshak Dam log transportation in full scale analysis was very similar to the screening analysis, with the main difference being that 50 years of simulated data were used, rather than just five screening years. Adjustments were made to the variables used in the analysis, based on more current information (see Section 3.1.1), but the logic of the analysis is identical. The model works by developing a cost for alternate truck transportation of logs normally rafted on Dworshak Lake. The model is a simple spreadsheet model, which is coupled with a statistics software package to develop the expected value for impacts.

3.2.1 Impacts to Deep Draft Navigation on the Lower Columbia River:

During the screening phase of the System Operation Review (SOR) alternatives, the Port of Portland, through an analysis of tide, river flows, and vessel transport data, concluded that there was a potential for impacts to shipping on the lower Columbia River as a result of draw down of the lower Snake River pools. Decreased flow from the Snake River into the Columbia River during the refill period, especially when it overlaps the low point of the Snake and Columbia Rivers natural hydrographs, may result in reduced river stages in the lower Columbia River, which could impact commercial navigation along the 40–foot channel. In addition to the normally maintained channel depths, deep draft vessels calling at the ports in the lower Columbia River regularly utilize an average of 2–6 feet of stage provided by tidal effects of the Pacific Ocean.

To analyze the potential for effects in Full Scale Analysis, a comparison of the stage available at key points in the lower Columbia River at various discharges from Bonneville Dam was combined with the probability of occurrence of the discharges in the alternatives requiring draw down of the lower Snake River pools during the months of August, September and October. The hydroregulation simulations showed these months have the greatest potential for impact from the refill period following drawdown alternatives. The three locations in the Columbia River that were studied were Portland/Vancouver (RM 106), Kalama (RM 75), and Wauna (RM 41.6).

The port locations represent the most depth sensitive departure points on the river and Wauna is a critical passage point for loaded outbound vessels.

The National Ocean Service dynamic wave model, DWOPR, was employed to model the system. To simulate the tidal variation, actual tidal data from 1985 was used. This tidal year was selected because it represents an average year, not affected by unusual events such as the El Niño of the early 1980s or early 1990s, and because the period of record is continuous. The inputs to the system from other tributaries to the Columbia River were held constant at the 50 percent exceedance value for each of the three months, as determined by the historical water flow data collected by the U.S. Geological Survey. The Bonneville outflow was varied in increments of 2,500 cfs between 70,000 cfs and 80,000 cfs and by 5,000 cfs between 80,000 cfs and 100,000 cfs. A set of tidal curves was generated at each chosen river location for the various Bonneville flows.

A frequency distribution for stage height at each Bonneville discharge for each location for each month was generated and a probability of occurrence determined. This was combined with the distribution of modeled daily flows from Bonneville for each of the draw down alternatives, the No Action alternative (SOS 1a), and the Base Case (SOS 2c). The daily flows were generated by the Anadromous Fish Work Group's CRiSP model. The daily flows represent how Bonneville would be operated, based on historical operations and current operating restrictions, given the average monthly outflow for a given alternative. Since Bonneville is the lowest dam on the Columbia River, it is operated within fairly tight discharge restrictions. Therefore projecting daily flows using existing operating procedures is a reasonable approach.

The end result of combining the stage and outflow distributions, is a stage frequency distribution for each alternative at each location for each of the three critical months. It should be noted that the absolute values of the stages generated at each location is less important than the difference in the stages under the various SOSs. The relative impacts on stage between various drawdown alternatives and the Base Case, SOS2c, are shown in Table 3–1: *Percent of Time: Comparisons with 2c–1993 Operating Strategy*. The results from the analysis of the draw down alternatives can be extended to the expected results of flow augmentation strategies. If significant storage volume is spilled early in the spring to meet flow targets, refill of reservoirs, especially if coupled with low power generation flows, could cause minimal flows from Bonneville, depending on the timing and length of the refill. Such a condition occurred in the fall of 1994. Further discussion of the relative economic impacts on navigation are included in the Economics Appendix.

Impacts to the velocity of the water at Ice Harbor and Lower Monumental Dams: During Screening, the barge operators noted that high flows from both Lower Monumental and Ice Harbor Dams were problematic in navigating barge tows below the dams. The optimal condition below Lower Monumental Dam is flows below 150,000 cfs and below Ice Harbor Dam is flows less than 100,000 cfs, when McNary pool is full. During full scale analysis, the average monthly flows for the 50 years of data were examined for each system strategy. The data was sorted and compared to both the Base Case (SOS 2c) and the No Action alternative (SOS 1A). It is acknowledged that the monthly flow averages do not reflect the daily conditions below the dam, that some high flow days might not be apparent when looking only at averages. Yet, using the monthly averages is useful for comparing the potential for chronic occurrence of the problem.

The results are shown in Table 3–2: *Summary–Flow Analysis For Lower Monumental & Ice Harbor.* The results reveal that most alternative strategies had little or no effect on the occurrence of high flow conditions. Only the flow augmentation alternatives showed noticeable, though minor, increases in the number of years out of the 50 years of simulation that average monthly flows exceeded the optimal conditions.

3.3 IMPACTS NOT MODELED

3.3.1 Physical Impacts to the Facilities along the Snake River due to Extended Draw Down

A survey of the owners of the facilities on the lower Snake River was conducted to have them describe the potential impacts on their facilities due to an extended draw down scenarios. The results are contained in Table 3–3, *Results of the Survey for Anticipated Physical Impacts*. No quantitative analysis of the impacts was completed by the NTWG.

3.3.2 Lake Roosevelt Ferry Operations

There are two ferry operations on Lake Roosevelt, behind Grand Coulee Dam. One is located at Keller, Washington, and the other at Gifford. The Gifford Ferry will be impacted when the water elevation behind Grand Coulee drops by more than 72 feet. The operators of the Keller Ferry report that when their normal terminus is affected by low water, they are able to utilize an old road bed nearby to come ashore. In reviewing the results of 50 years of modelled data, most alternatives did not cause significant changes in the monthly end elevations from historical or modelled base case data. Nearly all SOS alternatives resulted in the Gifford Ferry being impacted, on average, about 6 years in 50, usually in late April.

3.3.3 Increased Shoal Formation

The potential for increased shoal formation and increased dredging on the Snake and Columbia Rivers from higher flows associated with flow augmentation releases during the spring was identified in Screening. During full scale analysis, an empirical relationship between high flows was sought after in the flow and dredging records of the lower Columbia River. Unfortunately, in the Lower Columbia River, the records did not show a direct correlation. It was apparent from the records that the availability of dredge plant equipment played a great part in the volume of material dredged. Some years the maintenance probably barely stayed ahead of need, whereas in other years, some advance maintenance was possible in order to secure the channel depths for longer periods of time. This factor could not be filtered out. In order to provide some perspective on the potential for impact, however, it should be noted that typically, between seven and nine million cubic yards of sand are removed during annual maintenance dredging below Vancouver, Washington to mouth of the Columbia River. Based on recent costs for dredging in the Columbia River, a modest five percent increase in annual dredging would translate into over $600,000 dollars in additional dredging costs.

In the lower Snake River, where the shoals are formed under different conditions than in the lower Columbia River, the higher velocities result in a scouring effect on the river bed, which would result in less dredging.

Figure 3–4. Damage to Red Wolf Marina in the Lower Granite Pool during March 1992 Drawdown Test

Table 3–1. Percent of Time Comparison of Specific Operating Strategy with 2c*

Vancouver

August

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.1	1.0	−0.4	−0.3	−0.5	0.0	0.0	0.0	0.0	0.0
5b	0.0	0.1	1.4	−0.5	−0.4	−0.6	0.0	0.0	0.0	0.0	0.0
6a	0.0	0.1	1.0	−0.3	−0.3	−0.4	0.0	0.0	0.0	0.0	0.0
6b	0.0	0.1	1.5	−0.4	−0.4	−0.6	0.0	0.0	0.0	0.0	0.0
6af	0.0	0.1	1.2	−0.4	−0.3	−0.5	0.0	0.0	0.0	0.0	0.0
6bf	0.0	0.1	1.4	−0.4	−0.3	−0.6	0.0	0.0	0.0	0.0	0.0

September

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	−0.3	−0.6	0.3	0.3	0.2	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	2.2	0.1	−0.6	−1.2	−0.4	0.0	0.0	0.0	0.0
5b	0.0	0.0	4.5	2.4	−2.4	−3.1	−1.4	0.0	0.0	0.0	0.0
6a	0.0	0.0	1.9	−0.1	−0.5	−1.1	−0.3	0.0	0.0	0.0	0.0
6b	0.0	0.0	3.9	2.0	−2.0	−2.6	−1.2	0.0	0.0	0.0	0.0
6af	0.0	0.0	2.0	0.1	−0.7	−1.2	−0.4	0.0	0.0	0.0	0.0
6bf	0.0	0.0	4.5	2.2	−2.3	−3.0	−1.4	0.0	0.0	0.0	0.0

October

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	−0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.7	0.0	−0.2	−0.4	−0.3	0.0	0.0	0.0	0.0
5b	0.0	0.0	0.8	0.1	−0.2	−0.4	−0.3	0.0	0.0	0.0	0.0
6a	0.0	0.0	0.7	−0.2	−0.2	−0.4	−0.2	0.0	0.0	0.0	0.0
6b	0.0	0.0	0.6	−0.2	−0.1	−0.3	−0.2	0.0	0.0	0.0	0.0
6af	0.0	0.0	0.6	−0.2	−0.1	−0.3	−0.2	0.0	0.0	0.0	0.0
6bf	0.0	0.0	0.6	−0.2	−0.1	−0.3	−0.2	0.0	0.0	0.0	0.0

* Results include alternates not carried through to FEIS

Table 3–1. Percent of Time Comparison of Specific Operating Strategy with 2c* – CONT

Kalama

August

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.4	0.2	−0.2	−0.2	−0.3	0.0	0.0	0.0	0.0
5b	0.0	0.0	0.5	0.3	−0.3	−0.2	−0.4	0.0	0.0	0.0	0.0
6a	0.0	0.0	0.4	0.2	−0.2	−0.2	−0.2	0.0	0.0	0.0	0.0
6b	0.0	0.0	0.5	0.4	−0.2	−0.2	−0.4	0.0	0.0	0.0	0.0
6af	0.0	0.0	0.4	0.3	−0.2	−0.2	−0.3	0.0	0.0	0.0	0.0
6bf	0.0	0.0	0.5	0.4	−0.2	−0.2	−0.3	0.0	0.0	0.0	0.0

September

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	−0.1	−0.3	−0.1	0.2	0.2	0.1	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.5	1.1	−0.5	0.0	−0.7	−0.3	0.0	0.0	0.0
5b	0.0	0.0	1.0	2.9	−0.4	−0.9	−1.9	−0.8	0.0	0.0	0.0
6a	0.0	0.0	0.4	0.9	−0.5	0.0	−0.6	−0.2	0.0	0.0	0.0
6b	0.0	0.0	0.9	2.5	−0.3	−0.7	−1.6	−0.7	0.0	0.0	0.0
6af	0.0	0.0	0.4	1.0	−0.5	−0.2	−0.8	−0.3	0.0	0.0	0.0
6bf	0.0	0.0	1.0	2.9	−0.4	−0.8	−1.9	−0.8	0.0	0.0	0.0

October

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	−0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.2	0.4	0.0	−0.2	−0.3	−0.2	0.0	0.0	0.0
5b	0.0	0.0	0.2	0.4	0.0	−0.2	−0.4	−0.2	0.0	0.0	0.0
6a	0.0	0.0	0.2	0.3	−0.1	−0.2	−0.3	−0.1	0.0	0.0	0.0
6b	0.0	0.0	0.2	0.3	−0.1	−0.1	−0.3	−0.1	0.0	0.0	0.0
6af	0.0	0.0	0.2	0.3	−0.1	−0.1	−0.3	−0.1	0.0	0.0	0.0
6bf	0.0	0.0	0.1	0.3	−0.1	−0.1	−0.3	−0.1	0.0	0.0	0.0

* Results include alternates not carried through to FEIS

Table 3–1. Percent of Time Comparison of Specific Operating Strategy with 2c* – CONT

Wauna

August

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.0	0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0
5b	0.0	0.0	0.0	0.1	−0.1	−0.1	0.0	0.0	0.0	0.0	0.0
6a	0.0	0.0	0.0	0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0
6b	0.0	0.0	0.1	0.2	−0.1	0.0	0.0	0.0	0.0	0.0	0.0
6af	0.0	0.0	0.0	0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0
6bf	0.0	0.0	0.0	0.1	−0.1	0.0	0.0	0.0	0.0	0.0	0.0

September

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.1	0.0	0.1	0.2	−0.2	−0.1	0.0	0.0	0.0	−0.1	0.0
5b	0.2	0.1	0.2	0.4	−0.2	−0.3	−0.1	0.0	−0.1	−0.2	0.0
6a	0.1	0.0	0.0	0.2	−0.2	−0.1	−0.1	0.0	0.0	−0.1	0.0
6b	0.1	0.1	0.2	0.3	−0.1	−0.2	0.0	0.0	−0.1	−0.2	0.0
6af	0.1	0.0	0.0	0.2	−0.2	−0.1	−0.1	0.0	0.0	−0.1	0.0
6bf	0.2	0.1	0.2	0.4	−0.2	−0.3	−0.1	0.0	−0.1	−0.2	0.0

October

Operating Strategy	Stage Interval										
	−2	−1	0	1	2	3	4	5	6	7	8
1a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2c											
5a	0.0	0.0	0.1	−0.1	0.1	0.0	−0.2	0.0	−0.1	0.0	0.0
5b	0.0	0.0	0.1	0.0	0.1	0.0	−0.2	0.0	−0.1	0.0	0.0
6a	0.0	0.0	0.0	−0.1	0.0	0.0	−0.2	0.0	−0.1	0.0	0.0
6b	0.0	0.0	0.0	−0.1	0.1	0.0	−0.2	0.0	−0.1	0.0	0.0
6af	0.0	0.0	0.0	−0.1	0.1	0.0	−0.2	0.0	−0.1	0.0	0.0
6bf	0.0	0.0	0.0	0.0	0.1	0.0	−0.1	0.0	−0.1	0.0	0.0

* Results include alternates not carried through to FEIS

Table 3–2. Summary Flow Analysis for Lower Monumental & Ice Harbor
No. of Months Qave > Optimal Conditions**

LOWER MONUMENTAL SORT
Q Optimal < 150,000 cfs

APRIL		MAY		JUNE	
1a	3	2d	4	9c	2
1b	3	9b	4	1a	4
2c	3	2c	5	1b	4
2d	3	4c	5	2d	5
4c	3	5b	5	4c	5
5b	3	5c	5	5b	5
5c	3	6b	5	5c	5
6b	3	6d	5	6b	5
6d	3	9a	5	6d	5
9a	3	9c	5	2c	6
9b	3	PA	5	9b	6
9c	3	1a	6	PA	7
PA	3	1b	6	9a	9

ICE HARBOR SORT
Q Optimal < 100,000 cfs

APRIL		MAY		JUNE	
2d	9	2d	18	9c	15
1a	15	9c	21	1a	20
1b	15	9a	22	1b	20
4c	17	PA	22	5c	21
9a	17	1a	23	2c	22
5c	17	1b	23	4c	22
5b	18	5c	24	5b	22
6b	18	4c	25	6b	22
6d	18	5b	25	6d	22
9c	18	6b	25	PA	22
2c	19	6d	25	2d	23
9b	19	9b	25	9b	23
PA	19	2c	26	9a	25

** Out of 50 modeled water years, water data from 1929–1978

Table 3–3. Results of the Survey for Anticipated Physical Impacts* Due to Drawdown of Lower Snake River Pools

* Only comments relevant to the *physical* impacts are included. Economic Impacts are described in Economics TechnicalAppendix.

Name of Facility	RM	Type of Facility	Physical Impacts	Greater Impacts w/ Longer Draw down Other Comments on Physical Impacts
Port of Whitman – Almota Site	430	Port (grain)	bank sloughing, land subsidence, possible building failures, road failures, possible bridge failure, possible water system failure dolphin instability, barge loading facilities unusable, possible well pumps failure, water table drop	Longer draw down makes building failure more probable.
– Boyer Park & Marina	430	Park, Marina Restaurant	boat ramp unusable, swimming area unusable, boat docks unusable, gas dock ususable and possible line rupture, dikes slough, river bank slough, water table drop, possible break up of roads and parking area	This facility is immediately down stream of Lower Granite Dam. Flow and spill tests raise and lower the water level quickly and dramatically at the Marina. This fluctuation is very hard to deal with. A steady pool level, as experienced here, not an average for the reservoir, minimizes damage to the facilities and the costs to protect them. (paraphrased)
– Central Ferry	405	Heavy Industry Barge Port	bank sloughing, dolphin instability	
– Wilma Site	460	Heavy Industry Barge Port Commercial Marina	bank sloughing, dolphin instability, damage to floating docks, barge facilities unusable, possible land subsidence; structural integrity of sheet pile docks, tank farm foundation and building foundations is threatened	Longer draw down makes all physical impacts more likely to occur. We know some will occur with even a one month draw down...We don't know if we will see structural intergrity of the tank farm compromised by a longer draw down. Financial impact uncertain. The method of draw down may cause the physical failures – if it is done too fast. A slower draw down would minimize the failures.
Lewis–Clark Terminal Assoc.	465	Grain Storage River Terminal	settling/shifting of barge loading structure, resedimentation of barge slip, loss of ability to ship grain in an economical manner to export locations lack of adequate grain storage, (multiple financial impacts to employees and business....)	Longer draw downs would increase impacts to facilities. Will money become available to pay for damages or to retrofit for different modes of transport?
Port of Lewiston	465	Sea Port	dolphin settling, bank sloughing	

Table 3–3. Results of the Survey for Anticipated Physical Impacts* Due to Drawdown of Lower Snake River Pools – CONT

* Only comments relevant to the *physical* impacts are included. Economic Impacts are described in Economics Technical Appendix.

Name of Facility	RM	Type of Facility	Physical Impacts	Greater Impacts w/ Longer Draw down Other Comments on Physical Impacts
Potlatch Corp.	465	Manufacture lumber and bleached pulp products	requirement of water intake and effluent modifications, eliminate barge transportation of products, require alternate mode of transportation of product shipments	The effluent discharge permit is based on specific minimum flows for adequate dispersion, which may not be met under reduced flows during the draw down or refill period. (paraphrased)
Mountain Fir Chip Co.	465	Whole log chipping plant	facility would stop production when barge transportation became impossible and on–site storage would be insufficient	Financial impact to operation and associated operations (logging contractors, haulers, and purchasers) is much greater than the actual physical impact. (paraphrased)
Clarkston Grain Terminal, Inc.	464	Grain elevator		Respondent felt operation would close due to financial impacts.... **See Economic Analysis Appendix**
Port of Clarkston	463	Crane and cargo dock, marina, and land lease	shipments of cargo (grain, logs, containers, grass seed) and docking by boats and cruise ships stop.	Port of Clarkston has no rail system, so we depend greatly on river traffic to ship products. Red Wolf Marina would not operate due to lack of sufficient water levels... **See Economic Analysis Appendix**
Wilma Division, Mountain Fir Chip Company	460	Whole log chipping plant	facility would stop production when barge transportation became impossible and on–site storage would be insufficient	Financial impact to operation and associated operations (logging contractors, haulers, and purchasers) is much greater than the actual physical impact. (paraphrased) **See Economic Analysis Appendix**
Tidewater Terminal Co.	460	Barge loading unlaoding facility	damage to docks, especially the petroleum dock	Note: major concern is economic impact **See Economic Analysis Appendix**
Almota Elevator Company	430	Grain loading facility	intergrity of the facility would be compromised	Our facility is built on fill. Not all of the facility has piling underneath ... (impact would occur) if not this time, then next time.
Port of Garfield	405	Land lease	sloughing of the river bank, possible collapse of the grain elevators on site	The longer the draw down, the worse the physical impact will be. The engineers have stated the elevators cannot withstand the "drain/fill" process year after year. They will collapse. The roads through Garfield County cannot sustain the increased traffic if grain is forced to be moved by truck...

Table 3–3. Results of the Survey for Anticipated Physical Impacts* Due to Drawdown of Lower Snake River Pools – CONT

* Only comments relevant to the *physical* impacts are included. Economic Impacts are described in Economics Technical Appendix.

Name of Facility	RM	Type of Facility	Physical Impacts	Greater Impacts w/ Longer Draw down Other Comments on Physical Impacts
Pomeroy Grain Growers, Inc.	405	Grain elevator	sloughing of river bank, potential severe undermining of foundation support due to lowering of ground water levels and bank sloughing	The longer any drawdown occurs, the larger the potential occurs for any physical damage. For example, sloughing is the result of wave action on unprotected (below riprap) bank and the longer any drawdown occurs, the more wave action will occur. ... there will also be physical damage to the (alternate) transportation system, ie., roads and railroads...
Central Ferry Terminal Assoc.	405	Truck to barge grain loading operation	unable to load barges when water level is below MOP	Millions of bushels of grain will have to find another way to the coast (10.5 million Bu. handled here last year.) **See Economic Analysis Appendix**
Tidewater Terminal Co.	330	Barge loading unlaoding facility	upstream bound cargos unable to move past Ice Harbor Dam	Note: major concern is economic impact **See Economic Analysis Appendix**
Grain Growers	320	grain elevator barge loading	possible impacts due to ground movement	The facility was not designed to operate below minimum navigaiton levels.
Columbia Grain Growers, Inc	292	grain elevator barge loading	sloughing of embankment; possible structural damage to dolphins, barge loading tower and barge loading belt	Continued sloughing of embankment could damage our warehouse facility, which includes 547,000 bushel flat house; 616,000 bushel elevator; 1,5557,000 bushel corrugated steel and 283,000 bushel bolted steel bins
Longview Fibre Company	68	Pulp & paper mill	potential water quality problems during low flow refill period	Note: concern for potential low stage impacts of refill, which are discussed separately

CHAPTER 4

IMPACTS OF ALTERNATIVES

4.1 GENERAL DESCRIPTION OF ALTERNATIVES

Seven alternative System Operating Strategies (SOS) were considered in the Draft EIS. Each of the 7 SOSs contained several options, bringing the total number of alternatives considered to 21. This Final EIS also evaluates 7 operating strategies, with a total of 13 alternatives now under consideration when accounting for options. Section 4.1 of this chapter describes the 13 alternatives and provides the rationale for including these alternatives in the Final EIS. Operating elements for each alternative are summarized in Table 4–1. Later sections of this chapter describe the effects of these alternatives on navigation.

The 13 final alternatives represent the results of the third analysis and review phase completed since SOR began. In 1992, the agencies completed an initial effort, known as "Screening" which identified 90 possible alternatives. Simulated operation for each alternative was completed for five water year conditions ranging from dry to wet years, impacts to each river use area were estimated using simplified analysis techniques, and the results were compared to develop 10 "candidate SOSs." The candidate SOSs were the subject of a series of public meetings held throughout the Pacific Northwest in September 1992. After reviewing public comment on the candidate strategies, the SOR agencies further reduced the number of SOSs to seven. These seven SOSs were evaluated in more detail by performing 50–year hydroregulation model simulations and by determining river use impacts. The impact analysis was completed by the SOR workgroups. Each SOS had several options so, in total, 21 alternatives were evaluated and compared. The results were presented in the Draft EIS, published in July, 1994. As was done after Screening, broad public review and comment was sought on the Draft EIS. A series of nine public meetings was held in September and October 1994, and a formal comment period on the Draft EIS was held open for over 4 1/2 months. Following this last process, the SOR agencies have again reviewed the list of alternatives and have selected 13 alternatives for consideration and presentation in the Final EIS.

Six options for the alternatives remain unchanged from the specific options considered in the Draft EIS. One option (SOS 4c) is a revision to a previously considered alternative, and the rest represent replacement or new alternatives. The basic categories of SOSs and the numbering convention remains the same as was used in the Draft EIS. However, because some of the alternatives have been dropped, the final SOSs are not numbered consecutively. There is one new SOS category, Settlement Discussion Alternatives, which is labeled SOS 9 (see Section 4.1.6 for discussion).

The 13 alternatives have been evaluated through the use of a computerized model known as HYDROSIM. Developed by BPA, HYDROSIM is a hydroregulation model that simulates the coordinated operation of all projects in the Columbia River system. It is a monthly model with 14 total time periods. April and August are split into two periods each, because major changes can occur in streamflows in the first and second half of each of these months. The model is based on hydrologic data for a 50–year period of record from 1928 through 1978. For a given set of operating rule inputs and other project operating requirements, HYDROSIM will simulate elevations, flows, spill, storage content and power generation for each project or river control point for the 50–year period. For more detailed information, please refer to Appendix A, River Operation Simulation.

The following section describes the final alternatives and reviews the rationale for their inclusion in the Final EIS.

Table 4–1. SOS Alternative–1

Summary of SOS

SOS 1 Pre-ESA Operation	SOS 2 Current Operations	SOS 4 Stable Storage Project Operation
SOS 1 represents system operations before changes were made as a result of the ESA listing of three Snake River salmon stocks. SOS 1a represents operations from 1983 through the 1990–91 operating year, influenced by Northwest Power Act; SOS 1b represents how the system would operate without the Water Budget and related operations to benefit anadromous fish. Short-term operations would be conducted to meet power demands while satisfying nonpower requirements.	SOS 2 reflects operation of the system with interim flow improvement measures in response to the ESA salmon listings. It is consistent with the 1992–93 operations described in the Corps' 1993 Interim Columbia and Snake River Flow Improvement Measures Supplemental EIS. SOS 2c represents the operating decision made as a result of the 1993 Supplemental EIS and is the no action alternative for the SOS. Relative to SOS 1a, primary changes are additional flow augmentation in the Columbia and Snake Rivers and modified pool levels at lower Snake and John Day reservoirs during juvenile salmon migration. SOS 2d represents operations of the 1994-98 Biological Opinion issued by NMFS, with additional flow aumentation measures compared to SOS 2c.	SOS 4 would coordinate operation of storage reservoirs to benefit recreation, resident fish, wildlife, and anadromous fish, while minimizing impacts to power and flood control. Reservoirs would be managed to specific elevations on a monthly basis; they would be kept full longer, while still providing spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. SOS 4c attempts to accommodate anadromous fish needs by shaping mainstem flows to benefit migrations and would modify the flood control operations at Grand Coulee.

Actions by Project

	SOS 1	SOS 2	SOS 4
LIBBY	**SOS 1a** Normal 1983–1991 storage project operations **SOS 1b** • Minimum project flow 3 kcfs • No refill targets • Summer draft limit of 5–10 feet	**SOS 2c** Operate on system proportional draft as in SOS 1a **SOS 2d** • Provide flow augmentation for salmon and sturgeon when Jan. to July forecast is greater than 6.5 MAF • Meet sturgeon flows of 15, 20, and 12.5 kcfs in May, June, and July, respectively, in at least 3 out of 10 years	**SOS 4c** • Meet specific elevation targets as indicated by Integrated Rule Curves (IRCs); IRCs are based on storage content at the end of the previous year, determination of the appropriate year within the critical period, and runoff forecasts beginning in January • IRCs seek to keep reservoir full (2,459 feet) June-Sept; minimum annual elevation ranges from 2,399 to 2,327 feet, depending on critical year determination • Meet variable sturgeon flow targets at Bonners Ferry during May 25-August 16 period; flow targets peak as high as 35 kcfs in the wettest years

KAF = 1.234 million cubic meters

MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–1

SOS 5 Natural River Operation	SOS 6 Fixed Drawdown	SOS 9 Settlement Discussion Alternatives	SOS PA
SOS 5 would aid juvenile salmon by increasing river velocity. The four lower Snake River projects would have new outlets installed, allowing the reservoirs to be drawn down to near the original river elevation. The "natural river" operation would be done for 4 1/2 months in SOS 5b and year-round in SOS 5c. John Day would also be operated at MOP for 4 months, and flow augmentation measures on the Columbia River portion of the basin would continue as in SOS 2c.	SOS 6 involves drawing down lower Snake River projects to fixed elevations below MOP to aid anadromous fish. SOS 6b provides for fixed drawdowns for all four lower Snake projects for 4 1/2 months; SOS 6d draws down Lower Granite only for 4 1/2 months. John Day would also be operated at MOP for 4 months, and flow augmentation measures on the Columbia River portion of the basin would continue as in SOS 2c.	SOS 9 represents operations suggested by the USFWS, NMFS, the state fisheries agencies, Native American tribes, and the Federal operating agencies during the settlement discussions in response to the *IDFG v. NMFS* court proceedings. This alternative has three options, SOSs 9a, 9b, and 9c, that represent different scenarios to provide increased river velocities for anadromous fish by establishing flow targets during migration and to carry out other actions to benefit ESA-listed species. The three options are termed the Detailed Fishery Operating Plan (9a), Adoptive Management (9b), and the Balanced Impacts Operation (9c).	SOS PA represents the operation recommended by NMFS and the USFWS Biological Opinions issued March 1, 1995. This SOS supports recovery of ESA-listed species by storing water during the fall and winter to meet spring and summer flow targets, and protects other resources by setting summer draft limits to manage negative effects, by providing flood protection, and by providing for reasonable power generation.

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft as in SOS 1a **SOS 5c** Operate on system proportional draft as in SOS 1a	**SOS 6b** Operate on system proportional draft as in SOS 1a **SOS 6d** Operate on system proportional draft as in SOS 1a	**SOS 9a** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Provide sturgeon flow releases April-Aug. to achieve up to 35 kcfs at Bonner's Ferry with appropriate ramp up and ramp down rates **SOS 9b** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation • Provide sturgeon flow releases similar to SOS 2d • Can draft to elevation 2,435 by end of July to meet flow targets **SOS 9c** • Operate to the Integrated Rule Curves and provide sturgeon flow releases as in SOS 4c	**SOS PA** • Operate on minimum flow up to flood control rule curves beginning in Jan., except during flow augmentation period • Strive to achieve flood control elevations in Dec. in all years and by April 15 in 75 percent of years • Provide sturgeon flows of 25 kcfs 42 days in June and July • Provide sufficient flows to achieve 11 kcfs flow at Bonner's Ferry for 21 days after maximum flow period • Draft to meet flow targets, to a minimum end of Aug. elevation of 2,439 feet, unless deeper drafts needed to meet sturgeon flows

1 kcfs = 28 cms

1 ft = 0.3048 meter

Table 4–1. SOS Alternative–2
Actions by Project

	SOS 1	SOS 2	SOS 4
HUNGRY HORSE	**SOS 1a** Normal 1983–1991 storage project operations **SOS 1b** • No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	**SOS 2c** Operate on system proportional draft as in SOS 1a **SOS 2d** Operate on system proportional draft as in SOS 1a	**SOS 4c** • Meet specific elevation targets as indicated by Integrated Rule Curves (IRCs), similar to operation for Libby • IRCs seek to keep reservoir full (3,560 feet) June-Sept.; minimum annual elevation ranges from 3,520 to 3,450 feet, depending on critical year

	SOS 1	SOS 2	SOS 4
ALBENI FALLS	**SOS 1a** Normal 1983–1991 storage project operations **SOS 1b** No refill target	**SOS 2c** Operate on system proportional draft as in SOS 1a **SOS 2d** Operate on system proportional draft as in SOS 1a	**SOS 4c** Elevation targets established for each month, generally 2,056 feet Oct.–March, 2,058 to 2,062.5 feet April–May, 2,062.5 feet (full) June, 2,060 feet July–Sept. (but higher if runoff high); Oct.–March drawdown to 2,051 feet every 6th year

KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–2

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
Operate on system proportional draft as in SOS 1a	Operate on system proportional draft as in SOS 1a	• Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period	• Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Strive to achieve flood control elevations by April 15 in 75 percent of the years • Draft to meet flow targets, to a minimum end-of-August elevation of 3,540 feet
SOS 5c	**SOS 6d**	**SOS 9b**	
Operate on system proportional draft as in SOS 1a	Operate on system proportional draft as in SOS 1a	• Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation • Can draft to meet flow targets, to a minimum end-of-July elevation of 3,535 feet	
		SOS 9c	
		• Operate to the Integrated Rule Curves as in SOS 4c	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
Operate on system proportional draft as in SOS 1a	Operate on system proportional draft as in SOS 1a	Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period	• Operate to flood control elevations by April 15 in 90 percent of the years • Operate to help meet flow targets, but do not draft below full pool through Aug.
SOS 5c	**SOS 6d**	**SOS 9b**	
Operate on system proportional draft as in SOS 1a	Operate on system proportional draft as in SOS 1a	• Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Can draft to meet target flows, to a minimum end-of-July elevation of 2,060 feet	
		SOS 9c	
		• Elevation targets established for each month, generally no lower than 2,056 feet Dec.—April, no lower than 2,057 feet end of May, full (2,062.5 feet) June—Aug., 2,056 feet Sept.—Nov.	

1 kcfs = 28 cms   1 ft = 0.3048 meter

Table 4–1. SOS Alternative–3
Actions by Project

	SOS 1	SOS 2	SOS 4
GRAND COULEE	**SOS 1a** • Operate to meet Water Budget target flows of 134 kcfs at Priest Rapids in May 1/ • Meet minimum elevation of 1,240 feet in May **SOS 1b** • No refill target of 1,240 feet in May • Maintain 1,285 feet June–Sept.; minimum 1,220 feet rest of year • No May–June flow target	**SOS 2c** • Storage of water for flow augmentation from January through April • Supplemental releases (in conjunction with upstream projects) to provide up to 3 MAF additional (above Water Budget) flow augmentation in May and June, based on sliding scale for runoff forecasts • System flood control space shifted from Brownlee, Dworshak **SOS 2d** • Contribute, in conjunction with upstream storage projects, up to 4 MAF for additional flow augmentation • Operate in summer to provide flow augmentation water and meet downstream flow targets, but draft no lower than 1,280 feet	**SOS 4c** • Operate to end-of-month elevation targets, as follows: 1,288 Sept.-Nov 1,287 Dec. 1,270 Jan. 1,260 Feb. 1,270 Mar. 1,272 Apr. 15 1,275 Apr. 30 1,280 May 1,288 Jun.-Aug. • Meet flood control rule curves only when Jan.-June runoff forecast exceeds 68 MAF

	SOS 1	SOS 2	SOS 4
PRIEST RAPIDS	**SOS 1a** • Meet May-June flow targets 1/ • Maintain minimum flows to meet Vernita Bar Agreement 2/ **SOS 1b** • No May flow target • Meet Vernita Bar Agreement	**SOS 2c** Operate as in SOS 1a **SOS 2d** Operate as in SOS 1a	**SOS 4c** Operate as in SOS 1a

1/ Flow targets are weekly averages with weekend and holiday flows no less than 80 percent of flows over previous 5 days.
2/ 55 kcfs during heavy load hours October 15 to November 30; minimum instantaneous flow 70 kcfs December to April
KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–3

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate on system proportional draft and provide flow augmentation as In SOS 2c	**SOS 6b** Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 9a** • Operate to meet flood control requirements and Vernita Bar agreement • Provide flow augmentation releases to help meet targets at The Dalles of 220-300 kcfs April 16-June 15, 200 kcfs June 16-July 31, and 160 kcfs Aug. 1-Aug.31, based on appropriate critical year determination • In above average runoff years, provide 40% of the additional runoff volume as flow augmentation	**SOS PA** • Operate to achieve flood control elevations by April 15 in 85% of years • Draft to meet flow targets, down to minimum end-of-Aug. elevation of 1,280 feet • Provide flow augmentation releases to meet Columbia River flow targets at McNary of 220-260 kcfs April 20-June 30, based on runoff forecast, and 200 kcfs July-Aug.
SOS 5c Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 6d** Operate on system proportional draft and provide flow augmentation as in SOS 2c	**SOS 9b** • Operate on minimum flow up to flood control rule curves year-round, except during flow augmentation period • Can draft to meet flow targets, bounded by SOS 9a and 9c targets, to a minimum end-of-July elevation of 1,265 feet	
		SOS 9c • Operate to meet McNary flow targets of 200 kcfs April 16-June 30 and 160 kcfs in July • Can draft to meet flow targets, to a minimum end-of-July elevation of 1,280 feet • Contribute up to 4 MAF for additional flow augmentation, based on sliding scale for runoff forecasts, in conjunction with other upstream projects • System flood control shifted to this project	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Operate as in SOS 1a	**SOS 6b** Operate as in SOS 1a	**SOS 9a** Operate as in SOS 1a	**SOS PA** Operate as in SOS 1a
SOS 5c Operate as in SOS 1a	**SOS 6d** Operate as in SOS 1a	**SOS 9b** Operate as in SOS 1a	
		SOS 9c Operate as in SOS 1a	

1 kcfs = 28 cms 1 ft = 0.3048 meter

Table 4–1. SOS Alternative–4

Actions by Project

	SOS 1	SOS 2	SOS 4
SNAKE RIVER ABOVE BROWNLEE	**SOS 1a** Normal 1990—91 operations; no Water Budget flows **SOS 1b** Same as SOS 1a	**SOS 2c** Release up to 427 KAF (190 KAF April 16—June 15; 137 KAF Aug.; 100 KAF Sept.) for flow augmentation **SOS 2d** • Release up to 427 KAF, as in SOS 2c • Release additional water obtained by purchase or other means and shaped per Reclamation releases and Brownlee draft requirements; simulation assumed 927 KAF available	**SOS 4c** Same as SOS 1a
BROWNLEE	**SOS 1a** • Draft as needed (up to 110 KAF in May) for Water Budget, based on target flows of 85 kcfs at Lower Granite • Operate per FERC license • Provide system flood control storage space **SOS 1b** • No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	**SOS 2c** Same as SOS 1a except for additional flow augmentation as follows: • Draft up to 137 KAF in July, but not drafting below 2,067 feet; refill from the Snake River above Brownlee in August • Draft up to 100 KAF in Sept. • Shift system flood control to Grand Coulee • Provide 9 kcfs or less in November; fill project by end of month • Maintain November monthly average flow December through April **SOS 2d** Same as SOS 2c, plus pass additional flow augmentation releases from upstream projects	**SOS 4c** Same as SOS 1a except slightly different flood control rule curves

KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–4

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 1a	**SOS 6b** Same as SOS 1a	**SOS 9a** Provide up to 1.927 MAF through Brownlee for flow augmentation, as determined by Reclamation	**SOS PA** Provide 427 KAF through Brownlee for flow augmentation, as determined by Reclamation
SOS 5c Same as SOS 1a	**SOS 6d** Same as SOS 1a	**SOS 9b** Provide up to 927 KAF through Brownlee as determined by Reclamation	
		SOS 9c Provide up to 927 KAF through Brownlee as determined by Reclamation	

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 4c	**SOS 6b** Same as SOS 4c	**SOS 9a** • Draft up to 110 KAF in May, 137 KAF in July, 140 KAF in Aug., 100 KAF in Sept. for flow augmentation • Shift system flood control to Grand Coulee	**SOS PA** Draft to elevation 2,069 feet in May, 2,067 feet in July, and 2,059 feet in Sept., passing inflow after May and July drafts
SOS 5c Same as SOS 4c	**SOS 6d** Same as SOS 4c	**SOS 9b** • Draft up to 190 KAF April-May, 137 KAF in July, 100 KAF in Sept. for flow augmentation • Shift system flood control to Grand Coulee • Provide an additional 110 KAF in May if elevation is above 2,068 feet and 110 KAF in Sept. if elevation is above 2,043.3 feet	
		SOS 9c Same as SOS 9b	

1 kcfs = 28 cms

1 ft = 0.3048 meter

Table 4–1. SOS Alternative–5

Actions by Project

	SOS 1	SOS 2	SOS 4
DWORSHAK	**SOS 1a** • Draft up to 600 KAF in May to meet Water Budget target flows of 85 kcfs at Lower Granite • Provide system flood control storage space **SOS 1b** • Meet minimum project flows (2 kcfs, except for 1 kcfs in August); summer draft limits; maximum discharge requirement Oct. to Nov. (1.3 kcfs plus inflow) • No Water Budget releases	**SOS 2c** Same as SOS 1a, plus the following supplemental releases: • 900 KAF or more from April 16 to June 15, depending on runoff forecast at Lower Granite • Up to 470 KAF above 1.2 kcfs minimum release from June 16 to Aug. 31 • Maintain 1.2 kcfs discharge from Oct. through April, unless higher required • Shift system flood control to Grand Coulee April–July if runoff forecasts at Dworshak are 3.0 MAF or less **SOS 2d** • Operate on 1.2 kcfs minimum discharge up to flood control rule curve, except when providing flow augmentation (April 10 to July 31) • Provide flow augmentation of 1.0 MAF plus 1.2 kcfs minimum discharge, or 927 KAF and 1.2 kcfs, from April 10–June 20, based on runoff forecasts, to meet Lower Granite flow target of 85 kcfs • Provide 470 KAF from June 21 to July 31 to meet Lower Granite flow target of 50 kcfs • Draft to 1,520 feet after volume is expended, if Lower Granite flow target is not met; if volume is not expended, draft below 1,520 feet until volume is expended	**SOS 4c** Elevation targets established for each month: 1,599 feet Sept.-Oct.; flood control rule curves Nov.-April; 1,595 feet May; 1,599 feet June-Aug.;

KAF = 1.234 million cubic meters

MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–5

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b	**SOS 6b**	**SOS 9a**	**SOS PA**
• Operate to local flood control rule curve • No proportional draft for power • Shift system flood control to lower Snake projects • Provide Water Budget flow augmentation as in SOS 1a • Draft to refill lower Snake projects if natural inflow is inadequate	Same as SOS 5b	• Remove from proportional draft for power • Operate to local flood control rule curves, with system flood control shifted to Grand Coulee • Maintain flow at 1.2 kcfs minimum discharge, except for flood control or flow augmentation discharges • Operate to meet Lower Granite flow targets (at spillway crest) of 74 kcfs April 16-June 30, 45 kcfs July, 32 kcfs August	• Operate on minimum flow-up to flood control rule curve year-round, except during flow augmentation period • Draft to meet flow targets, down to min. end-of-Aug. elevation of 1,520 feet • Sliding-scale Snake River flow targets at Lower Granite of 85 to 100 kcfs April 10-June 20 and 50 to 55 kcfs June 21-Aug. 31, based on runoff forecasts
SOS 5c	**SOS 6d**	**SOS 9b**	
• Operate to flood control during spring • Refill in June or July and maintain through August • Draft for power production during fall	Same as SOS 5b	• Similar to SOS 9a, except operate to meet flow targets at Lower Granite ranging from 85 to 140 kcfs April 16-June 30 and 50-55 kcfs in July • Can draft to meet flow targets to a min. end-of-July elevation of 1,490 feet	
		SOS 9c	
		• Similar to SOS 9a, except operate to meet Lower Granite flow target (at spillway crest) of 63 kcfs April-June • Can draft to meet flow targets to a min. end-of-July elevation of 1,520 feet	

1 kcfs = 28 cms   1 ft = 0.3048 meter

Table 4–1. SOS Alternative–6

Actions by Project

LOWER SNAKE

SOS 1	SOS 2	SOS 4
SOS 1a • Normal operations at 4 lower Snake River projects (within 3 to 5 feet of full pool, daily and weekly fluctuations) • Provide maximum peaking capacity of 20 kcfs over daily average flow in May	**SOS 2c** • Operate reservoirs within 1 foot above MOP from April 16 to July 31 • Same as SOS 1a for rest of year	**SOS 4c** Same as SOS 2c
SOS 1b Same as 1a, except: • No minimum flow limit (11,500 cfs) during fall and winter • No fish-related rate of change in flows in May	**SOS 2d** Same as SOS 2c	

LOWER COLUMBIA

SOS 1	SOS 2	SOS 4
SOS 1a • Normal operations at 4 lower Columbia projects (generally within 3 to 5 feet of full pool, daily and weekly fluctuations) • Restricted operation of Bonneville second powerhouse	**SOS 2c** Same as SOS 1a except: lower John Day to minimum irrigation pool (approx. 262.5 feet) from April 15 to Aug. 31; operate within 1.5 feet of forebay range, unless need to raise to avoid irrigation impacts	**SOS 4c** Same as SOS 2c, except operate John Day within 2 feet of elevation 263.5 feet Nov. 1 through June 30
SOS 1b Same as 1a, except no restrictions on Bonneville second powerhouse	**SOS 2d** Same as SOS 2c	

KAF = 1.234 million cubic meters MAF = 1.234 billion cubic meters

Table 4–1. SOS Alternative–6

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b • Draft 2 feet per day starting Feb. 18 • Operate at natural river level, approx. 95 to 115 ft below full pool, April 16-Aug. 31; drawdown levels by project as follows, in feet: Lower Granite 623 Little Goose 524 L. Monumental 432 Ice Harbor 343 • Operate within 3 to 5 ft of full pool rest of year • Refill from natural flows and storage releases **SOS 5c** Same as SOS 5b, except drawdowns are permanent once natural river levels reached; no refill	**SOS 6b** • Draft 2 feet per day starting April 1 • Operate 33 feet below full pool April 16-Aug. 31; drawdown levels by project as follows, in feet: Lower Granite 705 Little Goose 605 L. Monumental 507 Ice Harbor 407 • Operate over 5-foot forebay range once drawdown elevation reached • Refill from natural flows and storage releases • Same as SOS 1a rest of year **SOS 6d** • Draft Lower Granite 2 feet per day starting April 1 • Operate Lower Granite near 705 ft for 4 1/2 months, April 16-Aug. 31	**SOS 9a** • Operate 33 feet below full pool (see SOS 6b) April 1-Aug. 31 to meet L. Granite flow targets (see Dworshak); same as SOS 1a rest of year • Spill to achieve 80/80 FPE up to total dissolved gas cap of 120% daily average; spill cap 60 kcfs at all projects **SOS 9b** • Operate at MOP, with 1 foot flexibility April 1-Aug. 31; same as SOS 1a rest of year • Spill to achieve 80/80 FPE up to total dissolved gas cap of 120% daily average; spill caps range from 18 kcfs at L. Monumental to 30 kcfs at L. Granite **SOS 9c** • Operate 35 to 45 feet below full pool April 1-June 15 to meet L. Granite flow targets (see Dworshak), refill by June 30; same as SOS 1a rest of year • Spill to achieve 80/80 FPE, as in SOS 9b	**SOS PA** • Operate at MOP with 1 foot flexibility between April 10 - Aug. 31 • Refill three lower Snake River pools after Aug. 31, Lower Granite after Nov. 15 • Spill to achieve 80% FPE up to total dissolved gas cap of 115% 12-hour average; spill caps range from 7.5 kcfs at L. Monumental to 25 kcfs at Ice Harbor

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 2, except operate John Day within 1.5 feet above elevation 257 feet (MOP) from May 1 through Aug. 31; same as SOS 2c rest of year **SOS 5c** Same as SOS 5b	**SOS 6b** Same as SOS 5 **SOS 6d** Same as SOS 5	**SOS 9a** • Same as SOS 5, except operate John Day within 1 foot above elevation 257 feet April 15-Aug. 31 • McNary flow targets as described for Grand Coulee • Spill to achieve 80/80 FPE, up to total dissolved gas cap of 120% daily average, as derived by agencies **SOS 9b** • Same as SOS 2, except operate John Day at minimum irrigation pool or 262.5 feet with 1 foot of flexibility from April 16-Aug. 31 • McNary flow targets as described for Grand Coulee • Spill to achieve 80/80 FPE, up to total dissolved gas cap of 120% daily average, as derived by Corps **SOS 9c** Same as SOS 9b, except operate John Day at minimum operating pool	**SOS PA** • Pool operations same as SOS 2c, except operate John Day at 257 feet (MOP) year-round, with 3 feet of flexibility March-Oct. and 5 feet of flexibility Nov.-Feb. • Spill to achieve 80% FPE up to total dissolved gas cap of 115% 12-hour average; spill caps range from 9 kcfs at John Day to 90 kcfs at The Dalles

1 kcfs = 28 cms

1 ft = 0.3048 meter

4.1.1 SOS 1-Pre–ESA Operation

This alternative represents one end of the range of the SOR strategies in terms of their similarity to historical system operations. This strategy reflects Columbia River system operations before changes were made as a result of the ESA listing of three Snake River salmon stocks. This SOS has two options:

- **SOS 1a (Pre–Salmon Summit Operation)** represents operations as they existed from 1983 through the 1990–91 operating year, including Northwest Power Act provisions to restore and protect fish populations in the basin. Specific volumes for the Water Budget would be provided from Dworshak and Brownlee reservoirs to attempt to meet a target flow of 85 kcfs (2,380 cms) at Lower Granite Dam in May. Sufficient flows would be provided on the Columbia River to meet a target flow of 134 kcfs (3,752 cms) at Priest Rapids Dam in May. Lower Snake River projects would operate within 3 to 5 feet (0.9 to 1.5 m) of full pool. Other projects would operate as they did in 1990–91, with no additional water provided from the Snake River above Brownlee Dam.

- **SOS 1b (Optimum Load–Following Operation)** represents operations as they existed prior to changes resulting from the Northwest Power Act. It is designed to demonstrate how much power could be produced if most flow–related operations to benefit anadromous fish were eliminated including: the Water Budget; fish spill requirements; restrictions on operation of Bonneville's second powerhouse; and refill targets for Libby, Hungry Horse, Grand Coulee, Dworshak, and Albeni Falls. It assumes that transportation would be used to the maximum to aid juvenile fish migration.

4.1.2 SOS 2-Current Operations

This alternative reflects operation of the Columbia River system with interim flow improvement measures made in response to ESA listings of Snake River salmon. It is very similar to the way the system operated in 1992 and reflects the results of ESA Section 7 consultation with NMFS then. The strategy is consistent with the 1992–93 operations described in the Corps' *1993 Interim Columbia and Snake Rivers Flow Improvement Measures Supplemental EIS* (SEIS). SOS 2 also most closely represents the recommendations issued by the NMFS Snake River Salmon Recovery Team in May 1994. Compared to SOS 1, the primary changes are additional flow augmentation in the Columbia and Snake Rivers and modified pool levels at lower Snake and John Day reservoirs during juvenile salmon migration. This strategy has two options:

- **SOS 2c (Final SEIS Operation- No Action Alternative)** matches exactly the decision made as a result of the 1993 SEIS. Flow augmentation water of up to 3.0 MAF (3.7 billion m^3) on the Columbia River (in addition to the existing Water Budget) would be stored during the winter and released in the spring in low–runoff years. Dworshak would provide at least an additional 300 KAF (370 million m^3) in the spring and 470 KAF (580 million m^3) in the summer for flow augmentation. System flood control shifts from Dworshak and Brownlee to Grand Coulee would occur through April as needed. It also provides up to 427 KAF (527 million m^3) of additional water from the Snake River above Brownlee Dam.

- **SOS 2d (1994–98 Biological Opinion)** matches the hydro operations contained in the 1994–98 Biological Opinion issued by NMFS in mid–1994. This alternative provides water for the existing Water Budget as well as additional water, up to 4 MAF, for flow augmentation to benefit the anadromous fish migration. The additional water of up to 4 MAF would be stored in Grand Coulee, Libby and Arrow, and provided on a sliding scale tied to runoff forecasts. Flow targets are established at Lower Granite and McNary.

In cases such as the SOR, where the proposed action is a new management plan, the No Action Alternative means continuing with the present course of action until that action is changed (46 FR 13027). Among all of the strategies and options, SOS 2c best meets this definition for the No Action Alternative.

4.1.3 SOS 4-Stable Storage Project Operation

This alternative is intended to operate the storage reservoirs to benefit recreation, resident fish, wildlife, and anadromous fish while minimizing impacts of such operation to power and flood control. Reservoirs would be kept full longer, but still provide spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. For the Final EIS, this alternative has one option:

- **SOS 4c (Stable Storage Operation with Modified Grand Coulee Flood Control)** applies year–round Integrated Rule Curves (IRCs) developed by the State of Montana for Libby and Hungry Horse. Other reservoirs would be managed to specific elevations on a monthly basis; they would be kept full longer, while still providing spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. Grand Coulee would meet elevation targets year–round to provide acceptable water retention times; however, upper rule curves would apply at Grand Coulee if the January to July runoff forecast at the project is greater than 68 MAF (84 billion m^3).

4.1.4 SOS 5-Natural River Operation

This alternative is designed to aid juvenile salmon migration by drawing down reservoirs (to increase the velocity of water) at four lower Snake River projects. SOS 5 reflects operations after the installation of new outlets in the lower Snake River dams, permitting the lowering of reservoirs approximately 100 feet (30 m) to near original riverbed levels. This operation could not be implemented for a number of years, because it requires major structural modifications to the dams. Elevations would be: Lower Granite – 623 feet (190 m); Little Goose – 524 feet (160 m); Lower Monumental – 432 feet (132 m); and Ice Harbor – 343 feet (105 m). Drafting would be at the rate of 2 feet (0.6 m) per day beginning February 18. The reservoirs would refill again with natural inflows and storage releases from upriver projects, if needed. John Day would be lowered as much as 11 feet (3.3 m) to minimum pool, elevation 257 feet (78.3 m), from May through August. All other projects would operate essentially the same as in SOS 1a, except that up to 3 MAF (3.7 billion m^3) of water (in addition to the Water Budget) would be provided to augment flows on the Columbia River in May and June. System flood control would shift from Brownlee and Dworshak to the lower Snake River projects. Also, Dworshak would operate for local flood control. This alternative has two options:

- **SOS 5b (Four and One–half Month Natural River Operation)** provides for a lower Snake River drawdown lasting 4.5 months, beginning April 16 and ending August 31. Dworshak would be drafted to refill the lower Snake River projects if natural inflow were inadequate for timely refill.
- **SOS 5c (Permanent Natural River Operation)** provides for a year–round drawdown, and projects would not be refilled after each migration season.

4.1.5 SOS 6-Fixed Drawdown

This alternative is designed to aid juvenile anadromous fish by drawing down one or all four lower Snake River projects to fixed elevations approximately 30 to 35 feet (9 to 10 m) below minimum operating pool. As with SOS 5, fixed drawdowns depend on prior structural modifications and could not be instituted for a number of years. Draft would be at the rate of 2 feet (0.6 m) per day beginning April 1. John Day would be lowered to elevation 257 feet (78.3 m) from May through August. All other projects would operate essentially the same as under SOS 1a, except that up to 3 MAF (3.7 billion m^3) of water would be provided to augment flows on the Columbia River in May and June. System flood control would shift from Brownlee and Dworshak to the lower Snake projects. Also, Dworshak would operate for local flood control. This alternative has two options:

- **SOS 6b (Four and One–half Month Fixed Drawdown)** provides for a 4.5–month drawdown at all four lower Snake River projects beginning April 16 and ending August 31. Elevations would be: Lower Granite – 705 feet (215 m); Little Goose – 605 feet (184 m); Lower Monumental – 507 feet (155 m); and Ice Harbor – 407 feet (124 m).
- **SOS 6d (Four and One–half Month Lower Granite Fixed Drawdown)** provides for a 4.5–month drawdown to elevation 705 feet at Lower Granite beginning April 16 and ending August 31.

4.1.6 SOS 9-Settlement Discussion Alternatives

This SOS represents operations suggested by USFWS and NMFS (as SOR cooperating agencies), the State fisheries agencies, Native American tribes, and the Federal operating agencies during the settlement discussions in response to a court ruling in the *IDFG v. NMFS* lawsuit. The objective of SOS 9 is to provide increased velocities for anadromous fish by establishing flow targets during the migration period and by carrying out other actions that benefit ESA–listed species. The specific options were developed by a group of technical staff representing the parties in the lawsuit. The group was known as the Reasonable and Prudent Alternatives Workgroup. They developed three possible operations in addition to the 1994–98 Biological Opinion. This strategy has three options:

- **SOS 9a (Detailed Fishery Operating Plan [DFOP])** establishes flow targets at The Dalles based on the previous year's end–of–year storage content, similar to how PNCA selects operating rule curves. Grand Coulee and other storage projects are used to meet The Dalles flow targets. Specific volumes of releases are made from Dworshak, Brownlee, and upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to near spillway crest level for 4 1/2 months. Specific spill percentages are established at run–of–river projects to achieve no higher than 120 percent daily average total dissolved gas. Fish transportation is assumed to be eliminated.
- **SOS 9b (Adaptive Management)** establishes flow targets at McNary and Lower Granite based on runoff forecasts. Grand Coulee and other storage projects are used to meet the McNary flow targets. Specific volumes of releases are made from Dworshak, Brownlee, and the upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to minimum operating pool levels and John Day is at minimum irrigation pool level. Specific spill percentages are established at run–of–river projects to achieve no higher than 120 percent daily average for total dissolved gas.
- **SOS 9c (Balanced Impacts Operation)** draws down the four lower Snake River projects to near spillway crest levels for 2 1/2 months during the spring salmon migration period. Full drawdown level is achieved on April 1. Refill begins after June 15. This alternative also provides 1994–98 Biological Opinion flow augmentation (as in SOS 2d), IRC operation at Libby and Hungry Horse, a reduced flow target at Lower Granite due to drawdown, limits on winter drafting at Albeni Falls, and spill to achieve no higher than 120 percent daily average for total dissolved gas.

4.1.7 SOS PA-Preferred Alternative

This SOS represents the operation recommended by NMFS and USFWS in their respective Biological Opinions issued on March 1, 1995. SOS PA is intended to support recovery of ESA–listed species by storing water during the fall and winter to meet spring and summer flow targets, and to protect other resources by managing detrimental effects through maximum summer draft limits, by providing public safety through flood protection, and by providing for reasonable power generation. This SOS would operate the system during the fall and winter to achieve a high confidence of the fall and winter to achieve a high confidence of refill to flood control elevations by April 15 of each year, and use this stored water for fish flow augmentation. It establishes spring flow targets at McNary and Lower Granite based on runoff forecasts, and a similar sliding scale flow target at Lower Granite and a fixed flow target at McNary for the summer. It establishes summer draft limits at Hungry Horse, Libby, Grand Coulee, and Dworshak. Libby is also operated to provide flows for Kootenai River white sturgeon. Lower Snake River projects are drawn down to minimum operating pool levels during the spring and summer. John Day is operated at minimum operating pool level year–round. Specific spill percentages are established at run–of–river projects to achieve 80–percent FPE, with no higher than 115–percent 12–hour daily average for total dissolved gas measured at the forebay of the next downstream project.

4.1.8 Rationale for Selection of the Final SOSs

Table 4–2 summarizes the changes to the set alternatives from the Draft EIS to the Final EIS. SOS 1a and 1b are unchanged from the Draft EIS. SOS 1a represents a base case condition and reflects system operation during the period from passage of the Northwest Power Planning and Conservation Act until ESA listings. It provides a baseline alternative that allows for comparison of the more recent alternatives and shows the recent historical operation. SOS 1b represents a limit for system operation directed at maximizing benefits from development–oriented uses, such as power generation, flood control, irrigation and navigation and away from natural resources protection. It serves as one end of the range of alternatives and provides a basis for comparison of the impacts to power generation from all other alternatives. Public comment did not recommend elimination of this alternative because it serves as a useful milepost. However, the SOR agencies recognize it is unlikely that decisions would be made to move operations toward this alternative.

In the Draft EIS, SOS 2 represented current operation. Three options were considered. Two of these options have been eliminated for the Final EIS and one new option has been added. SOS 2c continues as the No Action Alternative. Maintaining this option as the No Action Alternative allows for consistent comparisons in the Final EIS to those made in the Draft EIS. However, within the current practice category, new operations have been developed since the original identification of SOS 2c. In 1994, the SOR agencies, in consultation with the NMFS and USFWS, agreed to an operation, which was reflected in the 1994–98 Biological Opinion. This operation (SOS 2d) has been modeled for the Final EIS and represents the most "current" practice. SOS 2d also provides a good baseline comparison for the other, more unique alternatives. SOS 2a and 2b from the Draft EIS were eliminated because they are so similar to SOS 2c. SOS 2a is identical to SOS 2c except for the lack of an assumed additional 427 KAF of water from the upper Snake River Basin. This additional water did not cause significant changes to the effects between SOS 2a and 2c. There is no reason to continue to consider an alternative that has impacts essentially equal to another alternative. SOS 2b is also similar to SOS 2c, except it modified operation at Libby for Kootenai River white sturgeon. Such modifications are included in several other alternatives, namely SOS 2d, 9a, 9c, and the Preferred Alternative.

SOS 3a and 3b, included in the Draft EIS, have been dropped from consideration in the Final EIS. Both of these alternatives involved anadromous fish flow augmentation by establishing flow targets based on runoff forecast on the Columbia and Snake Rivers. SOS 3b included additional water from the upper Snake River Basin over what was assumed for SOS 3a. This operation is now incorporated in several new alternatives, including SOS 9a and 9b. Public comment also did not support continued consideration of the SOS 3 alternatives.

Table 4–2. Summary of Alternatives in the Draft and Final EIS

Draft EIS Alternatives		Final EIS Alternatives	
SOS 1	Pre–ESA Operation	SOS 1	Pre–ESA Operation
SOS 1a	Pre–Salmon Summit Operation	SOS 1a	Pre–Salmon Summit Operation
SOS 1b	Optimum Load Following Operation	SOS 1b	Optimum Load Following Operation
SOS 2	Current Practice	SOS 2	Current Practice
SOS 2a	Final Supplemental EIS Operation	SOS2c	Final Supplemental EIS Operation – No–Action Alternative
SOS 2b	Final Supplemental EIS with Sturgeon Operations at Libby	**SOS 2d**	**1994–98 Biological Opinion Operation**
SOS2c	Final Supplemental EIS Operation – No–Action Alternative		
SOS 3	Flow Augmentation		
SOS 3a	Monthly Flow Targets		
SOS 3b	Monthly Flow Targets with additional Snake River Water		
SOS 4	Stable Storage Project Operation	SOS 4	Stable Storage Project Operation
SOS 4a1	Enhanced Storage Level Operation	**SOS 4c**	**Enhanced Operation with modified Grand Coulee Flood Control**
SOS 4a3	Enhanced Storage Level Operation		
SOS 4b1	Compromise Storage Level Operation		
SOS 4b3	Compromise Storage Level Operation		
SOS 4c	Enhanced Operation with modified Grand Coulee Flood Control		
SOS 5	Natural River Operation	SOS 5	Natural River Operation
SOS 5a	Two Month Natural River Operation	SOS 5b	Four and One Half Month Natural River Operation
SOS 5b	Four and One Half Month Natural River Operation	**SOS 5c**	**Permanent Natural River Operation**
SOS 6	Fixed Drawdown	SOS 6	Fixed Drawdown
SOS 6a	Two Month Fixed Drawdown Operation	SOS 6b	Four and One Half Month Fixed Drawdown Operation
SOS 6b	Four and One Half Month Fixed Drawdown Operation	SOS 6d	Four and One Half Month Lower Granite Drawdown Operation
SOS 6c	Two Month Lower Granite Drawdown Operation		
SOS 6d	Four and One Half Month Lower Granite Drawdown Operation		
SOS 7	Federal Resource Agency Operations	**SOS 9**	**Settlement Discussion Alternatives**
SOS 7a	Coordination Act Report Operation	**SOS 9a**	**Detailed Fishery Operating Plan**
SOS 7b	Incidental Take Statement Flow Targets	**SOS 9b**	**Adaptive Management**
SOS 7c	NMFS Conservation Recommendations	**SOS 9c**	**Balance Impacts Operation**
		SOS Preferred Alternative	

Bold indicates a new or revised SOS alternative

SOS 4 originally included 5 options in the Draft EIS. They were similar in operation and impact. In SOS 4a and 4b, the primary feature was the use of Biological Rule Curves for Libby and Hungry Horse reservoirs. SOS 4c also included these rule curves but went further by optimizing the operation of the other storage projects, particularly Grand Coulee and Dworshak. For the Final EIS, the SOR agencies have decided to update the alternative by substituting the IRC for the Biological Rule Curves and by eliminating SOS 4a and 4b. The IRCs are a more recent, acceptable version of minimum elevations for Libby and Hungry Horse. Significant public comment in support of this alternative with IRCs was received. Similar to SOS 2 above, SOS 4a and 4b were not different enough in operation or impacts to warrant continued consideration.

The Natural River (SOS 5) and the Spillway Crest Drawdown (SOS 6) alternatives in the Draft EIS originally included options for 2 months of drawdown to the appropriate pool level and 4 1/2 months of drawdown. The practicality of 2–month drawdowns was questioned during public review, particularly for the natural river. It did not appear that the time involved in drawing down the reservoirs and later refilling them provided the needed consideration for other uses. Flows are restricted to refill the reservoirs at a time when juvenile fall chinook are migrating downstream and various adult species are returning upstream. The 2 1/2 month drawdown strategies (SOS 5a, 6a, and 6c) have been dropped from the Final EIS. However, 2 1/2 month spillway crest drawdown at all four lower Snake projects is still an element in SOS 9c, so the impacts associated with this type of operation are assessed in the Final EIS.

A new option was added to SOS 5, namely SOS 5c. This option includes natural river drawdown of the lower Snake River projects on a permanent, year–round basis. The Corps received comment on this type of alternative during the review of Phase I of the SCS, a reconnaissance assessment of potential physical modifications for the system to enhance fish passage. Many believe the cost for such modification would be less than that required for periodic, temporary drawdowns, which would require specialized facilities to enable the projects to refill and operate at two different pool elevations.

SOS 7 Federal Resource Agencies Operations, which included 3 options in the Draft EIS, has been dropped from the Final EIS and replaced with an alternative now labeled as SOS 9 that also has 3 options. SOS 7a was suggested by the USFWS and represented the State fishery agencies and tribes' recommended operation. Since the issuance of the Draft EIS, this particular operation has been revised and replaced by the DFOP (SOS 9a). The SOR agencies received comment that the DFOP was not evaluated, but should be. Therefore, we have included this alternative exactly as proposed by these agencies; it is SOS 9a. SOS 7b and 7c were suggested by NMFS through the 1993 Biological Opinion. This opinion suggested two sets of flow targets as a way of increasing flow augmentation levels for anadromous fish. The flow targets came from the Incidental Take Statement and the Conservation Recommendation sections of that Biological Opinion. The opinion was judged as arbitrary and capricious as a result of legal action, and these operational alternatives have been replaced with other alternatives that were developed through settlement discussions among the parties to this lawsuit. SOS 7b and 7c have been dropped, but SOS 9b and 9c have been added to represent operations stemming from NMFS or other fishery agencies. In particular, SOS 9b is like DFOP but has reduced flow levels and forgoes drawdowns. It is a modification to DFOP. SOS 9c incorporates elements of operation supported by the State of Idaho in its "Idaho Plan." It includes a 2 1/2–month spillway crest drawdown on the lower Snake River projects and several other elements that attempt to strike a balance among the needs of anadromous fish, resident fish, wildlife and recreation.

Shortly after the alternatives for the Draft EIS were identified, the Nez Perce Tribe suggested an operation that involved drawdown of Lower Granite, significant additional amounts of upper Snake River water, and full pool operation at Dworshak (i.e., Dworswak remains full year round). It was labeled as SOS 8a. Hydroregulation of that operation was completed and provided to the Nez Perce Tribe. No technical response has been received from the Nez

Perce Tribe regarding the features or results of this alternative. However, the elements of this operation are generally incorporated in one or more of the other alternatives, or impose requirements on the system or specific projects that are outside the range considered reasonable. Therefore, this alternative has not been carried forward into the Final EIS.

The Preferred Alternative represents operating requirements contained in the 1995 Biological Opinions issued by NMFS and USFWS on operation of the FCRPS. These opinions resulted from ESA consultation conducted during late 1994 and early 1995, which were a direct consequence of the lawsuit and subsequent judgement in *Idaho v. NMFS*. The SOR agencies are now implementing this operating strategy and have concluded that it represents an appropriate balance among the multiple uses of the river. This strategy recognizes the importance of anadromous fish and the need to adjust river flows to benefit the migration of all salmon stocks, as well as the needs of resident fish and wildlife species at storage projects.

4.2 SOS 1 PRE–ESA OPERATION

This alternative represents base case operations reflecting one end of the full range of alternatives in terms of the effects of system operations on anadromous fish migration. The strategy reflects Columbia River system operations before changes were made as a result of the listing of three Snake River salmon stocks. This SOS has two options:

4.2.1 SOS 1a (Pre–Salmon Summit Operation)

4.2.1.1 Impacts

Navigation on the Lower Snake and Columbia Rivers:

Alternative SOS 1A represents near optimal conditions for navigation on the waterway under short–term operations. On the Snake River increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 1A does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake:

Late summer drafting of the reservoir leaves log dumps dry in nearly all years. Particularly dry water years cause dumps to be inoperable earlier, some years never being usable.

4.2.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers

(1) To the degree possible, regulate flows to a maximum of 150,000 cfs from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling use of the log dumps at lower pools; (3) construct log storage areas to maximize use of the pool at optimal pool levels and; (4) use alternate methods of transportation.

4.2.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake

As proposed, the operation of the system in SOS 1A, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.2.2 SOS 1b

Optimum Load Following Operations represents operations as they existed prior to changes resulting from the Northwest Power Act. It is designed to demonstrate how much power could be produced if most flow–related operations to benefit anadromous fish were eliminated including: the Water Budget; fish spill requirements; restrictions on operation of Bonneville's second powerhouse; refill targets for Libby, Hungry Horse, Grand Coulee, Dworshak, and Albeni Falls; and fish–related rates of change on Snake River flows in May. It assumes that maximum fish transportation would be used to aid juvenile fish migration.

4.2.2.1 Impacts

Navigation on the Lower Snake and Columbia Rivers

Alternative SOS 1b represents near optimal conditions for navigation on the waterway under short term operations. On the Snake River increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 1b does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake

Late summer drafting of the reservoir leaves log dumps dry in nearly all years. Particularly dry water years cause dumps to be inoperable earlier, some years never being usable.

4.2.2.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers

(1) To the degree possible, regulate flows to a maximum of 150,000 cfs from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling use of the log dumps at lower pools; (3) construct log storage areas to maximize use of the pool at optimal pool levels and; (4) use alternate methods of transportation.

4.2.2.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake

As proposed, the operation of the system in SOS 1b, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.3 SOS 2 CURRENT OPERATION (1993)

This alternative reflects 1993 operation of the Columbia River system with interim flow improvement measures in response to ESA listings of Snake River salmon. It is very similar to the way the system operated in 1992 and reflects the results of ESA Section 7 consultation with the National Marine Fisheries Service. The strategy is consistent with the 1992–93 operations described in the Corps of Engineers' 1993 Interim Columbia and Snake River Flow Improvement Measures Supplemental EIS (SEIS). Relative to SOS 1, the primary changes are additional flow augmentation in the Columbia and Snake Rivers and modified pool levels at lower Snake and John Day Reservoirs during juvenile salmon migration. SOS 2c represents the no–action alternative. The alternative has three options.

4.3.1 SOS 2c (Current Operation–No–Action Alternative)

Represents the operations resulting from the SEIS. It includes the 3.0 MAF (3,702 million m^3) flow augmentation water on the Columbia, additional water volumes from Dworshak in the spring and summer, flood control shifts from Snake River projects to Grand Coulee, and up to 427 KAF (527 million m^3) of additional upper Snake River water.

4.3.1.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Alternative SOS 2c represents near optimal conditions for navigation on the waterway under short–term operations. On the Snake River increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 2c does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake:

Late summer drafting of the reservoir leaves log dumps dry in nearly all years. Particularly dry water years cause dumps to be inoperable earlier, some years never being usable.

4.3.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

(1) To the degree possible, regulate flows to a maximum of 150,000 cfs from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir:

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling continued use of the log dumps during lower pools; (3) construct log storage areas to maximize periods when the pool is at optimal pool levels and; (4) use alternate methods of transportation.

4.3.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 2c, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.3.2 SOS 2d (1994–98 Biological Opinion)

This alternative represents the 1994–98 Biological Opinion which includes up to 4 MAF flow augmentation on the Columbia River, flow targets a McNary and Lower Granite, specific volume releases from Dworshak, Brownlee and Upper Snake, meeting sturgeon flows 3 out of 10 years, and operating lower Snake projects at MOP and John Day at MIP.

4.3.2.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Navigation is maintained throughout the Columbia and Snake Rivers system under SOS 2d, however some inconvenience is introduced. Increased lockage time is probable for barge traffic when locks are operated at MOP. On the Snake River increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 2d does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake

Drafting of the reservoir leaves log dumps dry in nearly all months of all years.

4.3.2.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

(1) To the degree possible, regulate flows to a maximum of 150,000 cubic feet per second (cfs) from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir:

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling continued use of the log dumps during lower pools; (3) construct log storage areas to maximize periods when the pool is at optimal pool levels and; (4) use alternate methods of transportation.

4.3.2.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake:

As proposed, under SOS 2d, the use of Dworshak Lake for log transportation activities will be unavoidably discontinued. None of the impacts or the mitigative measures represents an irreversible commitment of resources.

4.4 SOS 4 STABLE STORAGE PROJECT OPERATION

This alternative is designed to coordinate operation of the storage reservoirs to benefit recreation, resident fish, wildlife, and anadromous fish, while minimizing the impacts of such operation to power and flood control. Reservoirs would be kept full longer, while still providing spring flows for fish and space for flood control. The goal is to minimize reservoir fluctuations while moving closer to natural flow conditions. The alternative has three main options, two of which have two sub options.

4.4.1 SOS 4c (Rev) Stable Storage Level Operation with Modified Grand Coulee Flood Control

This alternative attempts to achieve specific monthly elevation targets year round that improve the environmental conditions at storage projects for recreation, resident fish and wildlife. Integrated Rule Curves at Libby and Hungry Horse are applied year round. Grand Coulee, Albeni Falls and Dworshak meet specific elevation targets in all years. Upper Rule Curves are not applied at any project except at Grand Coulee when the January–July forecast is greater than 68 MAF and at Dworshak from November through April.

4.4.1.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Alternative SOS 4c represents near optimal conditions for Navigation on the waterway under short term operations. On the Snake River increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 4c does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake:

Under this scenario, the log dumps are fully operational through out the summer and fall. During the late winter and early spring the reservoir is drafted, but this has a negligible effect on the logging operations.

4.4.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

(1) To the degree possible, regulate flows to a maximum of 150,000 cubic feet per second (cfs) from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Lake:

None needed.

4.4.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake:

None of the impacts on the Dworshak log operations represents unavoidable impacts or irreversible commitment of resources.

4.5 SOS 5 NATURAL RIVER OPERATION

This SOS is designed to aid anadromous fish by increasing river velocity through mainstem reservoir drawdown at the four lower Snake projects. It provides for the installation of new outlets in the lower Snake River dams, permitting the lowering of reservoirs to near original river bed levels. Drawdown elevations would be: Lower Granite – 623 feet (190m); Little Goose – 524 feet (160m); Lower Monumental – 432 feet (132m); and Ice Harbor – 343 feet (105m). Drafting would be at the rate of 2 feet (.61m) per day starting on February 18. The reservoirs would refill again with natural inflows and storage releases from upriver projects, if needed. John Day would be lowered to 257 feet (78m) from May through August. All other projects would operate essentially the same as in SOS 1a except that up to 3 MAF (3,702 million m^3) additional flow augmentation water (above Water Budget) would be provided on the Columbia River in May and June, with system flood control shifted from Brownlee and Dworshak to lower Snake projects. Also, Dworshak would operate for local flood control The SOS has two options.

4.5.1 SOS 5b (Four and One-half Month Natural River Operation)

Provides for a drawdown lasting 4 1/2 months beginning on April 16 and ending on August 31.

4.5.1.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for Alternative SOS 5b: (1) In order to achieve the natural river elevations called for in this alternative, the lower Snake River dams begin drawdown in February of each year. The locks become unusable for commercial navigation very soon after the process begins and are not back on line until the following September. This amounts to a 7–month lock closure on the lower Snake River. (2) The ports and facilities on the Lower Granite Pool between River Miles 432 to 471 would have major impacts and would be affected during the same time frame (See Table 3–3, *Results of the Survey for Anticipated Physical Impacts Due to Drawdown of Lower Snake River Pools*). Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures, as well as the potentially destabilizing effects of having the foundation soils dry out and be rehydrated on an annual basis. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non–point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day Reservoir, a drawdown to 257 feet (78m) would have several navigation related effects. The impacts are discussed in detail in:

Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992) and summarized below. At an elevation of 257 feet (78m), the minimum operating pool on John Day Reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

(9) There would be a measurable impact, primarily in September of each year, (see Table 3–1) to stage on the lower Columbia River during the refill period. The refill period would occur during the naturally low point of the Snake and Columbia Rivers. Based on the analysis used for this study, the impacts would be a 5 percent increase in the amount of time that the stage at Vancouver, River Mile (RM) 106, is in the lowest stage interval, (0–1 foot, Columbia River Datum), and an increase of just over 1 percent at Kalama, RM 75. No significant impacts to stage would occur at Wauna, RM 41, where river elevation is primarily controlled by the tidal cycle. Further discussion of the possible economic ramifications of the impacts are contained in the Economics Appendix.

Log Rafting Operations on Dworshak Lake:

Late summer drafting of the reservoir leaves log dumps dry in nearly all years. Particularly dry water years cause dumps to be inoperable earlier, some years never being usable.

4.5.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

Limited opportunities are available for mitigating the *physical* impacts on navigation. (1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at natural river elevations, but the natural depths of the rivers behind the dams is not sufficient to accommodate the size of the present–day fleet. (3) The loading and unloading facilities along the river would also need modification in order to accommodate the widely fluctuating water level of the pools. (4) If the export market for commodities shipped through the system could be maintained on a less than year round delivery basis, an increase in grain storage facilities along the pools and at the points of origin (farms) could be constructed for winter shipment of grains. (5) Structural modifications of the facilities along the pools to enable them to with stand the wetting drying cycles are possible, though they are expensive, and would diminish the habitat value of the river banks. (6) Effects on the stage on the lower Columbia River could be diminished by greater releases from mainstem Columbia River storage projects.

Log Rafting Operations on Dworshak Lake:

The possible mitigation measures for the loss of the use of the Dworshak log dumps are: (1) to hold the pool higher through the summer; (2) extend the log dumps to the maximum length possible enabling continued use of the pool at lower elevations; (3) and to use other modes of transport to Lewiston.

4.5.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the pools behind the lower Snake River dams to natural river elevations will unavoidably constrain commercial navigation on the pools to

7 months of the year, as well as result in damage to marinas and port facilities along the river. While the physical effects of the drawdowns are reversible, any structural modifications to the dams or facilities to allow navigation to continue during the river outages or protect them from damage would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 5b, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.5.2 SOS 5c Permanent Natural River Operations

This alternative operates the four lower Snake River projects to near river bed levels year round by assuming construction of new low level outlets or some type of new channel at each project that allows all water to bypass the dam, powerhouse and spillway.

4.5.2.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for Alternative SOS 5c: (1) The locks become unusable for commercial navigation. (2) The Ports and facilities on the Lower Granite Pool between River Miles 432 to 471 would have major impacts.(See Table 3, *Results of the Survey for Anticipated Physical Impacts Due to Drawdown of Lower Snake River Pools*). Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non−point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day reservoir, a draw down to 257 feet would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992)* and summarized below. At an elevation of 257 feet, the minimum operating pool on John Day reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266−270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

(9) There would be a measurable impact, primarily in September of each year, (see Table 1) to stage on the lower Columbia River during the refill period. Based on the analysis used for this study, the impacts would be a five percent (5%) increase in the amount of time that the stage at Vancouver, River Mile (RM) 106, is in the lowest stage interval, (0−1 foot, Columbia River Datum), and an increase of just over 1 percent at Kalama, RM 75. No significant impacts to stage would occur at Wauna, RM 41,

where river elevation is primarily controlled by the tidal cycle. Further discussion of the possible economic ramifications of the impacts are contained in the Economics Appendix.

Log Rafting Operations on Dworshak Lake:

Under this scenario, the log dumps are fully operational through out most of the summer season. Some impacts to the use of the log dumps occurs in most years during September and October, but the majority of the timber volume is unaffected. During the winter and early spring the reservoir is drafted, but this has a negligible effect on the logging operations. This alternative is the second best scenario for log rafting operations on Dworshak Reservoir.

4.5.2.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

Limited opportunities are available for mitigating the *physical* impacts on navigation. (1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at natural river elevations, but the natural depth of the river behind the dams is not sufficient to accommodate the draft requirements the present day fleet. (3) The loading and unloading facilities along the river would also need modification in order to accommodate widely fluctuating water levels.

(4) If the export market for commodities shipped through the system could be maintained on a less than year round delivery basis, an increase in grain storage facilities along the pools and at the points of origin (farms) could be constructed for winter shipment of grains. (5) Structural modifications of the facilities along the pools to enable them to with stand the drying is possible, though expensive, and may diminish the habitat value of the river banks. (6) Effects on the stage on the lower Columbia River could be diminished by greater releases from mainstem Columbia River storage projects.

Log Rafting Operations on Dworshak Lake:

The possible mitigation measures for the loss of the use of the Dworshak log dumps are: (1) to hold the pool higher through September and October; (2) extend the log dumps to the maximum length possible enabling continued use of the pool at lower elevations; (3) and to use other modes of transport to Lewiston.

4.5.2.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the pools behind the lower Snake River dams to natural river elevations will unavoidably constrain commercial navigation on the pools, as well as result in damage to marinas and port facilities along the river. While the physical effects of the draw downs are reversible, any structural modifications to the dams or facilities to allow navigation to continue or to protect them from damage would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 5c, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.6 SOS 6 FIXED DRAWDOWN

The objective of this alternative is to increase river velocity by drawing down the four lower Snake projects to fixed elevations below minimum operating pool to aid anadromous fish. Drafting of the reservoirs under all suboptions would be at the rate of 2 feet (.61m) per day beginning April 1. Elevations would be as follows: Lower Granite – 705 feet (215m); Little Goose – 605 feet (184m); Lower Monumental – 507 feet (155m); and Ice Harbor – 407 feet (124m). John Day would be lowered to 257 feet (78m) from May through August. All other projects would operate essentially the same as under

SOS 1a except that up to 3 MAF (3,702 million m^3) of additional flow augmentation water would be provided on the Columbia River to augment flows in May and June, with system flood control shifted from Brownlee and Dworshak to lower Snake projects. Also, Dworshak would operate for local flood control. The alternative has four options.

4.6.1 SOS 6b (Four and One-half-Month Fixed Drawdown)

Would drawdown all four reservoirs for 4 1/2 months beginning on April 16 and ending on August 31.

4.6.1.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for Alternative SOS 6b. (1) In order to achieve the reduced pool elevations called for in this alternative, the lower Snake River dams begin drawdown in late March of each year. The locks become unusable for commercial navigation very soon after the process begins and are not back on line until the following September. This amounts to a 6 month lock closure on the lower Snake River. (2) Facilities in the pools would be effected during the same time frame. (*See Table 3–3, Results of the Survey for Anticipated Physical Impacts Due to Drawdown of the Lower Snake River Pools*). Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures, as well as the potentially destabilizing effects of having the foundation soils dry out and be rehydrated on an annual basis. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non–point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day Reservoir, a drawdown to 257 feet (78m) would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992)* and summarized below. At an elevation of 257 feet (78m), the minimum operating pool on John Day Reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

(9) There would be a measurable impact (see Table 3–1) to stage on the lower Columbia River during the refill period. The refill period would occur during the naturally low flow period of the Snake and Columbia Rivers. Based on the analysis used for this study, the impact of reduced flows into the Columbia during refill would be a 5 percent increase in the amount of time that the stage at Vancouver, River Mile (RM) 106, is in the lowest stage interval, (0 to 1 foot, Columbia River Datum), and an increase of just over 1 percent at Kalama, RM 75. No significant impacts to stage would occur

at Wauna, RM 41, where river elevation is primarily controlled by the tidal cycle. The effects would be present primarily in September of each year. Further discussion of the possible economic ramifications of the impacts are contained in the Economics Appendix.

Log Rafting Operations on Dworshak Lake:

Late summer drafting of the reservoir leaves log dumps dry in September about 50 percent of water years and in October in all years. Use of the log dumps is unimpeded from May through August in virtually all water years.

4.6.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

Limited opportunities are available for mitigating the *physical* effects on navigation.

(1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at lower river elevations, but it is questionable whether or not the present day barge fleet could navigate at the reduced channel depths. (3) The loading and unloading facilities along the river would also need modification in order to accommodate the widely fluctuating water level of the pools. (4) If the export market for commodities shipped through the system could be maintained on a less than year round delivery basis, an increase in grain storage facilities along the pools and at the points of origin (farms) could be constructed for winter shipment of grains. (5) Structural modifications of the facilities along the pools enabling them to with stand the wetting drying cycles are possible, though they are expensive and would diminish the habitat value of the river banks. (6) Effects on the stage on the lower Columbia River could be diminished by greater releases from mainstem Columbia River storage projects.

Log Rafting Operations on Dworshak Lake:

Mitigation measures for the loss of the use of the Dworshak log dumps are: (1) hold the pool higher through the summer; (2) extend the log dumps to the maximum length possible without damaging the logs; (3) and to use other modes of transport to Lewiston.

4.6.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the pools behind the lower Snake River dams to natural river elevations will unavoidably constrain commercial navigation on the pools to six months of the year, as well as result in damage to marinas and port facilities along the river. While the physical effects of the drawdowns are reversible, any structural modifications to the dams or facilities to allow navigation to continue during the river outages or protect them from damage would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 6b, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.6.2 SOS 6d (Four and One–Half–Month Lower Granite Fixed Drawdown)

Would drawdown Lower Granite for 4 1/2 months beginning on April 16 and ending on August 31.

4.6.2.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for those facilities located in the Lower Granite pool for Alternative SOS 6d. (1) The locks become unusable for commercial navigation very soon after the process begins and are not back on line until the following September. This amounts to a 5–month lock closure on the Lower Granite pool. (2) The Ports and facilities on the Lower Granite Pool between River Miles 432 to 471 would have major impacts and would be affected during the same time frame.(See Table 3–3, *Results of the Survey for Anticipated Physical Impacts Due to Drawdown of the Lower Snake River Pools*) Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures, as well as the potentially destabilizing effects of having the foundation soils dry out and be rehydrated on an annual basis. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non–point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day Reservoir, a drawdown to 257 feet (78m) would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992)* and summarized below. At an elevation of 257 feet (78m), the minimum operating pool on John Day Reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

(9) The projected impact to stage on the lower Columbia River from this alternative is negligible. The refill period after drawdown occurs while there is still sufficient natural runoff in the system to refill quickly. Alternative SOS 6d does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as currently authorized.

Log Rafting Operations on Dworshak Lake:

Late summer drafting of the reservoir impacts the operation of the log dumps in September and October in most water years, closing them in about 50 percent of water years. Use of the log dumps is unimpeded from May through August in virtually all water years.

4.6.2.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers

Limited opportunities exist for mitigating the *physical* effects on navigation. (1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at lower river elevations, but it is questionable whether or not the present day barge fleet could navigate at the reduced channel depths. (3) The loading and unloading facilities along the river would also need modification in order to accommodate the widely fluctuating water level of the pools.

(4) If the export market for commodities shipped through the Lower Granite pool could be main-

tained on a less than year round delivery basis, an increase in grain storage facilities along the pool and at the points of origin (farms) could be constructed for winter shipment of grains.

(5) The facilities along the pools would require structural modifications to enable them to withstand the wetting and drying cycles are possible, though they are expensive and would diminish the habitat value of the river bank.

Log Rafting Operations on Dworshak Lake:

Mitigation measures for the loss of the use of the Dworshak log dumps are: (1) hold the pool higher through the summer; (2) extend the log dumps to the maximum length possible without damaging the logs; (3) and to use other modes of transport to Lewiston.

4.6.2.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the Lower Granite pool by 33 feet, will unavoidably constrain commercial navigation on the pool to nine months of the year, as well as result in damage to marinas and port facilities along the river. While the physical effects of the drawdowns are reversible, any structural modifications to the dam or facilities to allow navigation to continue during the river outages would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed in the operation of the system in SOS 6c, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents an unavoidable or irreversible commitment of resources.

4.7 SOS 9 SETTLEMENT DISCUSSION ALTERNATIVES

The objective of this alternative is to provide increased flows for anadromous fish by establishing flow targets during the migration period and by carrying out other actions that benefit ESA listed species. This SOS represents operations suggested by agencies and tribes involved in settlement discussions in response to a court ruling in the lawsuit IDFG v. NMFS.

4.7.1 SOS 9a Detailed Fishery Operating Plan (DFOP)

This alternative establishes flow targets at The Dalles based on the previous year's end–of–year storage content, similar to how PNCA selects operating rule curves. Specific volumes of releases are made from Dworshak, Brownlee and Upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to near spillway crest level for four and one–half months. Specific spill percentages are established at run–of–river projects to achieve not higher than 120% daily average for total dissolved gas. Fish transportation is assumed to be eliminated.

4.7.1.1 Impacts

Navigation on the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for Alternative SOS 9a. (1) In order to achieve the reduced pool elevations called for in this alternative, the lower Snake River dams begin draw down on the first of April of each year. The locks become unusable for commercial navigation very soon after the process begins and are not back on line until the following September. This amounts to a 5 month lock closure on the lower Snake River. (2) Facilities in the pools would be effected during the same time frame. (*See Table 3, Results of the Survey for Anticipated Physical Impacts Due to Drawdown of the Lower Snake River Pools*). Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures, as well as the potentially destabilizing effects of having the foundation soils dry out and be rehydrated on an annual basis. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non-point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day reservoir, a draw down to 257 feet would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992)* and summarized below. At an elevation of 257 feet, the minimum operating pool on John Day reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

(9) Although SOS 9a was not specifically modelled for impacts to lower Columbia River navigation, the results of similar strategies indicate that there would be a measurable impact (see Table 1) to stage on the lower Columbia River during the refill period. The refill period would occur during the naturally low flow period of the Snake and Columbia Rivers. Based on the analysis used for this study, the impact of reduced flows into the Columbia during refill would be a five percent (5%) increase in the amount of time that the stage at Vancouver, River Mile (RM) 106, is in the lowest stage interval, (0 to 1 foot, Columbia River Datum), and an increase of just over 1% percent at Kalama, RM 75. No significant impacts to stage would occur at Wauna, RM 41, where river elevation is primarily controlled by the tidal cycle. The effects would be present primarily in September of each year. Further discussion of the possible economic ramifications of the impacts are contained in the Economics Appendix.

Log Rafting Operations on Dworshak Lake:

Summer drafting of the reservoir leaves log dumps dry July through October about 35 percent of water years. Use of the log dumps is unimpeded in June in virtually all water years.

4.7.1.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

Limited opportunities are available for mitigating the *physical* effects on navigation.

(1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at lower river elevations, but it is questionable whether or not the present day barge fleet could navigate at the reduced channel depths. (3) The loading and unloading facilities along the river would also need modification in order to accommodate the widely fluctuating water level of the pools. (4) If the export market for commodities shipped through the system could be maintained on a less than year round delivery basis, an increase in grain storage facilities along the pools and at the

points of origin (farms) could be constructed for winter shipment of grains. (5) Structural modifications of the facilities along the pools enabling them to with stand the wetting drying cycles are possible, though they are expensive and would diminish the habitat value of the river banks. (6) Effects on the stage on the lower Columbia River could be diminished by greater releases from mainstem Columbia River storage projects.

Log Rafting Operations on Dworshak Lake:

Mitigation measures for the loss of the use of the Dworshak log dumps are: (1) hold the pool higher through the summer; (2) extend the log dumps to the maximum length possible without damaging the logs; (3) and to use other modes of transport to Lewiston.

4.7.1.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the pools behind the lower Snake River dams to spillway crest elevations will unavoidably constrain commercial navigation on the pools to seven months of the year, as well as result in damage to marinas and port facilities along the river. While the physical effects of the draw downs are reversible, any structural modifications to the dams or facilities to allow navigation to continue during the river outages or protect them from damage would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 9a, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.7.2 SOS 9b (Adaptive Management)

This alternative establishes flow targets at McNary and Lower Granite based on runoff forecasts. Specific volumes of releases are made form Dworshak, Brownlee and Upper Snake River to try to meet Lower Granite flow targets. Lower Snake River projects are drawn down to minimum operating pool levels and John Day is at minimum irrigation pool level. Specific spill percentages are established at run–of–river projects to achieve no higher than 120% daily average for total dissolved gas.

4.7.2.1 Impacts

Navigation on the Lower Snake and Columbia Rivers:

Navigation is maintained throughout the Columbia and Snake Rivers system under SOS 9b, however some inconvenience is introduced. Increased lockage time is probable for barge traffic when locks are operated at MOP. On the Snake River, increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS 9b does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

Log Rafting Operations on Dworshak Lake

Drafting of the reservoir to meet flow targets leaves log dumps dry in nearly all years.

4.7.2.2 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

(1) To the degree possible, regulate flows to a maximum of 150,000 cubic feet per second (cfs) from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monu-

mental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir:

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling continued use of the log dumps during lower pools; (3) construct log storage areas to maximize periods when the pool is at optimal pool levels and; (4) use alternate methods of transportation.

4.7.2.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river.

Log Rafting Operations on Dworshak Lake:

As proposed, under SOS 9b, the use of Dworshak Lake for log transportation activities will be unavoidably discontinued. None of the impacts or the mitigative measures represents an irreversible commitment of resources.

4.7.3 SOS 9c Balanced Impacts Operation (Idaho Plan)

This alternative would draw down the four lower Snake River projects to near spillway crest levels for two and one–half months during the spring salmon migration period. Full drawdown level is achieved on April 1. Refill begins after June 15. This alternative also provides 1994–98 Biological Opinion flow augmentation, integrated Rule Curve operation at Libby and Hungry Horse, a reduced flow target at Lower Granite due to drawdown, winter drawup at Albeni Falls and spill to achieve no higher than 120% daily average for total dissolved gas.

4.7.3.1 Impacts

Navigation of the Lower Snake and Columbia Rivers:

Physical impacts to navigation and associated facilities on the lower Snake River are substantial for Alternative SOS 9c. (1) In order to achieve the April 1 target for spillway crest elevation draw down of the pools called for in this alternative, draw down of the lower Snake River dams begins in late March of each year. The locks become unusable for commercial navigation very soon after the process begins and are not back on line until the following June. This amounts to a three month lock closure on the lower Snake River. (2) Facilities in the pools would be effected during the same time frame. (*See Table 3, Results of the Survey for Anticipated Physical Impacts Due to Drawdown of the Lower Snake River Pools*). Damage to the foundations of structures along the pools is likely due to the extended loss of the hydraulic surcharge on the structures, as well as the potentially destabilizing effects of having the foundation soils dry out and be rehydrated on an annual basis. (3) Severe rains and wave action will cause erosion of unprotected banks, which could fail and further impact facilities. (4) Some facilities which depend on barges for cargo shipments of raw materials or finished products will simply cease operations. (5) Boat marinas may become fully or partially unusable and damage to the floating docks from resting on the river bottom during low water is likely. (6) Water quality impacts are possible if the lower flows during the refill process is not adequate to disperse the effluent from point and non–point discharges along the pools.

(7) A related transportation impact of restricting commercial barge traffic is the increased wear on the region's rail and highway infrastructure as barged commodities are shipped by truck or rail. The magnitude of the impact would be proportional to the amount of the commercial tonnage going by alternate carriers.

(8) At the John Day reservoir, a draw down to 257 feet would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System*

Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992) and summarized below. At an elevation of 257 feet, the minimum operating pool on John Day reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

Log Rafting Operations on Dworshak Lake:

Drafting of Dworshak through out the year impacts the log rafting activities during peak use months in 20 to 50 percent of the water years modelled. In particularly dry years, activity is curtailed altogether.

4.7.3.2 Mitigation Measures

Navigation on the Lower Snake and Columbia Rivers:

Limited opportunities are available for mitigating the *physical* effects on navigation:

(1) Alternate transportation for commodities ordinarily shipped by barge is possible and is described and evaluated in detail in the Economics Appendix. (2) At great cost, the dams could be modified to allow barges through at lower river elevations, but it is questionable whether or not the present day barge fleet could navigate at the reduced channel depths. (3) The loading and unloading facilities along the river would also need modification in order to accommodate the widely fluctuating water level of the pools. (4) If the export market for commodities shipped through the system could be maintained on a less than year round delivery basis, an increase in grain storage facilities along the pools and at the points of origin (farms) could be constructed for winter shipment of grains. (5) Structural modifications of the facilities along the pools to enable them to withstand the wetting drying cycles are possible, though they are expensive.

Log Rafting Operations on Dworshak Lake:

Mitigation measures for the loss of the use of the Dworshak log dumps are to: (1) hold the pool higher through the summer; (2) extend the log dumps to the maximum length possible enabling continued use of the pool at lower elevations; (3) and to use other modes of transport to Lewiston.

4.7.3.3 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

Drawing down the pools to near spillway crest will unavoidably constrain commercial navigation on the pools to nine months of the year, as well as result in damage to marinas and port facilities along the river. While the physical effects of the draw downs are reversible, any structural modifications to the dams or facilities to allow navigation to continue during the river outages would represent an irretrievable commitment of resources.

Log Rafting Operations on Dworshak Lake:

As proposed, the operation of the system in SOS 9c, impacts to the log transportation on Dworshak Lake are unavoidable. None of the impacts on or mitigation for the Dworshak log operations represents unavoidable or irreversible commitment of resources.

4.8 PREFERRED ALTERNATIVE

The objective of the Preferred Alternative is to support the recovery of ESA–listed species by storing water during the fall and winter to meet spring and summer flow targets, by managing detrimental effects to other natural resources through maximum summer draft limits, by providing public safety through flood protection and by providing for reasonable power generation.

4.8.1 Impacts

Navigation on the Lower Snake and Columbia Rivers:

Navigation is maintained throughout the Columbia and Snake Rivers system under SOS PA, however some inconvenience is introduced. Increased lockage time is probable for barge traffic when locks are operated at MOP. On the Snake River, increases in current velocities caused by release of high spring flows create navigability problems for longer tows in the reach below Ice Harbor and between Ice Harbor and Lower Monumental Dams. When flows exceed 150,000 cfs at Lower Monumental and 100,000 cfs at Ice Harbor tows must be broken into smaller groupings requiring multiple trips to safely navigate these areas. Breaking the tows increases the haul time, resulting in increased operations costs for the project and tug boat operators. Alternative SOS PA does not introduce any limitations on deep draft navigation through the Lower Columbia River ship channel as it is currently authorized.

At the John Day reservoir, a draw down to 257 feet would have several navigation related effects. The impacts are discussed in detail in: *Columbia River Salmon Mitigation Analysis System Configuration Study, Interim Status Report, Technical Appendix B, John Day Reservoir Minimum Operating Pool (November 1992)* and summarized below. At an elevation of 257 feet, the minimum operating pool on John Day reservoir, the lockage time through facilities from the forebay side would be increased by approximately 25 minutes for barges drafting 14 feet. There are no anticipated problems with lockage from the downstream side. Other navigation impacts include the need for channel dredging at several locations, including, but not limited to, Rock Creek Boat Ramp (RM 229), Roosevelt Grain Facility (RM 243.5), Port of Morrow Dock Facility and Access Channel (RM 266–270), McNary Downstream Lock Entrance (RM 291.5), Plymouth State Park, and Irrigon, Oregon. At around RM 290, a new shallow area will be exposed near the channel, which may require the installation of several new green side channel markers by the U.S. Coast Guard.

Log Rafting Operations on Dworshak Lake:

Drafting of the reservoir to meet flow targets leaves log dumps dry in nearly all months of the year. Only during June would water elevations be high enough to use the present log dumps in most years.

4.8.1.1 Mitigation Measures

Navigation of the Lower Snake and Columbia Rivers:

(1) To the degree possible, regulate flows to a maximum of 150,000 cubic feet per second (cfs) from Lower Monumental and to a maximum of 100,000 cfs below Ice Harbor Dam to reduce or eliminate the need for multiple lockages allowing maximum tows in some cases. (2) Minimize out flow from Dworshak and Brownlee Storage reservoirs during peak flow on the Lower Snake River in order to keep flows below critical discharges at Ice Harbor and Lower Monumental Dams. (3) Provide good tie–off dolphins below the problem reaches to facilitate safe transit when high flows are unavoidable.

Log Rafting Operations on Dworshak Reservoir:

(1) Hold the Dworshak Pool higher through the summer; (2) Extend the log dump ramps to their maximum practical length enabling continued use of the log dumps during lower pools; (3) construct log storage areas to maximize periods when the pool is at optimal pool levels and; (4) use alternate methods of transportation.

4.8.1.2 Unavoidable Adverse Impacts or Irreversible and Irretrievable Commitment of Resources

Navigation of the Lower Snake and Columbia Rivers:

The spring high flow problems encountered below Lower Monumental and Ice Harbor Dams are probably unavoidable. They are reflective of the natural hydrograph for this reach of the river. At minimum operating pool, all barge operations will realize increased transit time at the locks.

Log Rafting Operations on Dworshak Lake:
As proposed, under SOS PA, the use of Dworshak Lake for log transportation activities will be unavoidably discontinued for all but one month of the year. None of the impacts or the mitigative measures represents an irreversible commitment of resources.

CHAPTER 5

DISCUSSION AND COMPARISON OF ALTERNATIVES

5.1 IMPACTS COMMON TO ALTERNATIVES – GENERAL

The following two sections describe in a general way, how the Snake and Columbia Rivers are physically affected by changes in the operations of the dams and how use of Dworshak Lake for log rafting activities is impacted by the need for water from Dworshak to achieve down stream goals. A summary of all of the results of the Navigation Group analysis is shown in Table 5–1, *Summary of Full Scale Analysis Results Compared to Base Case*. It is important to note that while it was not possible to model some of the potential impacts identified, there would certainly be economic impacts. For example, it was not possible to derive from past records a reasonable correlation between high flows and dredging on the Columbia River below Bonneville Dam, and therefore, increased dredging costs could not be reasonably estimated.

5.1.1 Navigation on the Lower Snake and Columbia Rivers

For navigation on the lower Snake River, alternatives are easily divided into two categories, those that shut navigation down and those that do not. Alternatives that require draw down of the lower Snake River pools below MOP all have the same result –– commercial barge transportation stops. Although there is a limited ability to light load barges, none of the draw down alternatives analyzed dropped water levels within the range that light loading could occur, nor are the refill or draw down processes slow enough to take advantage of an intermediate water level. The only difference in impacts of the draw down scenarios is the length of time that the pools are below MOP. Some damages, those related to the weathering of exposed foundations and river banks, would increase with longer duration draw down events. The more significant impacts are those related to the financial losses of the shipping dependent businesses, which are detailed in the Economics Appendix.

Barge operators have identified the channel transits below Ice Harbor and Lower Monumental dams as being difficult under high flow conditions. Maximum flows for optimal conditions were described during Screening as 150,000 cfs below Lower Monumental Dam and 100,000 cfs below Ice Harbor Dam. All alternatives analyzed produced high flows in some years between April and June. The flow augmentation strategies tend to produce the worst conditions in the late spring. Table 3–2, *Summary Flow Analysis for Lower Monumental & Ice Harbor*, is a summary table of a data sort of the monthly average flows over the 50 water years modeled for the full scale analysis. It displays the number of years in the 50 years modeled that the monthly average would exceed the optimal maximums.

On the lower Columbia River, stage impacts are related to the length of the refill period after draw down. The alternatives modeled, included two month drawdowns and single dam draw downs which did not cause extended diminished flows from the Snake River into the Columbia River and did not have significant stage impacts. The 4.5–month multi–dam drawdowns produce noticeable effects in stage at Portland / Vancouver in September, but they are not extreme under average water conditions. Table 3–1, *Percent of Time: Comparison with 2c–1993 Operating Strategy*, show the stage effects of selected drawdown options as compared to SOS 2c, the Base Case, at three lower Columbia River locations in the late summer and early fall time frame.

Table 5–1. Summary of Full Scale Analysis Results (*Compared to Base Case*)

SOS	Lwr Columbia R. Stage Impacts	Lwr Snake R. Physical Impacts	Dworshak Log Rafting Impacts	Lake Roosevelt Ferrys
1a Pre–Salmon Summit	None	None	Benefits Log Operations	None
1b Optimum Load Following Operation	None Expected	None	Benefits Log Operations	None
2c Final SEIS w/ 427 kaf Upper Snake Water	None	None	None	None
BASE CASE				
2d [NEW] 1994–98 Biological Op	Less than 4% increase in duration of Low Stage @ Vancouver in September Expected	Some delays probable at locks	$93,000 add'l trans costs over Base Case	None
4c Revised Coulee Operation	None	None	Benefits Log Operations	None
5b Nat'l River, 4.5 Mo. Draw Dn	4% increase in duration of Low Stage @ Vancouver in September	Significant physical impacts to facilities	Benefits Log Operations	None
5c [NEW] Permanent Nat'l River	4% increase in duration of Low Stage @ Vancouver in September	Significant physical impacts to facilities	Benefits Log Operations	None
6b 4.5 Mo. Fixed Draw Dn, 33 ft	4% increase in duration of Low Stage @ Vancouver in September	Significant physical impacts to facilities	Benefits Log Operations	None
6d Lwr Gran Draw Dn, 4.5 Mo	None Expected	Significant physical impacts to facilities	Benefits Log Operations	None
9a Detail'd Fish'ry Operating Plan [NEW]	4% increase in duration of Low Stage @ Vancouver in September	Significant physical impacts to facilities	Benefits Log Operation	None
9b Adaptive Management [NEW]	None	Some delays probable at locks	$173,000 addt'l trans cost over Base Case	Slight increase in impacts to Gifford Ferry
9c Balanced Impacts [NEW]	4% increase in duration of Low Stage @ Vancouver in September	Significant physical impacts to facilities	Slight Benefit to Log Ops	Slight increase in impacts to Gifford Ferry
Preferred Alternative	None	Some delays probable at locks	$139,000 addt'l trans cost over Base Case	None

5.1.2 Log Rafting Operations on Dworshak Lake

The model used to develop a cost for alternative transportation of logs from Dworshak Lake to Lewiston produced a cost in all scenarios. Since the model does not account for any storage of logs at the dumps, this is thought to be conservative. It is more meaningful to consider the difference between the Base Case, SOS 2c, and the other strategies analyzed (See Table 5–2, *Dworshak Alternate Transportation Model Results*). With the exception of alternatives relying heavier on flow augmentation, all of the alternate system strategies were better for the log rafting operations on the lake, than the 1993 Operations (SOS 2c). The 1993 operation drafts heavily, early in the summer, from Dworshak Lake for spring flow augmentation. All alternatives which provided a stable high elevation in Dworshak Lake, or delayed the drafting of the lake for flow augmentation or refill of the lower Snake River dams, were beneficial to this authorized use of the project.

5.2 IMPACTS COMMON TO FLOW AUGMENTATION STRATEGIES (SOS 1A, 1B, 2C, 2D, AND PA)

5.2.1 Navigation on the Lower Snake and Columbia Rivers

Effects on commercial navigation and dependent facilities are negligible. Locks remain operable and stage for deep draft navigation below Bonneville Dam is not compromised. The occurrence of high flow conditions below Lower Monumental and Ice Harbor dams is slightly increased over the Base Case, but the period of occurrence is remains confined to April, May and June of the year.

5.2.2 Log Rafting Operations on Dworshak Lake

All of the flow augmentation alternatives rely heavily on the drafting of Dworshak Lake. These strategies have the greatest impact on the use of the log dumps, in most cases making them unavailable for the majority of the June through October seasonal use period.

Table 5–2. Dworshak Alternative Transportation Model Results Relative Impacts, Ascending Order by Mean Value

SOS	DESCRIPTION	MIN	10 PERC	MEAN	90 PERC	MAX	2C DIFF MEAN
4C	ST STOR W/ MOD GRND COULEE F.C.	$0	$0	$0	$0	$0	($228,188)
6D	DD LWR GRAN 4.5 MO	$47,587	$53,573	$63,103	$73,204	$92,584	($165,085)
6B	DD 4 PROJ 4.5 MO	$48,758	$53,997	$63,461	$74,548	$106,860	($164,727)
1B	LOAD FOLLOWING OPS	$83,537	$939,291	$108,541	$126,286	$161,192	($119,647)
1A	PRE–SALMON SUMMIT	$92,118	$99,071	$116,064	$134,283	$168,264	($112,124)
5B	NATL RIVER 4.5 MO DD	$118,621	$132,158	$146,144	$161,452	$186,975	($82,044)
5C	PERMANENT NAT'L RIVER	$118,671	$130,633	$146,156	$162,462	$188,556	($82,032)
9A	DETAILED FISHERY OP PLAN	$129,937	$149,302	$171,326	$194,649	$231,004	($56,862)
9C	BALANCED IMPACTS	$172,890	$195,396	$220,790	$248,738	$298,267	($7,398)
2C	SEIS W/ U. SNAKE WATER (427KAF)	$185,072	$20,331	$228,188	$256,039	$320,563	$0
2DR	94–98 BIOLOGICAL OPINION	$255,217	$285,463	$321,252	$357,533	$411,156	$93,064
9B	ADAPTIVE MANAGEMENT	$317,002	$361,913	$400,913	$446,219	$494,576	$172,725
PA	PREFERRED ALTERNATIVE						

5.3 IMPACTS COMMON TO DRAWDOWN STRATEGIES (SOS 5B, 6B, 6D, 9A, 9B, 9C)

5.3.1 Navigation on the Lower Snake and Columbia Rivers

The drawdown alternatives have the greatest potential for impacts to commercial navigation on the lower Snake and Columbia Rivers. Commercial barge navigation stops whenever the pool levels drop below MOP. Goods normally carried by barge, must be either stored for the duration of the outage or shipped by alternate transportation. The regional and national economic significance of the outages is described in the Economic Appendix. The exposure of the banks and facilities to extended and cyclical drying will cause damages and deterioration. The impacts on stage in the Lower Columbia River below Bonneville Dam are noticeable after the longer, 4.5–month drawdowns, when the refill period extends into the early fall. The impacts do not appear to be great during average water conditions and are primarily felt at Portland/Vancouver during the month of September.

The main navigation effects of drawing the Lower Snake River and John Day pool down to MOP (257 feet) are an increase in lockage time from the upstream approach and an increased need for dredging of access channels to facilities along the pool. Loading and unloading of barges at the various facilities would have to modified to accommodate and annual fluctuation in the water level of the pool.

Figure 5–1. The Confluence of the Snake (a) and Clearwater (b) Rivers during the March 1992 Lower Granite Drawdown Test

5.3.2 Log Rafting Operations on Dworshak Lake

Relative to the Base Case (SOS 2c), all of the draw down alternatives are beneficial to this use of Dworshak Lake. With the exception of the Natural River strategies, the longer the drawdown period, the greater the benefit to the log rafting.

5.4 IMPACTS COMMON TO STABLE POOL ALTERNATIVES (SOS 4C)

This alternative represents optimal conditions for navigation purposes.

5.4.1 Navigation on the Lower Snake and Columbia Rivers

This alternative strategy has no negative impact on navigation in the rivers.

5.4.2 Log Rafting Operations on Dworshak Lake

This is the very best alternatives for the Dworshak log rafting operations. The lake elevation is held high enough for the majority of the seasonal use period (June–October).

5.5 MITIGATION COMMON TO ALTERNATIVES

5.6 MITIGATION COMMON TO FLOW AUGMENTATION STRATEGIES (SOS 1A, 1B, 2A, 2C, 2D, AND PA)

5.6.1 Navigation on the Lower Snake and Columbia Rivers

Since the effects on commercial navigation and dependent facilities are negligible, mitigation strategies revolve mainly around dealing with the occurrence of high flow conditions below Lower Monumental and Ice Harbor dams. Since this situation has always occurred in the April–June period, mitigation measures would be similar to those presently employed. Presently, the mitigation is primarily operational on the part of the barge and dam operators. Breaking of tows and extreme caution on the part of the barge operator and provision of sufficient tie–off walls both upstream and down stream of the dams by the Corps may be all that is necessary to accommodate the annual occurrence of the high spring flows.

5.6.2 Log Rafting Operations on Dworshak Lake

The possible mitigation measures identified for the Dworshak log operations include using alternate methods of log transportation to Lewiston, holding the water level up through the summers and early fall, and extending the length of the log dumps to as low as elevation as possible, without causing damage to the logs.

5.7 MITIGATION COMMON TO DRAWDOWN STRATEGIES (SOS 5B, 6B, 6D, 9A, 9B, 9C)

5.7.1 Navigation on the Lower Snake and Columbia Rivers

Mitigation possibilities are limited for the effects of drawdown below MOP on the lower Snake River pools. Commodities ordinarily shipped by barge can be routed as rail or truck cargo. Additional storage at loading facilities and at the source (farms) can be employed to some degree, delaying the barging until after the outages. Revetments, and other stabilization methods could be employed to stabilize the river banks around cargo transfer facilities.

Mitigation measures for drawdown to MOP the Lower Snake River pools and on the John Day pool include increased dredging of access channels to facilities, modification of loading and unloading facilities to accommodate 5–foot water level fluctuations, and additional channel markings on the channel through the pool.

Effects on stage below Bonneville Dam can be mainly dealt with by careful scheduling of ships departures during the month of September. The Port of Portland's LoadMax tidal and stage forecasting is presently utilized for just this purpose. If a particular water year appeared to be causing more severe effects than were identified during the full scale analysis, the possibility of drafting Columbia River main stem reservoirs to make up flow deficits should be considered.

5.7.2 Log Rafting Operations on Dworshak Lake

The possible mitigation measures identified for the Dworshak log operations include using alternate methods of log transportation to Lewiston, holding the water level up through the summers and early fall, and extending the length of the log dumps to as low as elevation as possible, without causing damage to the logs.

5.8 MITIGATION COMMON TO STABLE POOL ALTERNATIVES – NAVIGATION PREFERRED ALTERNATIVE (SOS 4C)

This alternative is the preferred alternative for navigation purposes and no mitigation measures are necessary for the beneficial effects of this operation.

5.9 CUMULATIVE EFFECTS

5.9.1 Transportation Infrastructure

Changes in the way products are moved on the Snake River could have the effect of a general decrease in the condition of transportation infrastructure far removed from the immediate vicinity of the change. Since the expenditure of Federal funds for maintenance of navigation infrastructure (locks and channel dredging) is tied to the amount of commercial tonnage on the waterway, a decrease in the Snake River commercial barge shipments could mean a lower prioritization for funds for maintenance of other parts of the system as well. Further, the increased use of the alternate transportation modes (rail and truck) for products formerly shipped by barge will necessitate increased maintenance on the those transportation networks. This would impact the state transportation planning by forcing a shift in maintenance and improvement funds to rural roads to accommodate shipments now handled by barge and result in reallocation funds from other regions presently scheduled for infrastructure improvements.

The significant local and regional economic impacts resulting from the disruption of barge transportation on the lower Snake River are detailed in the Economics Appendix.

5.10 SHORT TERM VS LONG TERM PERSPECTIVES

5.10.1 Navigation on the Lower Snake and Columbia Rivers

The short–and long–term physical impacts to navigation are essentially the same. However, any growth or improvements of the navigation transportation system is tied to the region's economics. Economic benefits drive the Federally funded development or improvements of navigation projects. Likewise, the existence of a viable waterborne transportation network shapes economic development of some industries. Significant changes in the availability of a navigation network for a region will change the economic growth patterns, and in turn, impact the need for navigation improvements in the system. It is unlikely that barge companies would be able to cover operating expenses and still be competitive when barging is reduced to 5 or 6 months a year, as would be the case under some of the drawdown alternatives. With this industry gone, no future improvements to the lower Snake River navigation infrastructure would be likely.

5.10.2 Log Rafting Operations on Dworshak Lake

The use of Dworshak Lake for moving logs is economical and assists in sustaining a viable timber industry in the region. The long–term outlook for timber harvest in the region served by the log dumps is good, either sustained at present levels or increasing. Therefore, the effects of any alternative, either good or bad, will continue at least at the same level as discussed in the short–term analysis of impacts.

CHAPTER 6

LIST OF PREPARERS

Table 6–1. List of Preparers

Name	Education/Years of Experience	Experience and Expertise	Role In Preparation
Sheryl A. Carrubba	B.S. Envr. Res. Engr. 13 years	Dredging Coordination, 7 years	Work Group Coordination, Technical Writer, Editor, Model Development for Final Analysis
Michael A. Martin	B.S. Anthropolgy B.S. Sociology 20 years	Community Planner COE	Technical Writer, Editor
Tim Castille	B.S. Electrical Engineering BPA	Analysis of Impacts of Fish Measures on Hydro Power Operation, 2 years	Model Development for Screening
Sebastian Degens	B.A. Psychology M.S. Planning	Sr. Planner, Marine Port of Portland 10 years – Port Planning	Technical Input Deep Draft Navigation Analysis
Brian Shank	B.S. Economics	Economists, COE 5 years	Model Development for Final Analysis

Table 6–2. List of Preparers, Northwest

Name	Education/Years of Experience	Experience and Expertise	Role In Preparation
Hydraulic Consultants, Inc. Kent, Washington			Model for Stage Impacts Analysis

Table 6–3. List of Participants

AGENCY:	NAME:
US ARMY CORPS OF ENGINEERS	MR STEVE CHESSER
US ARMY CORPS OF ENGINEERS	MR BRIAN SCHMIDTKE
US ARMY CORPS OF ENGINEERS	MS SHERYL CARRUBBA
US ARMY CORPS OF ENGINEERS	MR JAKE REDLINGER
US ARMY CORPS OF ENGINEERS	MR JOE MURAR
US ARMY CORPS OF ENGINEERS	MR RUSS GEORGE
US ARMY CORPS OF ENGINEERS	MR MICHAEL MARTIN
BONNEVILLE POWER ADMINISTRATION	MR BILL GORDON
BONNEVILLE POWER ADMINISTRATION	MR TIM CASTILLE
BONNEVILLE POWER ADMINISTRATION	MR BOB SHANK
US FISH AND WILDLIFE SERVICE	COLUMBIA RIVER COORDINATOR
US BUREAU OF MINES	MR CARL ALMQUIST
BUREAU OF RECLAMATION	MR DAN YRIBAR
NW POWER PLANNING COUNCIL	MS DEBBIE KITCHIN
AMERICAN WATERWAYS OPERATORS	MR JERRY MCMAHON
PACIFIC NW GRAIN & FEED ASSN	MR JONATHAN SCHLUETER
COLUMBIA RIVER TOWBOATERS ASSN	MR MIKE RIKE
US DEPARTMENT OF THE NAVY	MR MIKE WENTINK
PUGET SOUND NAVAL SHIPYARD	
US DEPARTMENT OF AGRICULTURE	MR PHIL WARD
LAKE ROOSEVELT FORUM	
PACIFIC NW WATERWAYS ASSOC	MR GLEN VANSELOW
BERNERT BARGE LINES	MR JERRY GROSSNICKLE
BERNERT BARGE LINES	MR BOB BERNERT
BRIX MARITIME COMPANY	MR GLEN COMSTOCK
TIDEWATER BARGE	MR MARTIN PEPPER
OREGON DEPT OF TRANSPORTATION	MR ED IMMEL
WA DEPT OF TRANSPORTATION	MR RALPH RODRICK
PORT OF PORTLAND	MR SEBASTIAN DEGENS
PORT OF PORTLAND	MS ANN EIKE
STATE OF IDAHO TRANSPORTATION DEPARTMENT	MR RONALD KERR
LAFFERTY TRANSPORTATION CO	MR EDWIN R HAGLUND

CHAPTER 7

GLOSSARY

Alternatives: (n) The set of proposed changes in the general operating procedure for the projects on the Columbia and Snake River. see Option, System Operating Strategy

Authorized Project: (n) A project established by authority of the U.S. Congress for the specific purposes described in the legislation; eg. flood control, power generation, navigation, irrigation, recreation, fish and wildlife enhancement, etc.

Closure Windows: (n) Periods of time during which an activity may not occur

Draft: (1) (n) The depth of water a vessel draws, especially when loaded (2) (v) To draw off water from a reservoir

Forebay: (n) A reservoir from which water is taken to run equipment, such as a turbine or fish passage ladders

Light load: (v) To intentionally limit the cargo loaded on a vessel in order to reduce the draft of the vessel

Lockage: (n) An act or the process of passing a vessel through a lock

MOP: (n) Minimum Operating Pool, On reservoirs, the lowest water elevation of an operating range at which all authorized uses of the project can be maintained

Natural Hydrograph: (n) The unmodified volume of flow of streams and rivers for a drainage area The hydrograph of a river can be modified by the use of dams to control the flow.

NTWG: (n) Navigation Technical Work Group, the study team that developed, reviewed and commented on the analysis models and the Navigation Technical Appendix

Option: The incremental change of a particular method of operating a project. Some of the alternatives have more than one option, which optimize the operation of the system for the benefit of a particular goal.

Outage: (n) A period of interruption in use or service

Project: (n) The broad term covering the Federally constructed and maintained channels and structures on the Columbia River. A "Project" is a channel or facility constructed for variety of authorized purposes, such as, hydroelectric generation, flood control, navigation, etc.

Reach: (n) A section of a river; usually defined by River Mile

Refill period: (n) The time it takes for reservoirs to fill back to MOP

River Mile: (n) A consistent linear measurement from a particular defined place on a river. For the Columbia River, River Miles are measured from the mouth of the river at the Pacific Ocean. For the Snake River, River Miles may start with the Snake Rivers confluence with the Columbia Rive or from the Mouth of the Columbia River. In the Navigation Technical Appendix, measurement from the Mouth of the Columbia River is used for both the Snake and Columbia Rivers.

Screening: (n) In the SOR process, the initial technical review (following Scoping Meetings) of a set of alternatives for operation of the Columbia River and Snake River Federal hydroprojects, including Storage and Run of the River dams.

Scoping process: public review of the proposed study process and goals. Public meetings were held to define the range of possible interests and recommendations groups and individuals have in regard to operation of the projects on the Columbia and Snake Rivers.

Shoaling: (n) The natural process of filling in of portions of the river channel by sediments transported by water

Sill: (n) The base of the navigation lock

SOS: (n) System Operating Strategy, a combination of operating requirements and restrictions for the regulated dams on the Columbia and Snake River system, studied in the SOR process. The SOS is designed to achieve defined goals, such as greater stream flow, stable pool elevations, etc.

Tailwater: (n) Water below a dam or water power development

Value Measure: (n) The measurement used to establish the relative impact of various System Operating Strategies. During screening, the value measures for the navigation impact analysis was added transportation cost for waterborne cargo to be shipped by alternate land transportation (rail or truck).

Table 8–1. Inventory of Ports on the Columbia and Snake River Pools

Name	*Mile*	*Owner*	*Operator*	*Use*	*Depth Alongside*
COLUMBIA RIVER					
Bonneville Pool					
SDS Lumber Co. Dock	170.5	SDS Lumber Co	SDS Lumber Co.	Wood chips/log raft shipment	15
Mountain fir Lumber Co., The Dalles Division	187.1	Port of The Dalles	Mountain Fir Lumber Co.	Receipt of logs, wood chip shipment	12
Log and Wood Chip Docks					
Cargill The Dalles Grain Elevator Dock	188.7	Port of The Dalles	Cargill, Inc.	Grain shipment	15
Port of The Dalles Dock	189.6	Port of The Dalles	Port of The Dalles and Mid Columbia Grain Growers, Inc	Grain shipment, mooring cruise vessels	24
The Dalles Pool					
Mid Columbia Grain Growers	207.5	Mid Columbia Grain Growers	Mid Columbia Grain	Grain Shipment	25
A–House Dock			Growers, Inc.		
John Day Pool					
Cargill Arlington Grain Elevator Dock	241.6	Port of Arlington	Cargill, Inc.	Grain Shipment	19
Farmers Warehouse & Commission	243.5	Farmers Warehouse &	Farmers Warehouse	Grain Shipment	20
Co. Dock		Comm. Co.	& Comm. Co.		
Idaho Overseas Log Ramp	269.9	Port of Morrow	Idaho Oversea, Inc.	Log shipment by raft	15
Longview Fibre Co.	270.2	Port of Morrow	Longview Fibre Co.	Wood chip shipment	15
Boardman Wood Chip Dock					
Port of Morrow West Beach	270.6	Port of Morrow	Inland Container Service, Inc.	R/S general cargo, mooring	15
Terminal 3 Container Dock				barges for fleeting	
SK Terminal Dock	271.6	Port of Morrow	SK Terminal, Inc.	Grain shipment	
Morrow County Grain Growers,	278.2	Morrow County Grain Growers	Morrow county Grain Growers	Grain shipment	15
Hogue–Warner Elevator Warf					
Mc Nary Pool					
Port of Umatillia Commerical Dock	292.5	Port of Umatilla	Forest Recovery, Inc.	Containers, Heavy lift, wood chips	20

Table 8–1. Inventory of Ports on the Columbia and Snake River Pools – CONT

Name	*Mile*	*Owner*	*Operator*	*Use*	*Depth Alongside*
Mc Nary Pool – CONT					
Pendleton Grain Growers	292.7	Pendleton Grain Growers	Pendleton Grain Growers	Grain shipment	19
Tidewater Barge Lines	292.8	Tidewater Barge Lines	Tidewater Terminal Co.	R/S Petrol Prods, liquid fertilizer, fueling vessels	19
Walla Walla Grain Growers	311.6	Walla Walla Grain Growers	Walla Walla Grain Growers	Grain shipment	10–12
Walla Walla Grain Growers	314.5	Walla Walla Grain Growers	Walla Walla Grain Growers	Grain shipmnet	16
Boise Cascade Wallula Plant	316.5	Boise Cascade Corp.	Boise Cascade Corp	Wood pulp shipment	12
Phillips Pacific Chemical Co.	321.6	Phillips Pacific Chemical Co.	Phillips Pacific Chemical Co.	Shipment of liquid fertilizer	12
Chevron Chemical Co.	322.6	Chervon Chemical Co.	Not used	Not used	15
Unocal Chemicals	323.3	Unocal Chemicals Division	Unocal Chemicals Division	Receipt of ammonia & urea, shipment of ammonia	30
Northern Pacific Grain Growers	328.0	Northern Pac. Grain Growers	Northern Pacific Grain Growers	Grain shipment	14
Port of Benton Barge Slip	343.1	Port of Benton	Port of Benton	R/S heavy lift	10
Port of Benton	342.7	Port of Benton	Port of Benton	R/S general cargo	10
Port of Pasco Marine Terminal	328.2	Port of Pasco	Continental Grains/Columbia Marine Lines	Ship grain, receive petrol products	12–14
Port of Pasco Barge Slip RO/RO Dock	326.9	Port of Pasco	Port of Pasco	RO/RO, mooring barges	20
Port of Pasco Container Terminal	326.8	Port of Pasco	Columbia Basin Container Corp	R/S containers, heavy lift	20
Port of Walla Walla Dock	1.7	Port of Walla Walla	Not Used	Not used	6–10
Connell Grain Growers	1.8	Port of Walla Walla	Connell Grain Growers	Grain shipments	16–20
Cargill Burbank Grain Elevator Dock	2.0	Port of Walla Walla	Cargill, Inc.	Grain shipments	10–12
Chevron Pipe Line Co, East Pasco Terminal	2.2	Chervon USA, Inc.	Chevron Pipe Line Co	R/S petrol prods	22
Tidewater Terminal Co. Mooring Docks	2.7	Tidewater Terminal Co.	Tidewater Terminal Co	Mooring vessels, handling supplies	8
Tidewater Terminal Co	2.9	Tidewater Terminal Co.	Tidewater Terminal Co	R/S petrol prods	15
Tidewater Terminal Co. Molasses Dock	3.0	Tidewater Terminal Co.	Tidewater Terminal Co	R/S Molasses & liquid fertilizer	14

Table 8–1. Inventory of Ports on the Columbia and Snake River Pools – CONT

Name	*Mile*	*Owner*	*Operator*	*Use*	*Depth Alongside*
SNAKE RIVER					
Ice Harbor Pool					
Walla Walla Grain Groweres, Shefler Dock	29.0	Walla Walla Grain Growers	Walla Walla Grain Growers	Grain shipment	40
Louis Dreyfus Windust Station Dock	38.5	Louis Dreyfus Corp	Louis Dreyfus Corp	Grain shipment	16
Lower Monumental Pool					
Columbia County Grain Growers,	61.1	Columbia County Grain Growers, Inc.	Columbia County Grain Growers, Inc.	Grain shipment	26
Lyons Ferry Dock					
Little Goose Pool					
Pomeroy Grain Growers Dock	83.0	Port of Garfield	Pomeroy Grain Growers, Inc	Grain shipment	24
Columbia Grain,	83.5	Port of Whitman County	Columbia Grain, Inc.	Grain shipment	18
Centeral Ferry Elevator					
Centeral Ferry Terminal	83.7	Central Ferry Terminal Association	Harvest States Cooperatives	Grain shipment	20
McGregor Terminal	NA	McGregor Company	McGregor Company	Ammonia shipment	na
Almota Elevator Co. Dock	103.6	Almota Elevator Co	Almota Elevator Co	Grain shipment	30
S & R Grain Co., Port of Almota Dock	103.7	Port of Whitman	S & R Grain Co & Palouse Producers	Grain shipment, receive liquid fertilizer	12–13
Lower Granite Pool					
Tidewater Terminal Co.	135.5	Tidewater Terminal Co	Tidewater Terminal Co	R/S containers, R petrol prods, liquid fertilizer and salt	16
Port of Whitman County, Site H Wharf	135.6	Port of Whitman County	various lessees	R/S logs & general cargo	30
Potlatch Corp Dock	135.7	Potlatch Corp	Gem Chip & Trading, Inc	Ship wood chips	30
Mountain Fir Lumber Co. Wilma Dock	136.0	Longview Fibre Co	Mountain Fir Lumber Co, Inc	Ship wood chips	15
Stegner Grain Terminal Dock	136.5	Port of Whitman County	Stegner Grain and Seed C.	Grain shipment	30
Port of Whitman County Site A Dock	137.0	Port of Whitman County	various operators	R/S logs and general cargo	20
Port of Clarkston Dock	137.8	Port of Clarkston	Port of Clarkston	R/S containers, logs, heavy lift	16
Clarkson Grain Terminal Dock	138.4	United Grain Corp	Clarkston Grain Terminal, Inc	Grain shipment	12

Table 8–1. Inventory of Ports on the Columbia and Snake River Pools – CONT

Name	*Mile*	*Owner*	*Operator*	*Use*	*Depth Alongside*
Lower Granite Pool – CONT					
Mountain Fir Lumber Co,	0.5	Longview Fibre Co	Mountain Fir Lumber Co, Inc	Ship wood chips and hogged fuel	16
Lewiston Div Dock (Clearwater River)					
Port of Lewiston Container Terminal	1.1	Port of Lewiston	Knappton Terminals, Inc	R/S containers, general cargo, lumber, paper	14
Continental Grain Co, Lewiston Dock	1.3	Continental Grain Co	Continental Grain Co	Grain shipment	20
Lewis–Clark Terminal Association Dock	1.4	Lewis–Clark Term. Assoc., Inc	Lewis–Clark Term. Assoc., Inc	Grain shipment	15