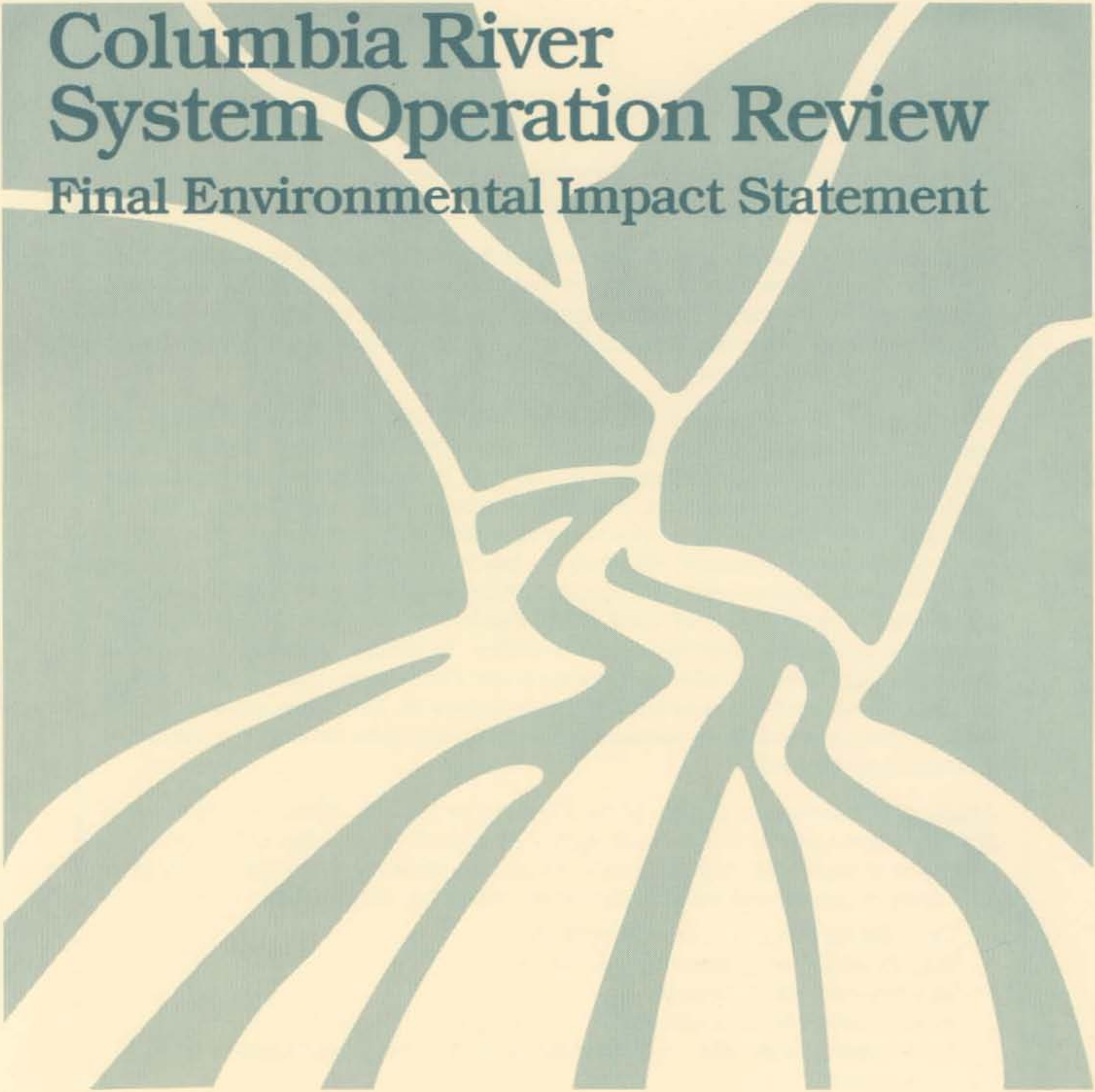
Columbia River System Operation Review

Final Environmental Impact Statement



Appendix F

Irrigation, Municipal and Industrial/Water Supply

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.

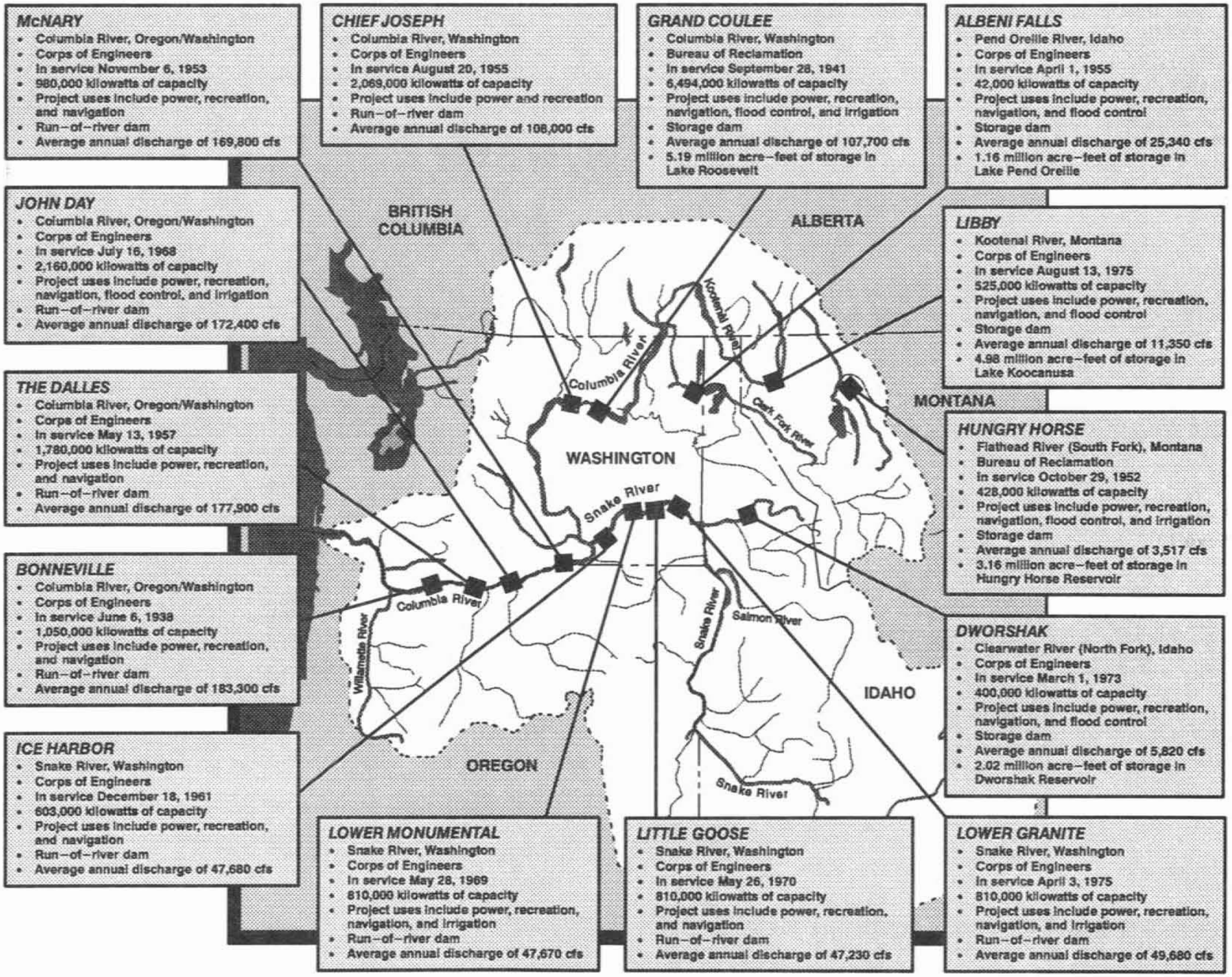
WHAT DO THE TECHNICAL APPENDICES COVER?

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 Irrigation/M&I appendix relies on supporting data contained in Appendix A. For complete coverage of all aspects of Irrigation/ M&I, readers may wish to review both (A and F) 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

INTRODUCTION: SCOPE AND PROCESS OF IRRIGATION/M&I STUDIES

1.1 GENERAL OVERVIEW

The Columbia River Basin drainage covers 219,000 square miles (567,200 square kilometers) in seven western states and 39,500 square miles (102,300 square kilometers) in British Columbia. Most of the Basin in the United States is located in Washington, Oregon, Idaho, and Montana. Minor portions of the Basin in other states include a small area on the western edge of Wyoming and a small area on the northern edge of Utah and Nevada.

The Columbia River originates at Columbia Lake on the west slope of British Columbia's Rocky Mountain Range. The river flows from Canada into the United States and eventually becomes the border between Oregon and Washington. The Columbia River is 1,214 miles (1,954 kilometers) long; it flows into the Pacific Ocean near Astoria, Oregon.

The Columbia River has an average annual runoff at its mouth of about 198 million acre–feet (244.3 billion cubic meters). The Canadian portion of this runoff is about 25 percent of the total, or 50.2 million acre–feet annually [61.9 billion cubic meters]. Since the 1930's, the Columbia River has been harnessed for the benefit of the Northwest and the nation. Federal agencies have built 30 major dams on the river and its tributaries. Dozens of non–Federal projects have been developed as well. The dams provide flood control, irrigation, navigation, hydroelectric power generation, recreation, fish and wildlife, and streamflows for wildlife, anadromous fish, resident fish, and water quality.

River users are increasingly competing for the limited water resources in the Columbia River Basin. Because several important multiagency contracts and international agreements involving power production rights and obligations will soon expire, it is now appropriate to review future system operations and river use issues.

The Corps of Engineers (Corps), Bonneville Power Administration (BPA), and Bureau of Reclamation (Reclamation) share portions of the complex set of responsibilities and legal authorities for the management of the Columbia River. The three agencies have entered into a study effort, the Columbia River System Operation Review (SOR), to evaluate alternative methods of operating the river system and to determine how best to operate the system in the future.

Since the SOR was initiated, three anadromous fish stocks that utilize the Columbia and Snake Rivers: sockeye, spring/summer chinook, and fall chinook, have been listed as endangered or threatened. Although this has added a new dimension to the study, it does not alter the objectives initially identified at the outset of the study. The investigation will evaluate the impacts of alternative operating strategies.

The SOR provides a public forum where individuals and organizations representing all interests can express their concerns and recommendations for system operation. To ensure continuing representation of public views during the investigation and preparation of the Draft EIS, work groups representing several functional areas have been established and subject matter experts have been invited to participate in the SOR analysis.

1.2 SUMMARY OF IRRIGATION, MUNICIPAL AND INDUSTRIAL WATER ISSUES RAISED DURING THE SCOPING PROCESS – AND DISPOSITION

The following section includes issues raised in the public scoping process, as well as those offered for consideration by members of the Irrigation and M&I

Work Group (I/M&IWG). In certain cases, the comments reflected the geographical interests of those participating at the public meetings –– as participants in one part of the Columbia River Basin expressed different interests than those in other parts of the basin.

Comments have been grouped into appropriate categories.

Comments received at the public scoping meetings on the use of water for agriculture production and for municipal and industrial uses ranged from numerous comments expressing a strong support for existing levels of irrigation use to suggestions by a few that water utilized for irrigated agriculture in the Pacific Northwest be monitored or reduced. There were many comments that related to issues involving irrigation and agriculture in the basin that are outside the scope of SOR. Following is a summary of comments for each category and their disposition. Issues that are outside the scope of SOR are so indicated.

Priority of Use:

Many commenters expressed the opinion that irrigation should be given top priority in the operation of the Federal Columbia River Power System (FCRPS). These opinions were exemplified by statements like "irrigation and power pay the bills", "create jobs and provide a tax base", and "irrigation, power, and flood control were the authorized purposes of the projects". The continuation of irrigation at present levels and for future growth was given high priority by many. Specifically, many comments expressed the opinion that irrigation development on the Federal Columbia Basin Project in central Washington be expanded as originally authorized by Congress. There were some comments that irrigation should coexist with other river purposes and that fishery interest be given equal priority. A few comments stated that irrigated agriculture should be given a lower priority than other uses, including the suggestion that the needs of native ecosystems should be placed first. In general these commenters felt that anadromous and resident fish and wildlife be given additional consideration in operation of the river system, and irrigation should sacrifice if tradeoffs are required.

Disposition: Three of the seven SOR alternative operating strategies have no direct effect on irrigation. Accordingly, other things being equal, existing levels of acreage and production in the Pacific Northwest (PNW) would be maintained.

The issue of giving additional consideration to fish and wildlife and that irrigation should share priority with other uses, including anadromous fisheries is addressed in five SOR alternatives: SOS4 – stable storage project operation, SOS5 –– natural river operation, SOS6 –– drawdown of lower Snake reservoirs, SOS9 –– which includes a number of operational changes and, the Preferred Alternative –– which includes drawdown at John Day and Lower Granite.

The issue of expanding the irrigated acreage of the Federal Columbia Basin Project is outside the scope of SOR and is dependent on other state and Federal actions, including Congressional appropriations. In August 1994, Reclamation announced it was discontinuing plans to issue a final EIS on expansion of the Columbia Basin Project.

Economy & Water Pricing:

Numerous comments stressed the importance of irrigation in the PN, including the production of food and fiber, as well as the importance of the economic infrastructure built around the irrigated agriculture sector. It was recommended that any adverse impact on irrigated agriculture from revised system operations be fully evaluated. There were some opinions expressed about the high cost of irrigation (from a public perspective) and the efficiency of irrigated agriculture in certain areas of the region. It was suggested that the concept of fair pricing of water resources for all users be incorporated into the analysis. One commenter suggested that only those irrigated areas that are most cost effective be retained in production.

Disposition: Three of the seven SOR alternative operating strategies have no direct effect on irrigation and consequently would not adversely effect irrigation and the associated economic infrastructure. Three SOR strategies (SOS5, SOS6, and the Preferred Alternative), those with reservoir drawdown of the lower Snake reservoirs to natural river and a fixed drawdown are strategies designed to give more consideration to non irrigation uses, such as anadromous fish species, resident fish, and wildlife. These alternative strategies involve some degree of adverse impact on irrigation pumpers on the Ice Harbor and John Day pools, as well as irrigation districts receiving water pumped from Grand Coulee.

Establishing a pricing structure for irrigation water and for other uses is outside the scope of SOR and the I/M&IWG.

Water Rights:

The majority of comments on this topic favored maintaining existing water rights for irrigation. In general, it was stated that there is sufficient water in the lower Snake and the Columbia Rivers to meet all established irrigation, municipal, and industrial water rights. The quantity of water diverted for these purposes is small compared to total river flow. The concept of modifying present water right laws to encourage and authorize water transfers was introduced. One commenter stated that water rights should be done away with and all water and water use should be considered a public right.

Disposition: The issue of water rights is outside the scope of SOR. Water rights for irrigation are under state and/or Federal jurisdiction. None of the SOR alternative operating strategies propose to diminish or reduce the priority of water rights, permits, or entitlements held by existing irrigation and M&I water users.

Conservation & Efficiency:

A moderate number of comments indicated the desirability of conservation and increased efficiency and should be incorporated into future water uses. This includes better water planning and management to not only make the best use of the water resources but to decrease electrical energy consumption.

Comments of how to implement conservation ranged from incentive programs aimed at encouraging voluntary adaptation of conservation to pricing mechanisms aimed at forcing adaptation of these measures. Several comments revolved around the wastefulness of water use in irrigation. Some commenters recognized the favorable progress of the irrigation community in adapting new technology and implementing conservation and efficiency measures.

The pros and cons of implementing conservation measures to reduce irrigation diversion was also addressed by some commenters. Some expressed opinions that irrigation conservation measures would release water that would then be available for other uses while others pointed out that the measures would adversely impact fish and wildlife habitat that has been developed as a result of the existing irrigation activity. Several individuals stated that the SOR analysis should not be the vehicle to identify site-specific water conservation opportunities in the northwest.

Disposition: The implementation of measures to increase irrigation efficiency, thereby freeing up water for other uses is beyond the scope of SOR. While the benefits of conservation are recognized, actual implementation is mostly at the field level and it would be inappropriate and beyond the authority of SOR to mandate performance standards. There are a number of efforts ongoing in the PN to identify water saving opportunities, including efficiency improvements, water banks, and other incentives. These efforts are being conducted by a number of entities, including private individuals, irrigation districts, state and Federal agencies, and others.

Pollution:

Several commenters expressed a general concern regarding the water quality of irrigation return flows to the river system. Several commenters noted that irrigation return flows are putting large silt and nutrient loads in the rivers. There were requests that the study address nonpoint pollution sources such as agricultural runoff and municipal and industrial discharges.

Disposition: Three of the seven SOR alternative operating strategies have no impacts on irrigation, thereby neither increasing or decreasing irrigation return flows. The Water Quality Work Group is responsible for evaluating the impacts on water quality of alternative operating strategies for the two strategies (SOS5 and SOS6) that contain proposals for lowered reservoir pools.

Water Resources & Other Issues:

Most of the comments on the general topic of water resources addressed priorities of water use. These have been summarized under this sub–heading. There were several comments about including the Snake River Basin in the SOR analysis. One member of the I/M&IWG felt that the "Upper Snake" basin should be included in the SOR analysis. Reasons for including the Snake Basin included the fact that the Snake Basin is a potential source of water for enhancement of anadromous fish species and it is part of the Columbia River Basin. Arguments were presented on both sides of the issue.

Disposition: The Snake River Basin was excluded in the SOR analysis because:

(1) The Snake River Basin is outside the geographical area of the 14 FCRPS projects;

(2) Because much of the water in the Upper Snake is currently allocated to irrigation through Federal contracts or via State water rights, conversions from irrigation to other uses would require contract or water right recession, or participation by willing sellers in water markets and water banks, Federal and State action, including appropriations, and/or changes in State water rights.

There were few direct comments about M&I supplies. As a summary, comments on M&I generally expressed the belief that M&I uses will continue to be of importance and that all SOR alternatives should accommodate such uses and recognize the need for expansion as population increases.

Table 1–1 summarizes the significant issues and their disposition.

Table 1–1. Issues and Disposition

Issue	Disposition
Priority of Use:	Addressed in alternative strategies.
Continued expansion of Federal Columbia Basin Project in central Washington	Not addressed in alternative strategies.
Economy/Price:	
Impact on irrigation economy	Differentially addressed in alternative strategies.
Establish "fair pricing" of water supplies.	Not addressed. Outside scope of SOR.
Water Rights:	Not addressed. Outside scope of SOR.
Conservation/Efficiency:	
Increase irrigation efficiency	Not addressed. Outside scope of SOR.
Specific water conservation measures	Not addressed. Outside scope of SOR.
Pollution:	
Water quality – irrigation water return flows	Evaluated by Water Quality Work Group.
Water Resources/General:	
Inclusion of Snake Basin in study	Not included. Outside scope of SOR.
Accommodate M&I water requirements	Differentially addressed in alternative strategies.

1.2.1 Irrigation/M&I Issues Raised During the Public Review of the Draft EIS – and Disposition

Comments received on the Draft EIS and the responses are contained in a separate volume to the final EIS.

The essence of public review comments (written and oral) on the Draft EIS regarding irrigation/M&I involved the estimated impact on irrigation and M&I users (pumpers) on the 4 lower Snake reservoirs and John Day. Comments expressed the view that users of these reservoirs, including the local economies, were bearing too large a portion of the costs to save anadromous fish species in the Pacific Northwest. Several comments suggested the Draft EIS analysis understated the economic impact on irrigation.

In regard to those comments directly related to the irrigation/M&I analysis, for the Final EIS analysis : 1) the list of irrigation and M&I pumpers was re–inventoried and resulted in the addition of one pump station on the John Day pool and refinement of data on several other pump stations, 2) O&M costs for pumpers on the 4 lower Snake River projects was increased over that used in the Draft EIS analysis, 3) Modification cost estimates for all stations were reevaluated and revised where necessary, and 4) the farm income analysis used in the Draft EIS analysis was deleted, and a cost–of–pumping analysis was utilized.

In addition to the measurement of impacts, Chapter 5 contains a discussion about the economic viability of reservoir pumpers under drawdown scenarios.

1.3 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

The Irrigation/Municipal and Industrial Work Group included agency staff from Reclamation, BPA, Corps, staff from state and other Federal agencies, individuals with irrigation and environmental interests, and water and land use experts from private firms and state universities. There were two levels of participation: (1) Active participants that attended work group meetings and accepted work tasks associated with the study effort; and (2) Those who did not attend meetings but requested copies of meeting notes and other study materials.

1.3.1 Study Scope of Irrigation/M&I Functions

Changes in the operation of the Federal storage and power system can have a direct and indirect impact on the irrigation and M&I functions. Irrigation and M&I entities pumping from or otherwise utilizing, reservoir pools on the lower Snake and Columbia rivers are directly affected by the manner in which the system is operated, especially by those alternatives with proposed reservoir drawdowns. The modification of pump facilities and the increase in electrical energy required to pump water to meet the accustomed water uses is considered a direct impact. A change in the energy rate charged for electrical energy or a change in grain shipping cost due to changes in the system operation is considered an indirect result of the altered system operation.

The impact on irrigators from lowered water elevations in the affected reservoir pools is evaluated in Chapters 4 and 5. Direct impacts to irrigation interests were evaluated by estimating the increased pumping cost. Chapter 3 identifies study methodology.

The change in pumping cost experienced by M&I users was also quantified. For purposes of this report, it is assumed the increased costs to secure a water supply for M&I purposes will be absorbed by the users and no further analysis, such as a net returns analysis, will be required.

The indirect impact of a changing power rate on all sectors or industries in the PN, including irrigation and M&I, stemming from alternative operating strategies was analyzed by the Economics Work Group. These impacts are on an industry or sector basis (agriculture, metals, etc.) and will include those impacts on irrigation and M&I pumpers in the impact area directly affected as well as in the Columbia River Basin.

1.4 SCREENING PROCESS

The purpose of screening was to identify an array of alternatives for further analysis in the DEIS. The process was a simplified analytical approach that attempted to examine all possible operating alternatives. The work groups for each functional area were responsible for identifying alternative Columbia River system operational scenarios which were favorable to their particular function. From this process and additional scenarios from project management and other sources, a total of 90 alternative scenarios were developed and included in the screening process.

1.4.1 Selection of Irrigation/M&I Alternatives

The I/M&I Work Group, as did other work groups, developed reservoir operations alternatives that would be favorable to these two purposes for the present level of development and for projected development 10 years and 30 years hence. Optimum conditions for irrigation would be full reservoirs from April to October (growing season), while the optimum for M&I would be full reservoir year round.

The I/M&IWG formulated three alternatives that are favorable to Irrigation, including two that assumes an increase in the irrigated acreage of the Columbia River Basin. Alternatives No. 62 and 63 assume increased irrigation depletions of 890,000 (1,098 million cubic meters) and 2.6 million acre feet (3,208 million cubic meters) respectively due to projected increases in the irrigated acreage. Alternatives (62. IRR–OPT1), (63. IRR–OPT2), and (64. IRR–OPT3) are described in detail on pages 37 and 38 of the "**Screening Analysis: A Summary**" document.[1]

A second set of alternatives assumes increased instream flows resulting from a decrease in irrigation diversions. The decrease in diversions and subsequent increase in instream flows in both the Columbia and the Snake Rivers could result from a combination of possible changes in water use and supply conditions. These include improved efficiency in the use of water, decreased consumptive use of water by crops or other plants, new upstream storage, use of uncontracted storage space, buy–back of existing storage rights, acquisition of natural flow rights, and/or lease option programs during low water years. Alternatives (65. RES–IRRFLO), (79. AMG–IRRFLO2), (89. RES–IRRFLO2), and (90. AMG–IRRFLO) are described in detail on pages 38, 40, and 41 of the "**Screening Analysis: A Summary**" document.[2]

1.4.2 Screening Process

For screening, each work group analyzed the effects of operational changes of the 90 alternatives on their particular function. Impacts to the irrigation/M&I functions were limited to reservoir pools on the lower Snake River and the Columbia River from Grand Coulee Dam down to John Day Dam. Cost curves reflecting additional capital investment and operating costs related to different pool elevations were developed for reservoir pools where the impact on irrigation and M&I withdrawals are expected to be greatest. Cost curves (spreadsheet) models were developed for the reservoir pools behind Grand Coulee, Ice Harbor, McNary, and John Day. A detailed description of the irrigation/M&I screening methodology is provided on pages 95 to 106 in Volume 1, "**Screening Analysis Volume 1 – Description and Conclusions, August 1992.**"[3]

Of the 90 alternatives, 21 have slight to significant adverse impact on the irrigation community. These (21 alternatives) involved drawdown and major target flow alternatives for enhancement of anadromous fish and other alternatives that include extensive and intensive irrigation water conservation/new storage/water right acquisition program. There are 52 alternatives that improve conditions for irrigation. All other alternatives (17 in number) had little or no impact on irrigation.

1.5 FULL–SCALE ANALYSIS

Although a total of 90 alternatives were initially analyzed in screening. These were blended into 10 alternative strategies based on the screening results. Following additional public review and input , the co–lead agencies consolidated the 10 strategies into the final 7 alternatives addressed in detail in Draft EIS.

For the Draft EIS these seven alternative strategies which had multiple component options resulted in a total of 21 operational options being evaluated in the full scale analysis. The results and tradeoffs for each resource area were contained in a draft technical appendix and summarized in the Draft EIS.

For the Final EIS analysis, several strategies were revised and several added resulting in 7 strategies being evaluated, including the Preferred Alternative. The seven strategies with multiple options resulted in a total of 13 operational options being evaluated in the Final EIS.

A description of the seven alternative operating strategies with multiple component options is contained in Chapter 4, Part 4.1.

The 13 alternative operating options are the subject of a detailed analysis of impacts, which is called the "full-scale" analysis. These options were evaluated by the various work groups for potential impacts to their area of interest, i.e., wildlife, fisheries, power, flood control, irrigation, etc. System hydrological studies called hydroregs, were prepared which simulates each reservoir's operation over the period of record. The hydroregs are the common denominator for evaluation by the various work groups.

The full scale analysis methodology for the irrigation/M&I function is described in Chapter 3, "Study Methods and Procedure," while the results of the analysis are presented in Chapter 4, "Alternatives and Their Impacts." The comparison of alternatives with the Base Case (SOS1A) and with the No Action Alternative (SOS2C) to determine incremental monetary impacts is presented in Chapter 5, "Comparison of Alternatives."

CHAPTER 2

IRRIGATION/M&I IN THE COLUMBIA BASIN TODAY

2.1 INTRODUCTION

Included in this chapter is a general overview of irrigation in the Pacific Northwest, including a tabulation of irrigated acres, irrigation depletions and diversion, by hydrologic basin, and a summary of state water rights as related to issues raised by the public during the scoping process.

Characteristics and conditions of the irrigation and M&I water users in the areas potentially affected by the operation of the Federal system are described. Although irrigation occurs throughout the Columbia River Basin, the irrigation and M&I characteristics and conditions for water users located outside the potentially affected area are not described.

2.2 OVERVIEW OF IRRIGATION/M&I IN THE PACIFIC NORTHWEST

2.2.1 Irrigation Today

Agriculture, including the production from irrigated lands, is an important industry in the economy of the Columbia River Basin. In 1991, crop and livestock sales amounted to $9.7 billion in the region, excluding British Columbia. In addition to the direct effect of these sales on the region's employment and income, the regions' economic base is enhanced. The enhancement results from the induced and stemming impacts generated by the processing, shipping and handling, and transportation of agricultural products, as well as the provision of production inputs to agricultural producers. A vast network of supporting infrastructure has been built up around the production of food and fiber in the region.

Water is one of the regions most important natural resources. In 1989–1990 the irrigated acreage for the Columbia River Basin (including British Columbia) was 7,324,300 acres (2,964,000 hectares), or approximately 4 percent of the regions total area. This acreage includes full and supplemental irrigation service to lands that range from relatively low intensive meadow hay production at high elevations in Idaho, eastern Oregon, and western Montana to intensive irrigation of fruits and vegetables in southern Idaho, Yakima Valley, Willamette Valley, central Washington, Columbia River corridor, and other areas. Idaho has the largest irrigated acreage with approximately 3.33 million acres (1.33 million hectares), while Washington and Oregon have 1.879 million and 1.317 million acres respectively (0.76 million hectares and 0.53 million hectares). Table 2–1 displays the distribution of irrigated acres in the region, including British Columbia, Canada.

Climate is perhaps the most important environmental factor in the region affecting irrigation and its potential. Annual precipitation and the length of the growing season varies widely over the region. Annual precipitation averages 28 inches (711 mm) over the region. However, many of the irrigated areas receive less than 15 inches (381 mm) per year. Precipitation generally increases with elevation. Much of the irrigation practiced in the region is dependent on the use of storage and diversions from rivers and streams, although a significant amount of irrigation occurs from groundwater wells.

Irrigation in the region is practiced over a wide range of agronomic conditions and with varying intensity. The value of crop production in the region can range from $6,000 per acre for high yielding apple and grape orchards with capital intensive drip or solid set systems to $150 per acre for meadow hay–pasture production at high elevations utilizing subirrigation or wild flooding.

Table 2–1. Irrigated Acreage By State – Columbia River Basin

State/Province	Acreage	Percentage
Idaho	3,332,200	45.5
Montana	433,700	5.9
Washington	1,878,900	25.6
Oregon	1,316,600	18.0
Wyoming	94,100	1.3
Utah	5,600	.1
Nevada	70,400	1.0
Total United States	7,131,500	
British Columbia	192,800	2.6
Total for Region	7,324,300	100.0

2.2.2 History of Irrigation in the Region

The biggest stimulus to agricultural development in the region was the discovery of gold and the resulting influx of people requiring food and shelter. With the miners came farmers and cattlemen. Dryland grain and forage production became the most common form of farming, especially in the Willamette Valley of Oregon. However, because vast amounts of land located in the arid area east of the Cascades could not support dry–farming, farmers turned to irrigation. The earliest practice of irrigation in the region was on a small scale by several Indian tribes, including those in the Yakima Valley.

From the beginning of white settlement, individuals and private companies diverted water from streams. Because of the distance from water supply sources the appropriation doctrine of water use was developed and served the region well.

From the early small diversions from streams to irrigate food crops and to produce feed for livestock, irrigation expanded to nearly a half million acres in 1900. Irrigation expanded rapidly after that to 2.3 million acres (0.93 million hectares) by 1910. Irrigation grew to 3.5 million acres (1.41 million hectares) in 1928, to 6.5 million acres (2.63 million hectares) in 1966, to 7.5 million acres (3.03 million hectares) in 1980, a then decreased slightly to the present 7.3 million acres (2.95 million hectares) in 1990.[4]

Many acts of Congress were made to encourage settlement and development of the west, including the Pacific Northwest. These acts included the Donation Land Act 1850–1855, the Homestead Act of 1862, the 1877 Desert Land Act, the Cary Act of 1894, and the 1902 Reclamation Act. Congressional land grants to railroads opened up additional parts of the public domain to development. The railroads provided the needed transportation for farm commodities and livestock. While private enterprise developed a substantial acreage of land in the region, is was apparent by the 1890's that further development would require a strong and active role by the Federal government. The 1902 Reclamation Act provided the authority and funding for the comprehensive development of river basins in the west. Of the 7.3 million acres (2.95 million hectares) irrigated in the region, lands receiving Reclamation water or utilizing Reclamation constructed systems to transport water accounted for approximately 3 million acres (1.21 million hectares) in 1990. In addition, powerplants at Reclamation dams provided the necessary low cost power required to pump water to land areas not reachable by gravity diversions alone.

2.2.3 Characteristics of Agriculture, Production and Value

All portions of the region have some irrigation. The major blocks of concentrated irrigation are located in the Yakima Valley, Boise and Payette valleys, along the Snake River Plain in southern and eastern Idaho, central Washington, north central Washington, the Deschutes basin, and lands adjacent to the Columbia River near the Tri–Cities area. There have been extensive private irrigation developments pumping from the McNary, John Day, and Ice Harbor dam pools.

Irrigated farming is usually characterized by a fairly high degree of diversification and intensive land use. There is no "average" irrigated farm that is representative of the region. In addition, many areas contain irrigated farms that are less than full–time operations on which the owner does not rely for his/her total income.

Commercial family farm size can range from a 40 acre (16 hectares) apple orchard to a 640 acre (259 hectares) cash–grain row crop operation. In addition, there are large size commercial or "corporate farms" that may irrigate thousands of acres. The largest of these are located along the Lower Snake River and immediately downstream below the confluence with the Columbia River. These particularly large operations may contain 10,000 to 20,000 thousand acres (4,000 to 8,000 hectares), and utilize complex high–tech irrigation pumping systems to deliver water to center pivot irrigation systems.

It is of particular interest that center pivot irrigation systems have enabled the irrigation of lands, especially large blocks along the Columbia River, along the Snake Plain, and in central Washington. These lands due to soil texture and topography, would have been classified as nonirrigable under gravity or rill irrigation. Soils in these areas are highly sandy with a low water holding capacity. As such, during the peak irrigation season these soils need water applied as often as every 3 to 4 days, which is impractical under gravity systems. Center pivot systems are able to deliver water at the necessary intervals and at graduated amounts to insure proper plant growth, provide plant cooling, and prevent soil erosion by wind during critical periods.

Production from irrigated land accounts for a substantial portion of the total crop production in the region. The production of some crops like potatoes, sugar beets, hops, mint, and fruit is almost exclusively from irrigated lands. Table 2–2 demonstrates the importance of irrigation and shows total crop production in Washington, Oregon, and Idaho in 1987 as well as the portion estimated to come from irrigation.

The region is the leading producer of many crops grown in the United States. Washington is the leading U.S. producer of apples, asparagus, hops, lentils, concord grapes, sweet cherries, spearmint oil, and pears. Idaho is the leading state in the production of potatoes and second in sugar beets. Oregon leads in the production of peppermint oil and ranks very high in the production of processing vegetables.

2.2.4 Future Increases In Irrigation

It is estimated that the region contains approximately 33 million acres (13.4 million hectares) that are potentially irrigable. These lands have favorable soils, topography, drainage, and climate which makes them suitable for irrigation. However, many of these lands have little or no prospect of irrigation and are better suited to other uses. The Irrigation and M&I Work Group considered possible future increases in irrigated acreage and concluded that only the 87,000 acres (35,200 hectares) currently being studied for irrigation development as part of the existing Columbia Basin Federal Reclamation Project be included as a projected future development. The existing food and fiber supply/demand situation, budget constraints, environmental restrictions, and financial feasibility of Federally sponsored irrigation developments precludes further projected

Table 2–2. Crop Production in Washington, Oregon and Idaho, and the Portion of Production from Irrigated Lands

Crop	Selected Major Commodities		
		Total Production For 3 States [1]	Percent of Total From Irrigated Lands[2]
	Units	Production	Percentage
Corn for grain	Bu.	14,134,000	86.9
Wheat	Bu.	249,907,000	31.0
Potatoes	Cwt	178,452,000	99.0
Hops	Lbs	14,457,000	100.0
Mint, Oil	Lbs	5,748,000	100.0
Hay, alfalfa & mix	Tons	8,480,000	63.7
Vegetables	Acres	331,000	73.2
Orchards	Acres	346,000	85.0
Sugar beets	Tons	4,710,000	100.0

1/Source: 1987 Census of Agriculture data for Idaho, Oregon, and Washington. Data exclude western Montana, and portions of the basin in Wyoming, Utah and Nevada – not able to disaggregate data from total for state.

2/Source: Percentages are estimates utilizing 1987 Census of Agriculture, including the 1988 Irrigation Supplement with 1988 data.

increases in development. As with any economic sector, the irrigation acreage in the region varies annually depending on economic conditions in the agricultural sector, national economic conditions, water supply as well as other considerations.

2.2.5 Use Of Water

Irrigation diversions from the regions streams, rivers, and reservoirs is a function of the crop consumptive use requirement, delivery system losses, and on–farm losses, including application efficiency. Net irrigation depletions, essentially diversions minus return flows, is the more meaningful indicator to system operations because the residual water is the actual amount available to benefit other uses, including the power system. Return flows are available for hydro power generation, fish flows, etc. and need be accounted for in flood control operations. On–farm and system operational efficiencies vary widely over the region. Irrigation application methods have changed significantly in the region.

Sprinkler application essentially started with the introduction of light weight sprinkler pipe in the 1940's and continues to be utilized. With the introduction of wheel roll systems, and especially center pivot irrigation technology, the conversion from gravity to sprinkler application accelerated in the late 1960's and 1970's. Essentially all new irrigation development since the mid 1970's has utilized sprinkler application. Center pivot technology has allowed irrigation of lands that previously would be non–irrigable because of topography, field size, and water holding capability. In certain areas gravity application remains a highly viable and efficient method of application. It is estimated that 43 percent of the irrigation in the region is with gravity systems and 57 percent with sprinkler systems.

The science of irrigation application technology has steadily progressed to where it now includes satellite technology to transmit agricultural and meteorological data to irrigators to improve water management and reduce energy use. Crop water use infromation networks such as AgriMet have been developed to assist irrigation districts and individual irrigators to schedule irrigation, improve application efficiency, and conserve energy.

Total irrigation diversions in the region were 32.56 million acre–feet (40.2 billion cubic meters) for the 1990–1991 base level of development, but with a net depletion 13.73 million acre–feet (16.9 billion cubic meters). Table 2–3 summarizes irrigation diversions and depletions for the hydrologic basins in the region for the 1990–1991 base level of development.

2.2.6 Municipal and Industrial Water Supply

The current level of M&I depletions were not considered to be significant in the measurement of impacts under SOR alternative operating strategies. Approximately 90 percent of the total water withdrawn in the Pacific Northwest is for irrigation. Public water supply and domestic use account for about 4 percent, commercial use about 2 percent, and industrial use about 2 percent. The remaining amount is shared by livestock, mining, and thermoelectric. Water withdrawn for nonagricultural use has a higher return rate than for agricultural uses. Accordingly, total depletion for the M&I uses is estimated at less than 2 percent.[1]

2.3 IRRIGATED ACREAGE AND WATER RIGHTS

2.3.1 Irrigated Acreage

Information about the irrigated land base and the water depletions, due primarily to irrigation activity, is useful in the management of the Columbia River System and provides data for administration of the Canadian Entitlement Allocation Agreement. Under the auspices of the Pacific Northwest River Basins Commission, a detailed tabulation of irrigated acreage within the Pacific Northwest was completed for 1980.

Table 2–3. Irrigation Diversions and Net Depletions by Basin [1]

Hydrologic Basin	Irrigation Diversion Acre–Feet	Net Irrigation Depletion Acre–Feet
Upper Columbia & Kootenai	179,260	113,580
Clark Fork–Pend Oreille & Spokane	1,287,000	768,600
Columbia Plateau, East Cascade, & Yakima	5,632,370	3,425,050
Upper Snake River	14,365,500	4,661,060
Central Snake River	7,545,580	2,623,520
Lower Snake River	849,010	533,490
Mid Columbia	2,352,610	1,334,920
Lower Columbia	59,020	22,300
Willamette	290,670	231,870
Total	**32,561,060**	**13,734,400**

[1]/Source: "Draft USBR/BPA, Columbia River Basin, System Operation Review, Irrigation Depletion Estimate, September 10, 1993, prepared for Bonneville Power Administration by A.G. Crook Company.

An update of the irrigated acreage and irrigation diversions and depletions for the Columbia River Basin was prepared for BPA. The report entitled "Modified Streamflows – 1990 Level of Development, Columbia River and Coastal Basins, 1929–1989" identifies irrigated acreage, and irrigation diversions and net depletions by hydrologic basin. The I/M&IWG assisted in identifying data sources and collecting and verifying data used to update the irrigated acreage base. Table 2–4 shows irrigated acreages in the Columbia River Basin by state and province for the 1989–1990 period. A more detailed discussion of irrigated acreages, application methods is maintained by the Bureau of Reclamation as a supporting volume to this appendix.

2.3.2 Irrigated Acreage by River Section of Columbia River

The county data for each of the four states were combined into subregions and subareas, each containing one or more tributary basins to the Columbia River. The areas are defined by logical drainage basin areas. Where a county is located in two or more subareas the division of acreage between subareas is based on the proportionate relationship identified in the 1980 Pacific Northwest River Basins Commission report or current information, if more appropriate. Portions of Wyoming, Utah, Nevada, and British Columbia that are also in the Columbia River Basin were included in the tabulation.

There is an estimated 7.3 million irrigated acres (3 million hectares) in the Columbia River Basin. Of this, 46 percent is in Idaho, 18 percent in Oregon, 26 percent in Washington, 6 percent in Montana, and the remaining 4 percent in Nevada, Utah, Wyoming, and British Columbia. The following table shows the irrigated acreage by state and for British Columbia for major segments of the river reaches within the Basin.

Table 2–4. Irrigated Acreage in Columbia River Basin By State – 1989–90

State or Province	Above Grand Coulee	Grand Coulee to Mouth of the Snake	Above Ice Harbor Dam	Ice Harbor Dam to Bonneville Dam	Below Bonneville Dam	Total Irrigated Acres
Idaho	25,800	0	3,306,400	0	0	3,332,200
Montana	433,700	0	0	0	0	433,700
Washington	60,600	1,509,800	77,300	207,900	23,300	1,878,900
Oregon	0	0	502,000	531,500	283,100	1,316,600
British Columbia	89,700	103,100	0	0	0	192,800
Wyoming	0	0	94,100	0	0	94,100
Utah	0	0	5,600	0	0	5,600
Nevada	0	0	70,400	0	0	70,400
Total Acres	**609,800**	**1,612,900**	**4,055,900**	**739,400**	**306,400**	**7,324,300**

2.3.3 Water Rights – Irrigated Agriculture

This section is a summary of state water rights pertaining to irrigated agriculture in the Pacific Northwest. This discussion responds to issues raised during the public scoping process and to increased interest in the possible transfers of water from irrigated agriculture to alternative uses such as instream flows. As pointed out previously, it is beyond the scope and authority of SOR to propose to limit or diminish existing irrigation water rights held by irrigation districts, individuals, and other entities.

The summary discussion follows. A more detailed discussion of water rights, which is the basis for the summary is maintained by the Bureau of Reclamation as a supporting volume to this appendix.

a. The water codes and water laws in each of the Pacific Northwest states are very similar. Each of the states has adopted the appropriation doctrine as the basis for its water right law. This doctrine is well suited for conditions in these states. Water rights vested under the riparian doctrine are recognized in Oregon and Washington, but it is assumed that these, or other claims to vested water rights are not significant for purposes of this study.

b. The administration of water law is centralized in an agency or entity of state government (e.g., department of water resources or state engineer). Montana was the last of the Pacific Northwest states to adopt the centralized system in 1973. Administrative procedures of each state are similar. Increasingly, alternative uses such as instream flows are being recognized under the water right codes of each of the Pacific Northwest states.

c. Most streams in the Pacific Northwest are fully or over appropriated. The water code of each state allows for court adjudications. These adjudications settle disputes among users, provide a means of legally terminating unused water rights and provide a means of accommodating and settling claims to vested rights or Federal reserved water rights. A number of major adjudications are under way, including: the entire state of Montana, the upper Snake River in Idaho, and the Yakima River in Washington.

d. All of the Pacific Northwest states allow water transfers. A cornerstone of the water codes in this regard is that third party water right holders are protected from injury due to water right transfers. As a result, the transferable quantity is almost always limited to the historic consumptive use (evaporation and transpiration). Generally, in the Pacific Northwest, indirect or third party impacts are not recognized. An exception to this is that the State of Idaho requires that any water transfer be evaluated against its impact on the agricultural economy of the area, specifically the farm sector. Also, Washington State Department of Ecology may deny or condition transfers to protect the public interest or to assure maximum net benefits. The transfer process generally includes public notice and otherwise meets established legal and administrative requirements. The determination of the historical consumptive use can often be complicated and expensive. In contrast, temporary water transfers, usually in time of drought, offer considerable flexibility toward solving water supply problems and are considerably easier to effect.

e. A newly evolving area of water right law involves water conservation. The courts have consistently found that water users do not have a right to waste or use water in unreasonable ways. On the other hand, nonuse leads to the loss of the water right. As it is often put: "Eternal vigilance is the price of a good water right!" Consequently water is often diverted when it is not absolutely needed. Oregon has a water law that provides a significant incentive to encourage water salvage through conservation. The water banking allowed in Idaho offers some promise as well, although presently the process is restrictive. Washington's trust water rights program allows for salvaged water to be acquired by the state without loss of priority date and reallocated for public benefit. Incentives to participate are provided by state and federal cost sharing programs.

f. Federal reserved water rights must be integrated into the various states' water appropriation system. Until this is accomplished there will remain considerable uncertainty about the worth of the previously established state water rights. Many Federal water rights, unused and undefined, have been dormant and will be superimposed on the states' priority system. A Federal right that was never used could very well have the highest priority in a river basin and depending on its quantity, could render many established water rights relatively worthless.

In conclusion, it is apparent that legal constraints exist to obtaining and transferring water from agriculture to other alternative uses. Considerable progress has been made along this line; alternative uses such as instream flows for fish are now officially recognized as a beneficial use. Oregon's recent legislation covering water salvaged from water conservation, Idaho's water banking and Washington's trust water rights program are other examples. However, without further changes in the water codes of the Pacific Northwest states it will remain difficult to transfer substantial amounts of water from irrigated agriculture to alternative uses.

2.4 IRRIGATION AND M&I ISSUES – BASIN-WIDE AND AT SPECIFIC LOCATIONS

2.4.1 Introduction

Analysis of SOR operational options indicates that six reservoirs would experience lowered reservoir pools under at least one of the options. The reservoirs by name of dam are: (1) Grand Coulee, (2) Lower Granite, (3) Little Goose, (4) Lower Monumental, (5) Ice Harbor, and (6) John Day. Although irrigation and M&I water use occurs at many locations and reservoirs in the Columbia River Basin, only the six FCRPS reservoirs affected by SOR alternative strategies are included in the impact analysis.

Irrigation water is pumped from reservoirs behind Grand Coulee, Ice Harbor, and John Day dams. M&I water, and related ancillary water, is utilized from all six reservoirs.

2.4.2 Grand Coulee (Lake Roosevelt) – Irrigation

Grand Coulee Dam located in north central Washington on the Columbia River (river mile 596.6) impounds Lake Roosevelt (FDR), which has an active capacity of 5,185,000 acre–feet (6.4 billion cubic meters). The powerplant has a total nameplate capacity of 6,494 MW making it one of the largest in the world. Power generation in excess of that needed to pump water for irrigation, is delivered to BPA for sale to wholesale customers. The dam is part of the Federally authorized Columbia Basin Project, a multipurpose project constructed by the Bureau of Reclamation with the authorized purposes of power, flood control, irrigation, and navigation. An extensive system of irrigation pumping plants, canals and laterals, storage reservoirs, and a drainage system has been constructed to serve the authorized irrigation acreage. The project supplies water to approximately 557,500 acres (225,600 hectares) in Grant, Adams, and Franklin counties, Washington. In addition, approximately 97,000 acres (39,300 hectares) are served by interim water service contracts, ground water licenses, or other arrangements.

Water is delivered to project lands via a pumping plant located on the south side and immediately upstream of the dam. The pumping plant lifts water approximately 300 feet (91 meters) from FDR to Banks Lake, an offstream equalizing reservoir with an active storage capacity of 715,000 acre–feet (882 million cubic meters). The pumping plant consists of 12 units, units 1–6 (P1–6) are pumping units only, while units 7–12 (P/G7–12) are pump–generating units. As such, the P/G units can pump water as well as generate electricity, in which case water is returned from Banks Lake to FDR.

From Banks Lake water is supplied to irrigation water users, represented by three irrigation districts, which have contracted with the United States for a water supply. The Columbia Basin Project is authorized to irrigate approximately 1,095,000 acres (443,100 hectares). With 557,500 acres (225,600 hectares) currently irrigated, irrigation of the remaining authorized acreage has been the subject of numerous investigations and feasibility studies. In the late 1970's a second conveyance facility called the Bacon Siphon and Tunnel No. 2 was constructed in anticipation of irrigation of the remaining acreage and to alleviate peak delivery shortages of the Bacon Siphon and Tunnel No. 1. The expansion or development of the second half of the project was evaluated in a draft EIS published in September, 1989 and a supplement to the draft published in September, 1993. Work on the final EIS was discontinued in 1994.

The Columbia Basin Project being endowed with favorable soils, climate, and water supply produces a wide variety of crops, and generated approximately $550 million in crop sales (farmgate value) in 1992. The production of these crops generates additional income and employment in Washington that are induced and/or stemming from processing, shipping, and the provision of inputs utilized by farmers in production. In addition to irrigation and power benefits, recreation and fish and wildlife opportunities are significant in the area, the result of numerous water bodies created by the project, slack water on FDR, and habitat development from irrigation, and return flows. Figure 2−1 is a picture showing Grand Coulee Dam, Lake Roosevelt in the foreground, pump−generating plant and feeder canal to Banks Lake, and Banks Lake in the background. Figure 2−2 is a map showing the location of Grand Coulee Dam and the irrigated lands of the Columbia Basin Project.

SOR alternative operating strategies that lower the level of FDR during the irrigation (pumping) season increase the pumping cost because of the increased pumping head to Banks Lake, i.e., additional electrical energy is needed to run the pumps. Individual irrigators pay pumping cost including additional pumping through their representative irrigation district.

2.4.3 Grand Coulee – M&I

Minor amounts of water are pumped from FDR Lake and from nearby bank storage, at several locations on the lake and reservoir. The water is used for M&I and small tract irrigation. Due to the minor amount of water involved and the potential impacts, these installations were not included in the impact analysis.

2.4.4 Lower Granite, Little Goose, and Lower Monumental

Lower Granite, Little Goose, and Lower Monumental dams are located on the Snake River at river mile 107.5, 70.3, and 41.6 respectively. The three are run−of−river projects constructed by the Corps of Engineers. The authorized purposes for all three projects are power, navigation, recreation, fish and wildlife, and irrigation. As run−of−river projects, the reservoir level fluctuations are kept to a narrow range, although in recent years have been operated at or near minimum operating pool (MOP) during parts of the spring and summer to minimize salmonid smolt travel time through the reservoir.

M&I Water Use

M&I pumping installations at these reservoirs include Corps of Engineers wildlife pumps, a sand and gravel operation, Whitman county Parks, Clarkston golf course, Washington State Parks, and Idaho State Parks. A total of nine installations are located on Lower Granite pool, two on Lower Monumental, and two on Little Goose.

2.4.5 Ice Harbor — Irrigation

Ice Harbor Dam is located on the Snake River at river mile 9.7 and the reservoir (Lake Sacajawea) extends upstream approximately 32 miles (51.5 kilometers). Ice Harbor was constructed by the Corps of Engineers with the authorized purposes being power, navigation, recreation, fish and wildlife, and irrigation. Ice Harbor is a run−of−river project like Lower Granite, Little Goose, and Lower Monumental. Reservoir level fluctuations at Ice Harbor are kept to a narrow range, although in recent years the reservoir has been operated at or near MOP during parts of the spring and summer.

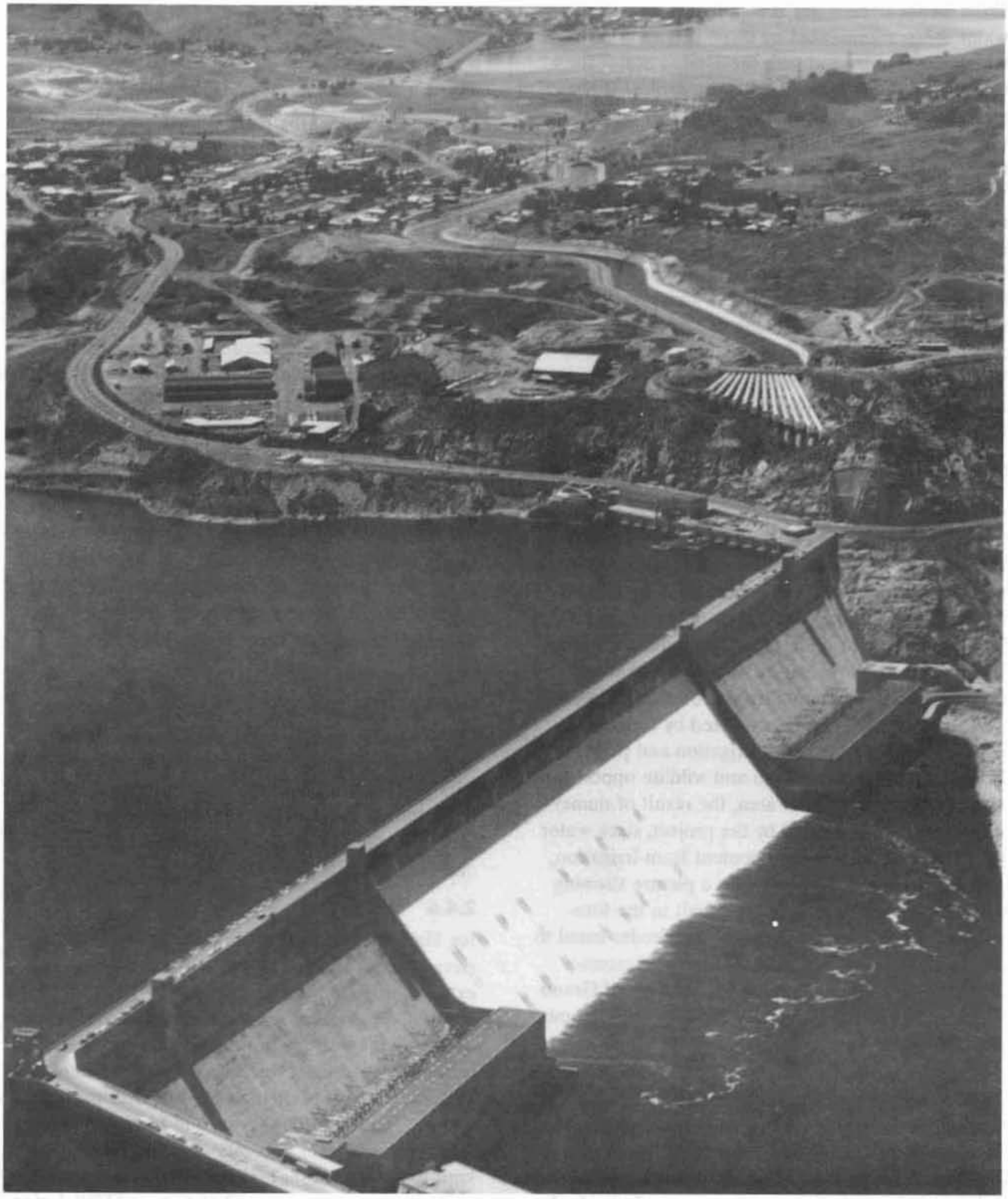

Figure 2–1. Grand Coulee Dam

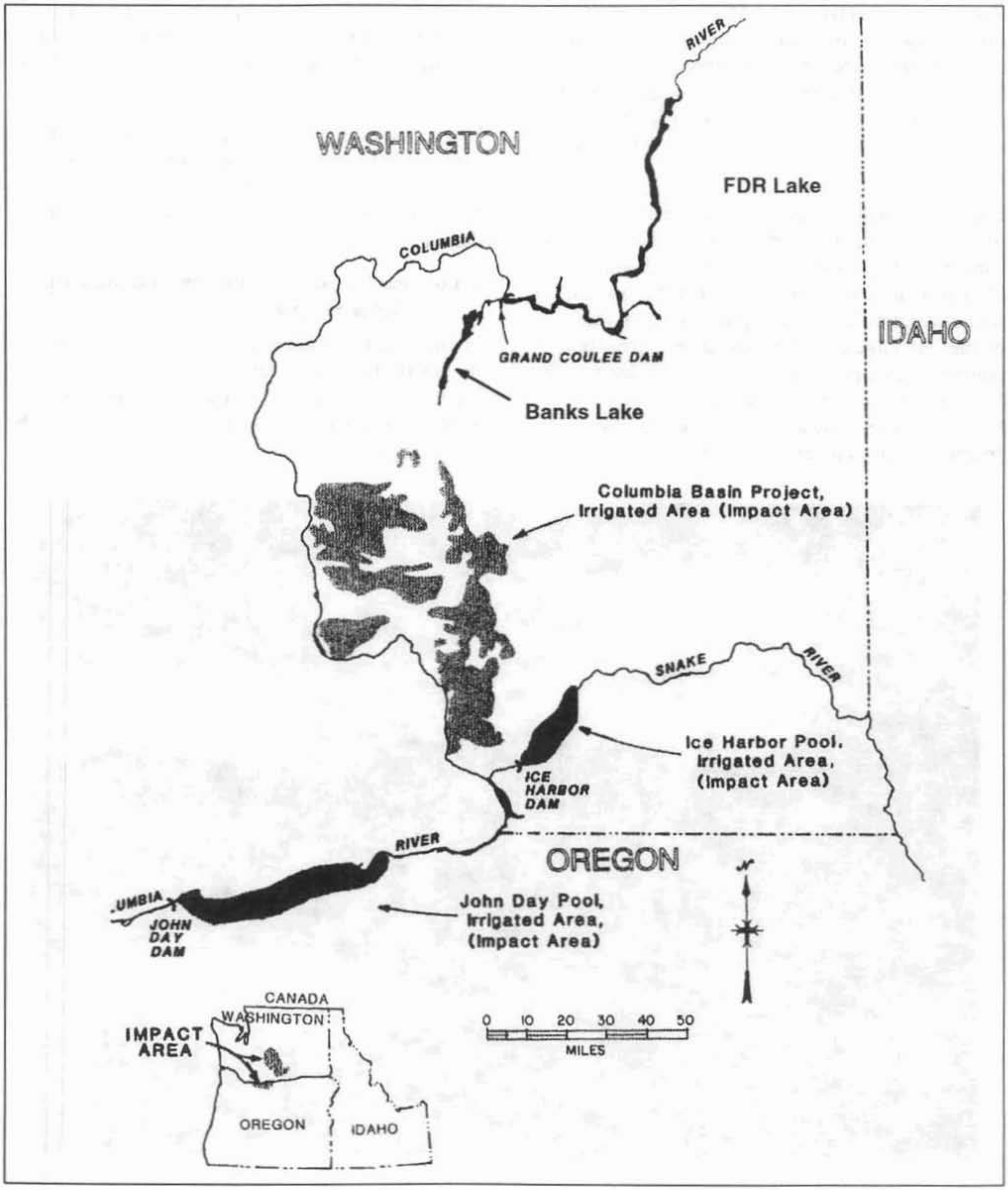

Figure 2–2. Irrigated Impact Areas

Since the construction of Ice Harbor Dam in the early 1960's, private entities have funded the irrigation of lands adjacent to the reservoir in Franklin County (north side) and Walla Walla County (south side). Figure 2–3 shows a typical irrigation pumping plant located on the Ice Harbor or John Day pool.

Figure 2–2 shows the general location of the lands irrigated from the Ice Harbor pool. A tabulation by consultants to the Corps of Engineers identified 13 irrigation pumpers irrigating 36,389 acres (14,700 hectares) from the reservoir pool. Many of these entities are large corporate operations. Irrigation pumpers utilize pumping plants or collection systems located on the reservoir bank to pump water to lands lying essentially adjacent to the reservoir. Irrigation entities pumping from reservoir pools utilize natural flow water rights permitted or granted by the Washington Department of Ecology as well as easements and permits issued by the Corps of Engineers.

Five of the 13 SOR operating options contain proposals to lower the Ice Harbor reservoir pool which would affect irrigation pumping by increasing the pumping lift (head) and necessitating the modification of pumping plants.

2.4.6 Ice Harbor — Municipal and Industrial Water Supply

In addition, to commercial irrigation pumping from the Ice Harbor pool, a total of three pumps used by the Corps of Engineers to irrigate wildlife habitat would be affected by SOR alternatives that lower the reservoir pool.

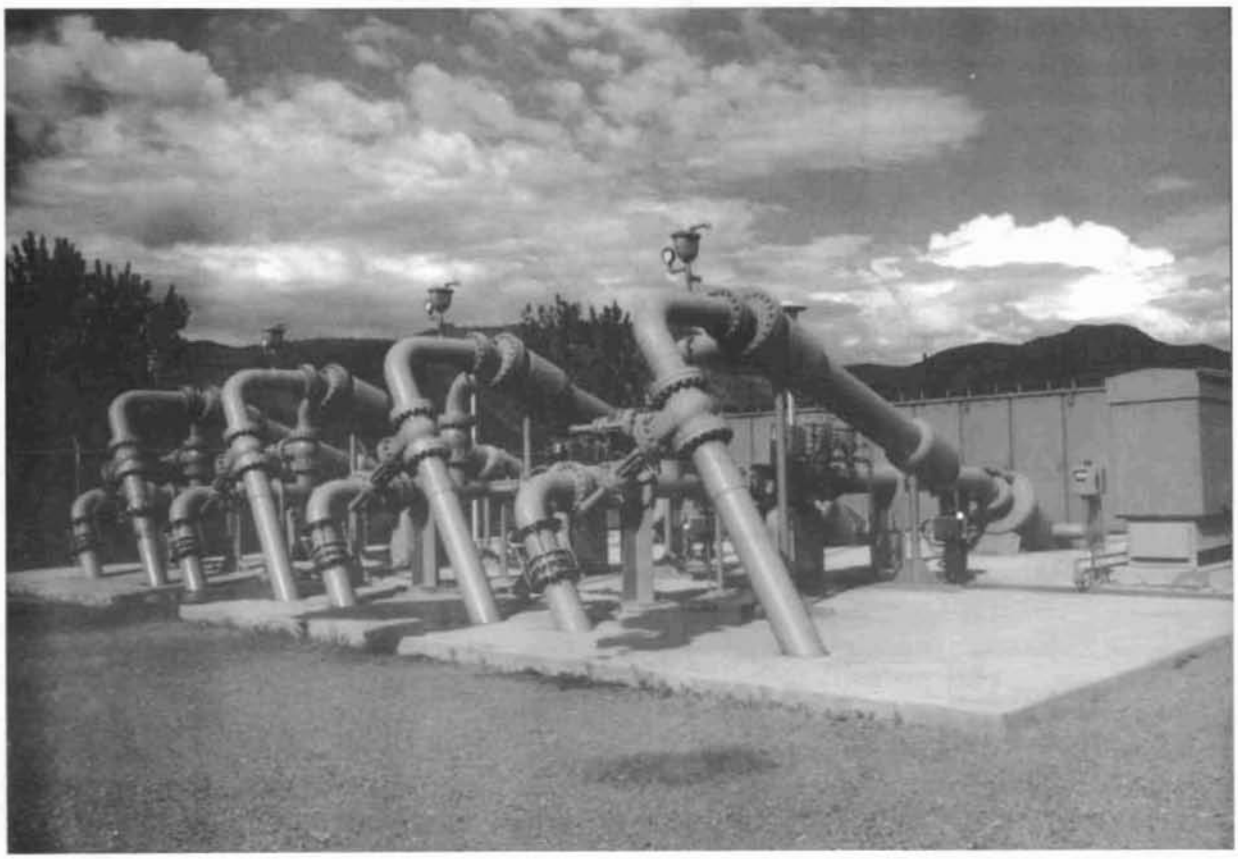

Figure 2–3. Typical Irrigation Pumping Plant

2.4.7 John Day — Commercial Irrigation

John Day Dam is located on the Columbia River at river mile 347 and the reservoir extends upstream to McNary Dam. The dam was constructed by the Corps of Engineers for the authorized purposes of power, recreation, navigation, flood control, irrigation, fish and wildlife, and water quality. The normal operating pool normally fluctuates between 265 feet (80.8 m) and 268 feet (81.7 m) during the irrigation season and between 260 and 265 feet at other times of the year. The reservoir has some flood control capacity although it is usually operated as a run–of–river project.

A significant amount of private irrigation has developed on the Oregon side (Sherman and Gilliam counties) and on the Washington side (Klickitat and Benton counties) of the reservoir. Figure 2–2 shows the general location of the lands irrigated from the John Day pool. A tabulation by consultants to the Corps of Engineers identified 25 irrigation pumpers irrigating 139,500 acres (56,455 hectares) from the reservoir pool. Many of these entities are large corporate operations. Irrigation pumpers utilize pumping plants or collection systems located on the reservoir bank to pump water to lands lying essentially adjacent to the reservoir.

Irrigation entities pumping from reservoir pools utilize water rights permitted or granted by Oregon Water Resources Department on the Oregon side and by the Washington Department of Ecology on the Washington side as well as easements and permits issued by the Corps of Engineers.

Seven of the 13 SOR operating options contain proposals to lower the John Day reservoir pool, including the Preferred Alterative, which would affect irrigation pumping by increasing the pumping lift (head) and necessitating the modification of pumping plants.

2.4.8 John Day — Municipal and Industrial Water Supply

In addition, to commercial irrigation from the John Day pool, non–commercial irrigation users, termed M&I users were identified that would be affected by alternative operating strategies. These M&I type uses include two fish hatcheries, city of Boardman water supply, city of Umatilla sewage treatment outlet, individual ground water wells located on the river bank, an aluminum plant, a school and dredging required at the mouth of the Umatilla River at the confluence with the Columbia River.

CHAPTER 3

STUDY METHODS AND PROCEDURE

3.1 OVERVIEW

This chapter identifies the study methods and procedures used to measure the monetary impacts of SOR alternative operating strategies on entities who pump from, or are otherwise affected by the operation of, reservoir pools on the Columbia and Lower Snake rivers. The analysis is called the "**full-scale analysis**." This chapter also references the results of the screening analysis as the product of formulated operating strategies identified earlier in the SOR screening process.

Along with a discussion of study methods and procedures, the germane assumptions and the parameters or constraints of study procedures are identified and addressed in this chapter.

3.2 SCREENING RESULTS AND SUMMARY

The results of the screening analysis, which was prior to the full-scale analysis are contained in "Screening Analysis: A Summary" and "Screening Analysis", Volume 1, Description and Conclusions, August 1992.

3.3 FULL SCALE ANALYSIS

The full scale analysis was made for each of the 13 SOR operating options, including the Prefered Alternative.

The full scale analysis of impacts on reservoir pumpers affected by alternative operating strategies is divided into two components: (1) The first is for irrigation pumping associated with commercial agriculture termed "commercial irrigation," and (2) The second component is for M&I users, which includes pumpers who utilize reservoir water for municipal and industrial purposes (M&I), water for fish hatcheries, Corps of Engineers pumping for recreation areas and wildlife habitat, irrigation of state parks, and other entites that would be directly affected by lowered reservoir pools.

Analysis of alternative operating strategies reveals that of the 14 reservoirs in the FCRPS six reservoirs would experience lowered pool levels impacting irrigation and M&I users. Those reservoirs are (by dam) Lower Granite, Little Goose, Lower Monumental, Ice Harbor, John Day, and Grand Coulee. Exhibit A contains a summary of the simulated hydrology studies, called hydroregs showing end of month elevations for the period of record for the six reservoir pools.

Pumping from reservoir pools for commercial irrigation was identified for three reservoirs – those behind Grand Coulee, John Day, and Ice Harbor dams. Pumping from Grand Coulee is almost exclusively by the Bureau of Reclamation which delivers water to irrigation districts of the Federally constructed Columbia Basin Project. There is some minor irrigation and M&I pumping from Grand Coulee (Lake Roosevelt or FDR) by individuals.

Irrigation water is pumped from John Day and Ice Harbor pools by private individuals or corporations. These entities utilize appropriative state water rights, and permits issued by the Corps of Engineers to irrigate lands adjacent to the two reservoir pools.

The full scale analysis utilized the increased pumping cost to measure impacts on irrigation resulting from reservoir drawdown for John Day, Ice Harbor pools, and Grand Coulee.

Impacts on M&I pumpers were also measured by determining the pumping plant modification cost, and the increased operation, maintenance, and pumping cost for those installations to obtain a total annual cost.

Power Rate Impacts on Pumping

Theoretically, reservoir drawdowns could adversely affect FCRPS power production causing power rate increases.

Increased pumping requirements associated with reservoir drawdown (increased lift) were evaluated at the existing power rates charged by the local utilities, and not at the induced power rate. The Power Appendix discusses potential power rate impacts on classes of power customers.

Discounting For Occurrence of Value

Because the SOR operating options have different implementation dates it was necessary to discount the annual occurrence of monetary measures for each alternative (pumping cost) to year 1 of the analysis, or 1995. This procedure, consistent with standard time value of money evaluation concepts, is necessary to insure that the comparison among SOR alternatives is on an equal basis. The Federal discount rate for fiscal year 1995 of 7.75 percent and a 3.0 percent "real" interest rate with a 100 year period of analysis was used to discount and amortize values to obtain an annual equivalent value.

The implementation, or on–line, dates for alternatives is listed below.

Alternative Strategy	Implementation Date
SOS1 & SOS2	1995
SOS4c	1995
SOS5b	2010
SOS5c	2000
SOS6b	2005
SOS6d	2000
SOS9a and c	2005
SOS9b	1995
Preferred Alternative	1998

3.3.1 Impact of Reservoir Drawdowns on Commercial Irrigation

3.3.1.1 Grand Coulee

The Bureau of Reclamation pumps water from Lake Roosevelt to Banks Lake an offstream reservoir, for use by irrigators who belong to irrigation districts served by the Columbia Basin Project in central Washington. In accordance with the project Congressional authorization, the electrical energy necessary to run the pumps (called project pumping) is furnished by project generation. On farm (or non-project) pumping requirements are obtained from local utilities. Electrical power to run the 12 pumps comes directly from the hydroelectrical power units at Grand Coulee. Project pumping is approximately 960 million kwhrs annually which is approximately 4.7 percent of the total generation at Grand Coulee (Coulee). Generation in excess of project needs is delivered and available for use by the Federal Columbia River Power System as operated by BPA. [5/6]

Currently, the Columbia Basin Project provides water to approximately 557,500 acres (225,600 hectares), which includes a small amount of lands served by pumping from the McNary pool. In addition, approximately 97,000 acres (39,250 hectares) are served by interim water service contracts, ground water licenses, or other arrangements.

The irrigation pumping requirement at Coulee for each of the 13 operational options was determined in mwhrs and monetized at the current repayment rate of .95 mills per kwh, which is based on the cost of operation and maintenance of power units 1–18 at Coulee.

The pumping requirement at Grand Coulee was modeled as a function of: (1) The amount of water pumped annually; (2) The head differential between Banks Lake and Grand Coulee, (3) The operating characteristics, including pump efficiency, for each of the 12 pumps available for pumping use, and (4) monthly (14 periods) pumping requirement (in mwhrs) for each year in the period of analysis, and (5) Variable power operations at Coulee in effect to optimize power generation. The model yields the monthly pumping requirement (in mwhrs) for each year in the period of analysis, 1929 through 1978. The 14 periods per year are consistent with the SOR hydroregs which splits April and August into 15 day periods – hence a total of 14 periods per year.

The major variable affecting the amount of water pumped is the irrigated acreage. The average historical monthly pumping requirement for the period 1988 through 1992 was utilized to reflect the current level of irrigation development and water use efficiencies. Because the elevation at Banks Lake varies only slightly during the pumping season and is not impacted directly by the SOR alternatives, the average monthly (14 periods) elevations for the 1988 through 1992 period were used to calculate head differentials between Banks Lank and FDR Lake. The hydroregs identified end of month elevations at FDR Lake for each SOR alternative. The pumping model utilized end of month elevations for each month of the 50 year period of record (1929 through 1978) in the determination of head differentials. Computations of pumping head reflect beginning–of–month to end–of–month data to derive the average for the month.

The first six pumping units at Coulee (P1–P6) are pumping units only, while the second six units (PG 7–12) are pump/generating units. The model reflects the difference in pumping efficiency over the differential head range between the pumping units and the pump/generating units, as well as the constraint, that the pump/generating units are not operated when the elevation at Coulee (FDR) is lower than certain prescribed seasonal elevations.

The summary of the pumping requirements and the monetization of that pumping at a rate of .95 mills per kwh ($.00095 per kwh) is shown in Chapter 4. Additional information is included in Exhibit A.

3.3.1.2 Ice Harbor and John Day Reservoirs

The impact on commercial irrigation pumpers affected by possible drawdowns of the Ice Harbor (Lake Sacajawea) and John Day (Lake Umatilla) pools was measured by estimating the increased pumping cost for each pump station.

Utilizing the estimated increased pumping cost as the measure of the impact was a change from the farm income methodology utilized in the Draft EIS analysis.

Other than Grand Coulee, John Day and Ice Harbor are the only reservoirs with irrigation pumpers affected by alternative strategies. Impacts on M&I users is described in section 3.3.2. Many of the SOR options have no effect on reservoir pool levels and thus there is no direct impact on pumpers.

The effect of lowered pool levels on reservoir irrigation pumpers is manifested by the increased cost to maintain the existing level of delivery. Pumping plants are operated and maintained by individual owners, and under reservoir drawdowns pumping plants would require modification in order to continue operation. In addition to pump modification, additional operation, maintenance, and power costs would be incurred. Pump modification cost estimates were prepared by the Corps of Engineers and private engineering consultants. Modification costs are necessary, in general, to lower the intake structure, extend the intake lines further into the reservoir pool, to dredge a channel to the intake line, or some combination of these.

Sources and Price Indexing

Modification costs were prepared to reconnaissance level of detail for all types of pump stations to the spillway and run–of–river elevation. Costs were price indexed to 1992 using the ENR Index.

Adjusting to Average Elevations

The hydroregs specify end of month elevations for the period of record. Average elevations for the month were calculated by using data for the beginning and end of month values. The resulting average elevation was used to calculate increased costs. It was not necessary to prepare a critical period analysis because the hydroregs show the reservoirs involved are drawn down to the same elevation for every month of the period of record.

Modification costs are assumed necessary when the water surface is lower than the present capability of the pumping station. Pump modification costs reflect the lowest drawdown month for the particular alternative based on the hydroregs. Interviews conducted by consultants with pump station owners identified the water surface level where each pump was affected. Estimates of pumping plant data were used where information was not available. Pump modification cost estimates for elevations between where the pump was affected and spillway height were interpolated, as well as for points between spillway and run of river elevations.

Increased Operation and Maintenance Cost

Operation and maintenance cost associated with the pump modification cost were estimated at 3 percent of the modification cost for John Day, and at 5 percent for the 4 lower Snake reservoirs.

Based on input received from pumpers and engineering consultants in the area, the O&M was increased from 3 percent in the Draft EIS to 5 percent for this analysis for the 4 lower Snake reservoirs. There is a lack of actual performance data for the operation of these pumping stations at lower pool elevations.

Increased Power Cost

Increased power costs were estimated using monthly water pumping requirements, local utility power rates, and estimates of the increased energy needed to pump from the lower water surface based on information developed by consultants.

Exhibit A contains supporting information developed by the Corps of Engineers regarding pump station information, including the development of cost data.

As a general rule, the agricultural operations of the Ice Harbor and John Day reservoir pumpers are characterized by very large farms, some of which are greater than 20,000 acres (8,000 hectares), high yields, a high level of irrigation management practices including center pivot irrigation systems, and large amounts of hired labor. Cropping on these lands is influenced by the high capital investment costs for pumping plants, plus above average pumping costs, and by soil texture. Subsequently, these operations depend on income from high value crops like potatoes, vegetables, and fruit, while accepting marginal returns (but enough to cover variable cost) from other rotational crops like wheat and corn.

Electrical power rates for irrigation pumping were the current rates for the areas in question. A rate of 29 mill per kwh was used for pumping from the Ice Harbor Pool which is based on the average irrigation rate charged by local utilities. For the John Day pool a rate of 25 and 33.5 mills per kwh was used for pumpers on the Washington and Oregon side respectively which are the current representative irrigation rates charged by local utilities.

Pump Modification Cost and Operating and Power Cost

Pumping plant modification cost, including the increased operating and power cost, was developed by the Corps of Engineers for the appropriate level of reservoir drawdown utilizing modification cost provided by consultants. The modification cost is only applied to those SOR alternatives with a proposed drawdown. Hydroreg studies indicate end of month elevations during the pumping season which is the essential variable on which modification and increased operating costs are based.

Modification cost to irrigation pumps were identified with Ice Harbor for SOR alternatives SOS5b, SOS5c, SOS6b, SOS9a, and SOS 9c and those plans plus SOS6d and the Preferred Alternative for John Day. Modification cost and the increased operating and power costs are shown in Table 3–1 for the applicable SOR alternative operating strategies.

3.3.2 Impact on M&I Users (Nonagricultural Irrigation and Other Uses)

In addition to commercial irrigation, other reservoir water users have been identified who would be impacted by proposed drawdowns of the six reservoir pools. These uses include conventional M&I water uses, plus fish hatcheries, parks, irrigation of wildlife habitat and several other entities who have operations on the reservoirs. As a group they are called M&I users for this analysis.

The impact of alternative operating strategies on nonagricultural and other entities pumping from reservoir pools was identified by estimating the pump modification cost and the increased operation and maintenance cost, including power. The number of users by reservoir pool who will be impacted by drawdown are identified as follows:

Reservoir Pool	Number of Pumpers Affected	
Lower Granite	9	• Sand and gravel company • Whitman County Parks – pumps • Clarkston golf course • Corps of Engineers pumps (3) • Washington State Parks – pumps • Idaho State Parks – pumps
Lower Manumental	2	• Corps of Engineers wildlife pumps
Little Goose	2	• Corps of Engineers wildlife pumps
Ice Harbor	3	• Corps of Engineers wildlife pumps
John Day	7	• (Fish hatcheries at Umatilla and Irrigon • City of Boardman water supply • City of Umatilla sewage treatment outlet • Individual ground–water wells • Dredging Umatilla River mouth • Aluminum company
Grand Coulee	0[1]	

1/ Minor amounts of water are pumped from Coulee (Lake Roosevelt) bank storage and directly from the reservoir at several locations. The water is used for M&I and small tract irrigation. A review of reservoir elevation changes indicates that pump modification cost would be very minor, if required at all, and with only minor increases in operating costs. The impacts were considered insignificant for this analysis.

The modification cost and the increased operation and maintenance and power cost for M&I users (nonagricultural irrigation and other reservoir pool water pumpers) are shown in Tables 3–2 and 3–3 respectively.

Table 3–1. SOR Alternatives – Modification Cost and Increased Operating Cost, Commercial Irrigation[1]

SOR Study No.	John Day Capital – $	John Day Annual OM&P	Ice Harbor Capital – $	Ice Harbor Annual OM&P
SOS1a	0	0	0	0
SOS1b	0	0	0	0
SOS2c	0	0	0	0
SOS2d	0	0	0	0
SOS4c	0	0	0	0
SOS5b	14,340,000	664,000	28,300,000	1,800,000
SOS5c	14,340,000	664,000	28,300,000	1,838,000
SOS6b	14,340,000	664,400	15,000,000	889,000
SOS6d	14,340,000	664,400	0	0
SOS9a	10,790,000	578,000	15,000,000	890,000
SOS9b	0	0	0	0
SOS9c	14,340,000	708,000	16,020,000	890,000
Pref. Alt.	14,340,000	751,000	0	0

1/ Values not discounted for plan implementation date.

Table 3–2. Modification Cost, M&I Pumpers[1]

SOR Alternatives	John Day $	Ice Harbor $	Lower Granite $	Little Goose $	Lower Monumental $
SOS1a	0	0	0	0	0
SOS1b	0	0	0	0	0
SOS2c	0	0	0	0	0
SOS2d	0	0	0	0	0
SOS4c	0	0	0	0	0
SOS5b	36,147,000	1,467,500	3,523,000	705,000	852,000
SOS5c	36,147,000	1,467,000	3,523,000	705,000	852,000
SOS6b	36,147,000	767,500	2,983,000	286,000	401,000
SOS6d	36,147,000	0	2,983,000	0	0
SOS9a	36,147,000	767,500	2,983,000	286,000	390,000
SOS9b	0	0	0	0	0
SOS9c	36,147,000	818,700	3,258,000	385,000	532,000
Pref. Alt.	39,524,000	0	0	0	0

1/Values not discounted for plan implementation date.

Table 3–3. Increased Annual Operation, Maintenance and Power Cost, M&I Pumpers[1]

SOR Alternatives	John Day $	Ice Harbor $	Lower Granite $	Little Goose $	Lower Monumental $
SOS1a	0	0	0	0	0
SOS1b	0	0	0	0	0
SOS2c	0	0	0	0	0
SOS2d	0	0	0	0	0
SOS4c	0	0	0	0	0
SOS5b	2,551,750	77,000	177,000	39,000	44,000
SOS5c	2,551,750	78,000	178,000	76,000	44,000
SOS6b	2,551,750	40,000	150,000	15,000	21,000
SOS6d	2,551,750	0	150,000	0	0
SOS9a	2,551,750	40,000	150,000	15,000	20,000
SOS9b	0	0	0	0	0
SOS9c	2,551,750	41,000	163,000	20,000	27,000
Prev. Alt.	2,551,750	0	0	0	0

1/Values not discounted for plan implementation date.

CHAPTER 4

ALTERNATIVES AND THEIR IMPACTS

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 irrigation.

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 2c** 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 1b • No maximum flow restriction from mid-Oct. to mid-Nov. • No draft limit; no refill target	**SOS 2d** Operate on system proportional draft as in SOS 1a	

	SOS 1	SOS 2	SOS 4
ALBENI FALLS	**SOS 1a** Normal 1983–1991 storage project operations	**SOS 2c** 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 draw-down to 2,051 feet every 6th year
	SOS 1b No refill target	**SOS 2d** Operate on system proportional draft as in SOS 1a	

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 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 **SOS 9b** • 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 PA** • 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 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 **SOS 9b** • 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.	**SOS PA** • 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.

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

SOS 5	SOS 6	SOS 9	SOS PA
SOS 5b Same as SOS 4c **SOS 5c** Same as SOS 4c	**SOS 6b** Same as SOS 4c **SOS 6d** 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 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	**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

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

	SOS 1	SOS 2	SOS 4
LOWER SNAKE	**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	

	SOS 1	SOS 2	SOS 4
LOWER COLUMBIA	**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 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 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 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 5c Same as SOS 5b, except drawdowns are permanent once natural river levels reached; no refill	**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 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 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 6b** 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 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
SOS 5c Same as SOS 5b	**SOS 6d** Same as SOS 5	**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	

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 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 IMPACTS – FULL SCALE ANALYSIS

A full scale analysis was made for each of the 13 SOR operational options. Monetary impacts for each alternative are presented in this section.

The impacts on reservoir pumpers who might be impacted by each option are presented in two parts: (1) The first part is for irrigation pumping associated with commercial agriculture termed "commercial irrigation"; and (2) The second part is for M&I users, which includes pumpers who utilize reservoir water for municipal and industrial purposes (M&I), fish hatcheries, Corps of Engineers pumping for recreation areas and wildlife habitat, and other uses.

Impacts on commercial irrigators have been identified for pumpers from reservoirs behind Grand Coulee, Ice Harbor and John Day dams. Impacts on M&I users have been identified for reservoirs behind Ice Harbor, John Day, Lower Granite, Lower Monumental, and Little Goose dams.

Discounting For Time Of Occurrence

Because SOR alternative strategics have different implementation dates it was necessary to discount all values to year 1 of the analysis, or 1995. Monetary impacts are expressed as annual equivalent values (present worthed and amortized) at both 7.75 percent (the Federal discount rate) and 3.0 percent.

4.2.1 Impact of Reservoir Drawdown on Commercial Irrigation

Impacts of SOR operational options on reservoir pumpers classified as commercial irrigation was analyzed for two categories of users: (1) Irrigators receiving water from Grand Coulee; and (2) Entities pumping water from the John Day and Ice Harbor pools.

4.2.1.1 Grand Coulee

Water is pumped from Lake Roosevelt (Coulee) to Banks Lake by Reclamation for use by irrigators who belong to irrigation districts served by the Federally constructed Columbia Basin Project.
As authorized by Congress and through appropriate contracts with the irrigation districts, Reclamation, among other provisions, delivers water to the districts. The districts pay pumping costs based on criteria established in the contract. The current repayment rate (1993) is .95 mills per kwh ($.00095/kwh).

The irrigation pumping requirements at Coulee were identified for each of the 13 SOR operational options, which includes the Base Case (SOS1a), the No Action Alternative (SOS2c), and the Preferred Alternative. Chapter 3 describes the variables and measurement standards used to model the pumping requirement.

It was assumed that modification of the pumping plant units at Coulee would not be required.

The existing annual irrigation pumping requirement at Coulee and the repayment cost to pump the water is approximately 969,000 mwhrs and $920,300 respectively under the Base Case (SOS1a). Table 4–3 shows the annual pumping requirement in mwhrs and the monetary valuation of that power at the repayment rate for each of the 13 SOR operational options.

Alternative operating strategies have a relatively minor effect on the irrigation pumping cost at Coulee. This impact is illustrated in the graph in Figure 4–1. The greatest impact occurs under option SOS9a with an annual pumping cost of $946,200, an increase of $25,900 over the Base Case.

4.2.1.2 Ice Harbor and John Day

Commercial irrigation has been identified with 13 pumpers irrigating 36,389 acres (14,726 hectares) from the Ice Harbor pool and 25 pumpers irrigating 139,500 acres (56,455 hectares) from the John Day pool.

Chapter 3 contains the discussion of the measurement standards and determinants of the increased pumping cost. Supporting Section A contains additional information.

All estimates were discounted for time of plan implementation to yield an annual equivalent value at both 7.75 and 3.0 percent.

Proposed reservoir drawdowns on the Ice Harbor and John Day pools impact the income of irrigators by increasing the cost to own and operate pumping plant systems located on or adjacent to the reservoir pool. Increased cost include the capital cost necessary to modify the pumping plant as well as the increased annual operation and maintenance cost, and the increased power cost due to greater lift requirements (total dynamic head). Exhbit A contains information on pumping plant modification costs, including operating and power cost, as developed and furnished by the Corps of Engineers.

Tables 4–4 and 4–5 show estimates of the annual equivalent increased pumping cost at 7.75 and 3.0 percent for each of the 13 SOR operating options for the Ice Harbor and John Day pools respectively. Alternatives are marked with either a "yes" or "no" to indicate if pump modification and increased operating cost are required.

Table 4–3. Grand Coulee – Irrigation Pumping Requirement – Annual Equivalent Pumping Cost

(Irrigation pumping from Lake Roosevelt to Banks Lake)
(Federal Columbia Basin Project)

SOR Study No.	Annual Megawatt Hours of Pumping	Value of Energy at Repayment Rate @ $.00095/kwh	Implementation Date	Annual Equivalent Value @ 3%	Annual Equivalent Value @ 7.75%
SOS1a	968,701	$ 920,300	1995	920,300	920,300
SOS1b	968,667	920,200	1995	920,200	920,200
SOS2c	959,254	911,300	1995	911,300	911,300
SOS2d	955,776	908,000	1995	908,000	908,000
SOS4c	939,874	892,900	1995	892,900	892,900
SOS5b	959,279	911,300	2010	911,300	911,300
SOS5c	959,279	911,300	2000	911,300	911,300
SOS6b	959,279	911,300	2005	911,300	911,300
SOS6d	959,279	911,300	2000	911,300	911,300
SOS9a	995,961	946,200	2005	946,200	946,200
SOS9b	964,975	916,700	1995	916,700	916,700
SOS9c	965,614	917,300	2005	917,300	917,300
Pref. Alt	956,300	908,500	1998	908,500	908,500

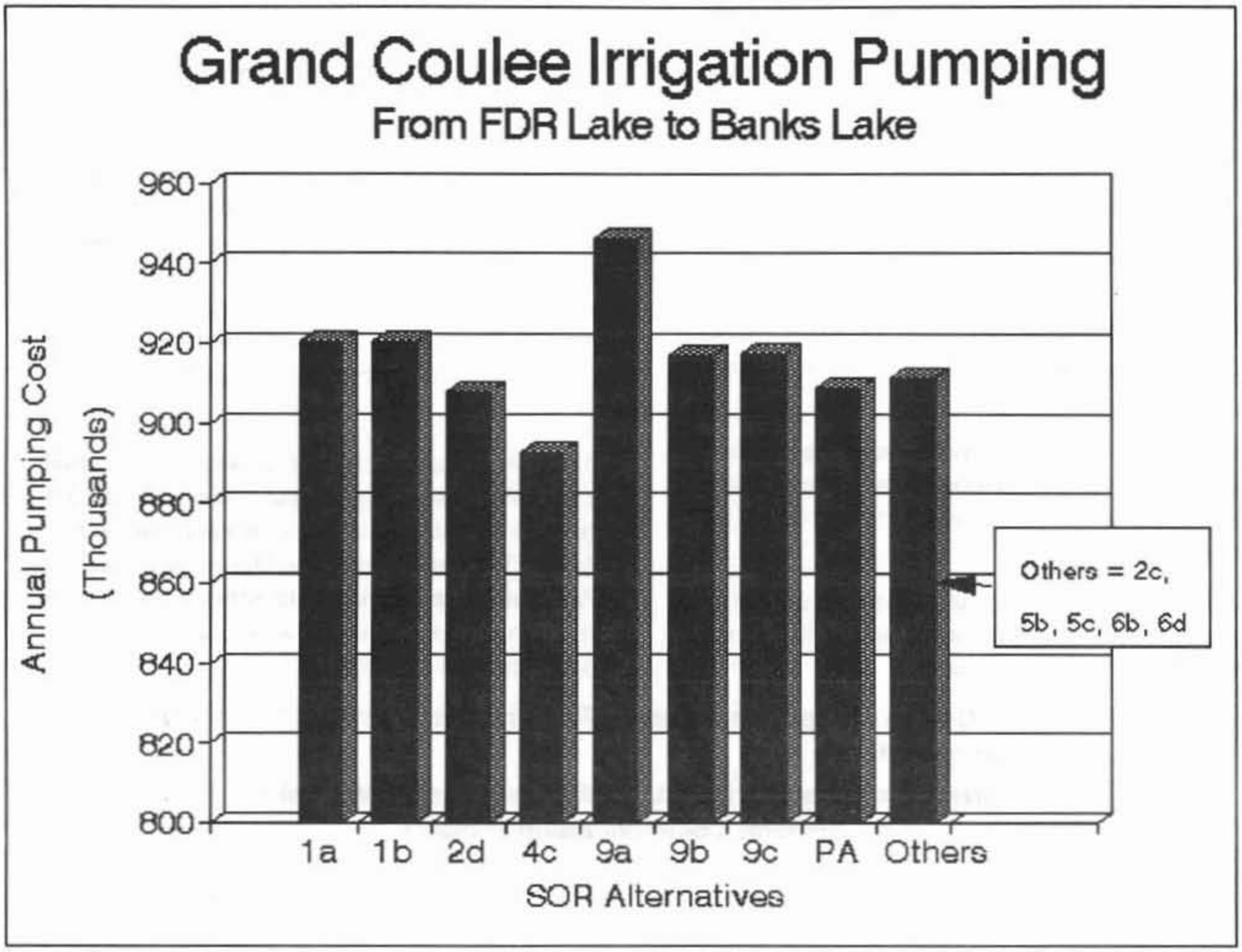

Figure 4–1. Grand Coulee Irrigation

Ice Harbor

Impacts on pumpers occur under SOS5b, SOS5c, SOS6b, SOS9a and SOS9c. The greatest impact occurs under SOS5c with an annual increase in pumping cost of approximately $3.1 million, which is equivalent to $84 per acre.

John Day

Impacts occur under SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative. The greatest impact occurs under the Preferred Alternative with an annual increased pumping cost of $1.7 million, which is equivalent to $12 per acre.

4.2.2 Impacts on M&I Water Users – Pumpers

The impact on M&I users directly affected by reservoir drawdowns was analyzed in terms of the cost to modify pumping plants and the associated increased operating and power cost. These costs allow the entities to continue pumping from the reservoir pools, or otherwise operate their facilities, under reservoir drawdown conditions as identified in the hydroregs.

Table 4–4. Ice Harbor Irrigation – Increased Annual Pumping Cost

SOR Study No.	Acres Irrigated	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	@ 7.75% $000
SOS1a	36,389	no	1995	0	0
SOS1b	36,389	no	1995	0	0
SOS2c	36,389	no	1995	0	0
SOS2d	36,389	no	1995	0	0
SOS4c	36,389	no	1995	0	0
SOS5b	36,389	yes	2010	2,305.4	1,443.8
SOS5c	36,389	yes	2000	3,164.7	3,072.9
SOS6b	36,389	yes	2005	1,377.4	1,080.9
SOS6d	36,389	no	2000	0	0
SOS9a	36,389	yes	2005	1,378.1	1,081.3
SOS9b	36,389	no	1995	0	0
SOS9c	36,389	yes	2005	1,427.6	1,126.2
Pref. Alt.	36,389	no	1998	0	0

See Exhbit A for derivation annual equivalent values.

Table 4–5. John Day Irrigation – Increased Annual Pumping Cost

SOR Study No.	Acres Irrigated	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	@ 7.75% $000
SOS1a	139,500	no	1995	0	0
SOS1b	139,500	no	1995	0	0
SOS2c	139,500	no	1995	0	0
SOS2d	139,500	no	1995	0	0
SOS4c	139,500	no	1995	0	0
SOS5b	139,500	yes	2010	1,013.8	650.7
SOS5c	139,500	yes	2000	1,375.0	1,373.0
SOS6b	139,500	yes	2005	1,181.1	945.2
SOS6d	139,500	yes	2000	1,375.0	1,373.0
SOS9a	139,500	yes	2005	945.9	748.4
SOS9b	139,500	no	1995	0	0
SOS9c	139,500	yes	2005	1,213.2	966.1
Pref. Alt.	139,500	yes	1998	1,540.2	1,663.7

See Exhbit A for derivation annual equivalent values.

Impacts on M&I pumpers were identified at six reservoir pools: Lower Granite, Lower Monumental, Little Goose, Ice Harbor, John Day. Minor impacts on M&I and small tract irrigation were identified at Grand Coulee but were not evaluated further.

Table 4–6 shows the annual unadjusted increase in pumping cost, the plan implementation dates, and the increased annual equivalent pumping cost at 7.75 and 3.0 percent. Columns with a zero entry indicate that pump modification and increase operating cost was not required under that alternative. Exhbit A contains additional information pursuant to the development of data for increased pumping plant cost.

Impacts on M&I pumpers was identified for SOR options SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative. Increased annual equivalent pumping cost range from approximately $2.1 million for SOS5b to $4.7 million for Preferred Alternative (@ 7.75 percent).

The basic reason the impacts are greatest for the Preferred Alternative is that the John Day pool is drawn down year–round rather than for 2 to 4.5 months.

Chapter 5, presents the comparison of alternatives and the incremental impacts between the alternatives and the Base Case (SOS1a) and the No Action Alternative (SOS2c).

Table 4–6. Increased Annual Pumping Cost – M&I Pumpers [1/2/3/]

Annual Cost of Pump Modification Plus Operation, Maintenance, and Power

SOR Study No.	Pump Modification Required	Implementation Date	Annual Equivalent Value @ 3% $000	Annual Equivalent Value @ 7.75% $000
SOS1a	no	1995	0	0
SOS1b	no	1995	0	0
SOS2c	no	1995	0	0
SOS2d	no	1995	0	0
SOS4c	no	1995	0	0
SOS5b	yes	2010	3,256.9	2,111.0
SOS5c	yes	2000	4,520.1	4,483.8
SOS6b	yes	2005	3,617.3	2,921.6
SOS6d	yes	2000	4,126.2	4,100.5
SOS9a	yes	2005	3,616.0	2,920.6
SOS9b	no	1995	0	0
SOS9c	yes	2005	3,662.5	2,957.8
Pref. Alt.	yes	1998	4,273.4	4,670.3

1/See Exhbit A for derivation of increased pumping costs.

2/Impacts on Grand Coulee M&I pumpers considered insignificant.

3/Annual cost includes amortization of pump modification cost, plus increased operation, maintenance, and pumping power cost.

CHAPTER 5
COMPARISON OF ALTERNATIVES

5.1 OVERVIEW

This chapter presents the comparison of impacts among alternatives. Accordingly, the incremental differences or tradeoffs in the monetary value of impacts between alternatives and the Base Case (SOS1a) and the No Action Alternative (SOS2c) are displayed for the Irrigation/M&I analysis. In order to assist and facilitate decisions regarding operation of the Federal Columbia River System, the incremental changes or differences between alternatives is displayed and the more significant impacts discussed.

5.2 SUMMARY

Annual monetary impacts on irrigation and M&I reservoir pumpers affected by SOR strategies with drawdown proposals range from no change in pumping cost to $6.3 million with the Preferred Alternative and to $8.9 million under SOS 5c. Pumping cost reductions (negative values) reflect those alternatives where pumping cost at Grand Coulee are reduced over the Base Case (SOS1a) or the No Action option (SOS2c). Incremental impacts for all categories of users is represented graphically in Figure 5–1.

The $6.3 million annual increase in pumping cost with the Preferred Alternative reflects the year–round drawdown of John Day, which is significantly influenced by the increase in costs for John Day M&I users ($4.67 million) and for John Day irrigation pumpers ($1.66 million).

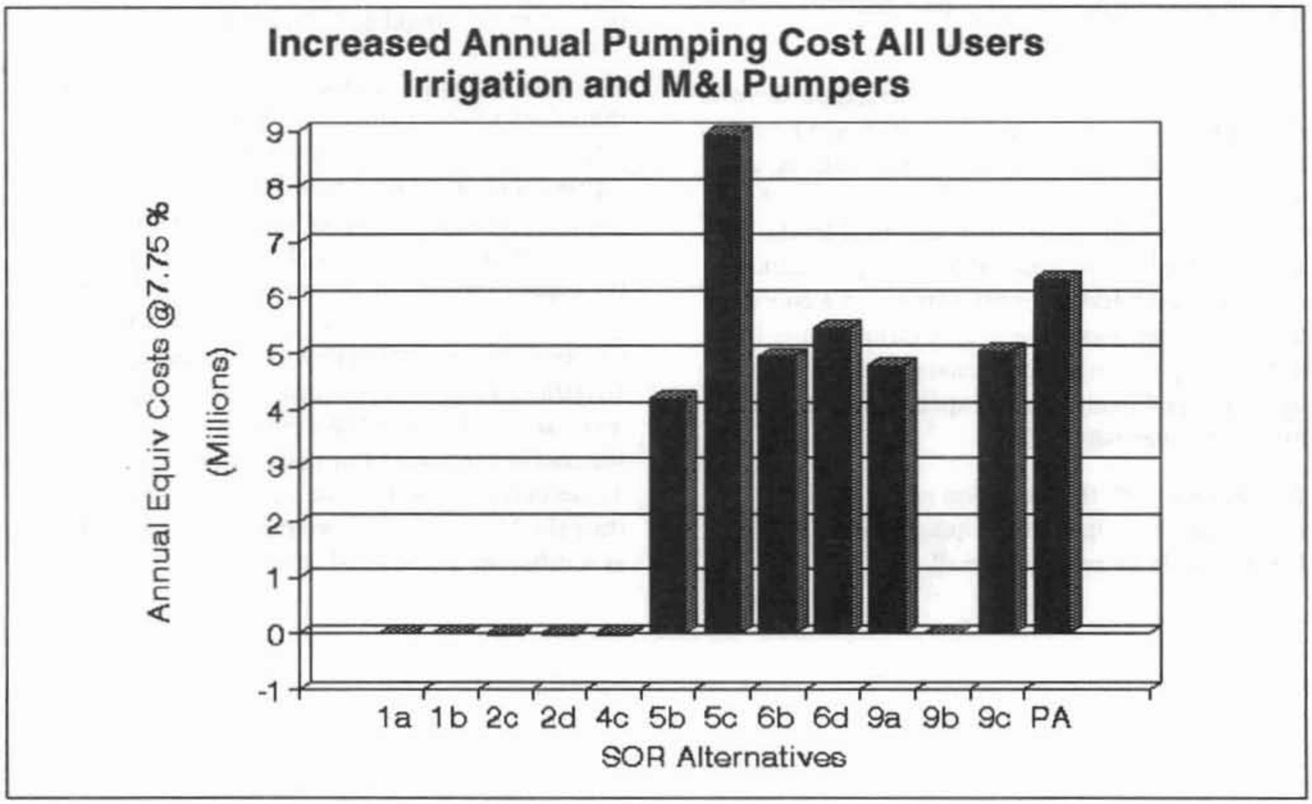

Figure 5–1. Impacts – All Categories

5.2.1 Commercial Irrigation – Grand Coulee

Analysis of the irrigation pumping requirement at Grand Coulee indicates that SOR alternative operating strategies with drawdowns would have a relatively minor effect on pumping. Some alternatives have a lower irrigation pumping cost than the Base Case or the No Action Alternative. The incremental increase in pumping energy from the Base case (SOS1a) to the alternative with the highest use is approximately 3 percent –– or from 968,700 mwhs (SOS1a) to 995,900 mwhrs in (SOS9a). The increased pumping cost would be approximately $25,900 annually.

Analysis of the hydroregs show alternative SOS9a drafting FDR Lake to unprecedented levels during the spring and summer. Consequently, during certain months of critical water years irrigation deliveries from Banks Lake may not be fully met. This is because pumping from FDR Lake to Banks Lake cannot keep up with peak irrigation demand as the efficiency of the pumping units decrease as the level of FDR Lake goes down.

In addition to those months when irrigation demand cannot be fully met under SOS9a, it should be noted that during critical water periods the pumping units are operating for extended periods of time and at head differentials greater than historical levels. The amount of increased wear on the pumping units at these operating levels is unknown and is a concern to project operators. The loss of farm income from not meeting full irrigation demand and any increase operation and maintenance expenses was not evaluated for alternative SOS9a.

In summary, with the exception of the above discussion, the irrigation pumping impacts at Grand Coulee would be relatively small.

Table 5–2 shows incremental change in the irrigation pumping requirement at Grand Coulee. The table shows the pumping cost for each option as well as the incremental change (increase/decrease) between the option and the Base Case (SOS1a) and between the option and the No Action option (SOS2c).

5.2.2 Commercial Irrigation – John Day and Ice Harbor

Chapter 4 presented the impact on pumping cost for the 13 SOR options. Pumping costs are increased for those options with drawdown. In order to continue full crop production, pumping plants must be modified and increased operation and power cost incurred. These additional costs reduce farm income over options without drawdown.

Increased pumping costs have been discounted for time of occurrence based on the implementation dates for the various options. The result is expressed as an annual equivalent value.

The discounting for time of occurrence can reduce the values substantially from the unadjusted values reflecting the time value of money. Impacts when expressed on an annual equivalent basis tend to mask the immediate impact on pumpers when a drawdown is implemented. Entities must finance the capital investment cost to modify their pumps as well as to pay the increased annual O&M and power cost out of current cash flow or retained earnings. Irrigation pumpers, in particular, can not pass on the increased cost. Some M&I pumpers could pass on the cost in the form of increased rates to customers. These entities tend to have a shorter time horizon than the 100 year period used in this analysis, as well as a different debt/capital structure.

Table 5–1. Comparative Summary – All Users (Irrigation + M&I) [1/]

Study No.	Incremental Annual Equivalent Impacts – All Pumpers Between Alternative And: Base Case SOS1a $1,000 [2/] [3/]	No Action Alternative SOS2c $1,000 [2/] [3/]
SOS1a	0	9.0
SOS1b	–.1	8.9
SOS2c	–9.0	0
SOS2d	–12.3	–3.3
SOS4c	–27.4	–18.4
SOS5b	4,196.6	4,205.6
SOS5c	8,920.7	8,929.7
SOS6b	4,938.7	4,947.7
SOS6d	5,464.5	5,473.5
SOS9a	4,776.2	4,785.2
SOS9b	–3.6	5.4
SOS9c	5,047.1	5,056.1
Pref. Alt.	6,322.2	6,331.2

1/ Includes: (1) Increased pumping cost at Grand Coulee; (2) Increased pumping cost for Ice Harbor and John Day commercial irrigation pumpers; and (3) Increased pumping cost for M&I users.

2/ Annual equivalent values at 7.75%.

3/ A positive number indicates an increase in pumping cost, a negative number indicates an decrease in pumping cost.

Table 5–2. Grand Coulee – Incremental Annual Irrigation Pumping Cost

Study No.	Annual Pump Cost @ Repay Rate	Incremental Pumping Cost Between Alternative And: [3/]	
		Base Case SOS1a $1,000 [1/]	No Action Alternative SOS2c $1,000 [2/]
SOS1a	920,300	0	9.0
SOS1b	920,200	−.1	8.9
SOS2c	911,300	−9.0	0
SOS2d	908,000	−12.3	−3.3
SOS4c	892,900	−27.4	−18.4
SOS5b	911,300	−9.0	0
SOS5c	911,300	−9.0	0
SOS6b	911,300	−9.0	0
SOS6d	911,300	−9.0	0
SOS9a	946,200	25.9	34.9
SOS9b	916,700	−3.6	5.4
SOS9c	917,300	−3.0	6.0
Pref. Alt.	908,500	−11.8	−2.8

1/ Difference between Alternative Plan and SOS1a.

2/ Difference between Alternative Plan and SOS2c.

3/ A positive number indicates an increase in pumping cost, a negative number indicates a decrease in pumping cost.

5.2.2.1 Ice Harbor

Five SOR options propose drawdowns of the Ice Harbor pool. They are SOS5b, SOS5c, SOS6b, SOS9a, and SOS9c. Option SOS5c draws down the Ice Harbor pool 95.7 feet (29.2 meter) during the pumping season while other alternatives draw down the pool approximately 32 feet. Accordingly, pumping cost increases are greater under SOS5c

Annual pumping cost increases range from $1.1 million under SOS6b, SOS9a, and SOS9c to $3.1 million under SOS5c. Table 5–3 is a comparison of the increased pumping cost between alternative plans and the Base Case and the No Action Alternative. Figure 5–2 graphically illustrates the increased pumping cost for Ice Harbor.

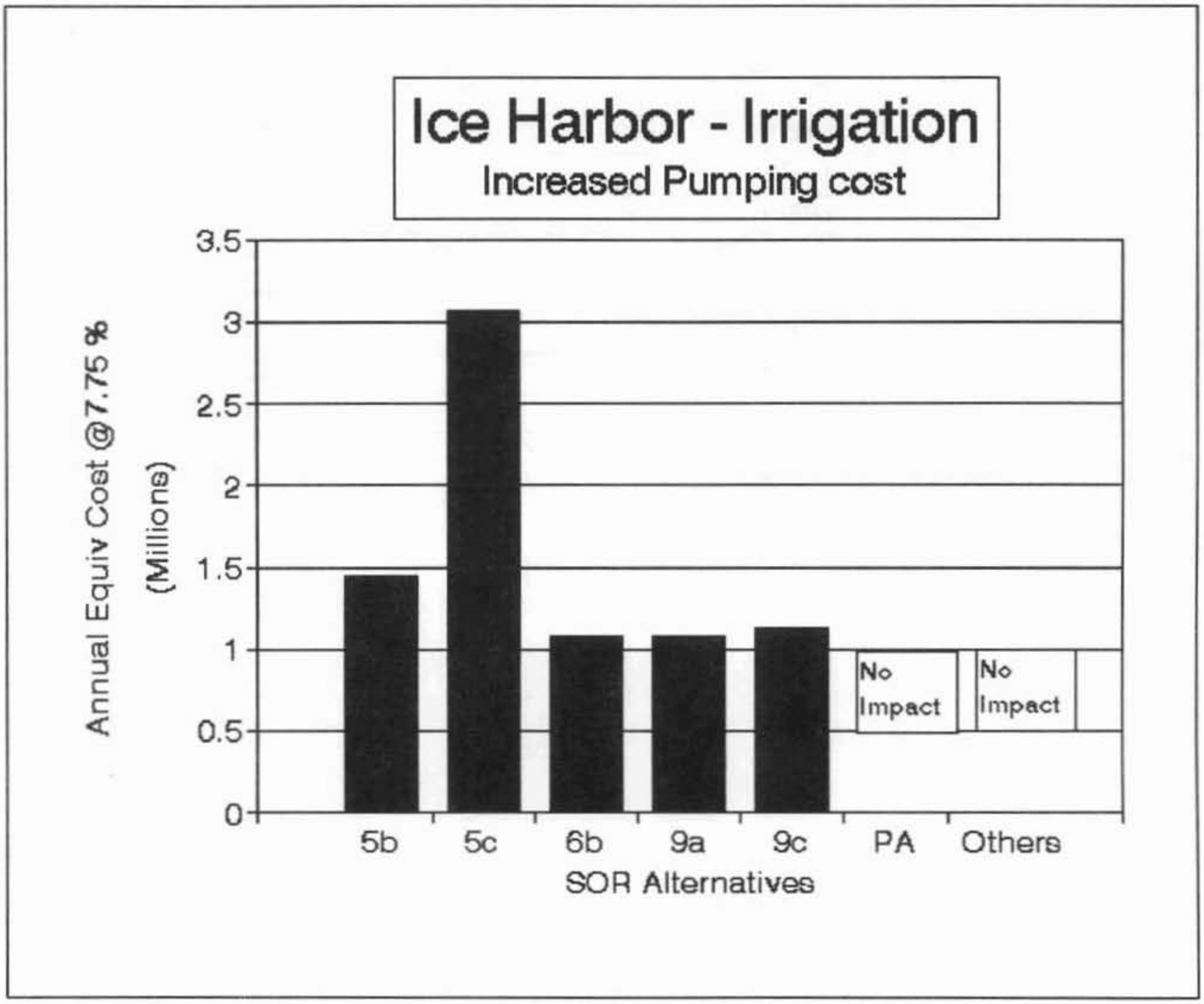

Figure 5–2. Ice Harbor Irrigation

Table 5–3. Annual Increase in Pumping Cost – Ice Harbor Irrigation

Study No.	Incremental Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 1/	No Action Alternative SOS2c $1,000 1/
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	1,443.8	1,443.8
SOS5c	3,072.9	3,072.9
SOS6b	1,080.9	1,080.9
SOS6d	0	0
SOS9a	1,081.3	1,081.3
SOS9b	0	0
SOS9c	1,126.2	1,126.2
Pref. Alt	0	0

1/ Annual equivalent values at 7.75 percent.

5.2.2.2 John Day

Seven SOR options propose drawdown of the John Day pool. These are SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c and the Preferred Alternative. The essential difference between options as far as drawdown is concerned, is the length of the drawdown during the irrigation season. Drawdown proposals at John Day result in relatively less monetary impacts on a per acre basis than at Ice Harbor because the drawdown is less –– 6.5 feet (2 meters) at John Day versus up to 95.7 feet (29.2 meters) at Ice Harbor. However, a greater acreage is irrigated from the John Day pool, 139,500 acres versus 36,389 acres (56,455 versus 14,726 hectares) from Ice Harbor.

Drawdowns of the John Day pool result in an increase in pumping cost ranging from $651 thousand to $1.7 million under the Preferred Alternative, or $5 to $12 per acre respectively.

The $1.7 million increase under the Preferred Alternative reflects the year–round drawdown of John Day. Table 5–4 is a comparison of the increased pumping cost between options and the Base Case and the No Action option. Figure 5–3 illustrates the increased pumping cost for John Day.

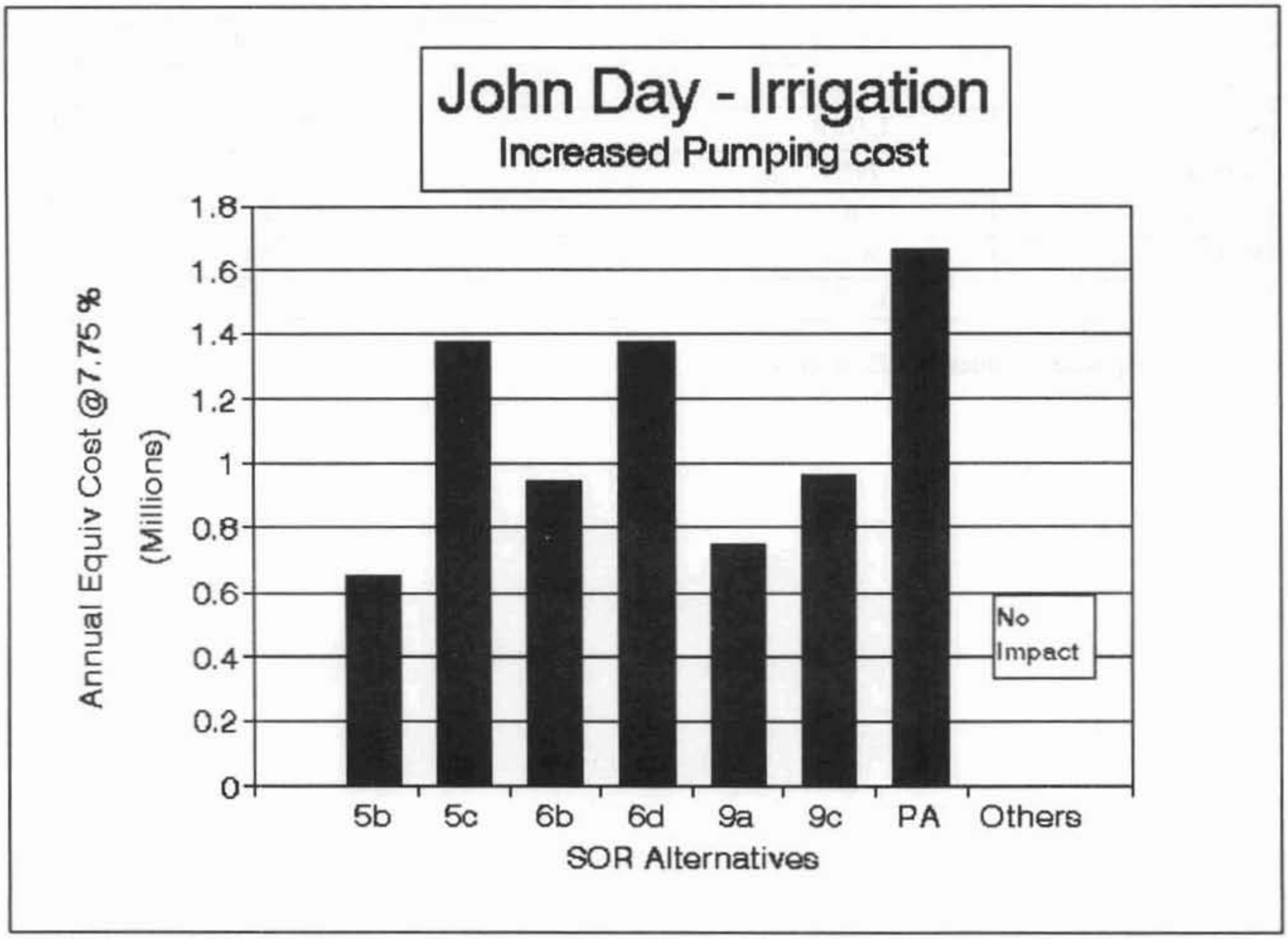

Figure 5–3. John Day Irrigation

Table 5–4. Annual Increase in Pumping Cost – John Day Irrigation

Study No.	Incremental Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 [1/]	No Action Alternative SOS2c $1,000 [1/]
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	650.7	650.7
SOS5c	1,373.0	1,373.0
SOS6b	945.2	945.2
SOS6d	1,373.0	1,373.0
SOS9a	748.4	748.4
SOS9b	0	0
SOS9c	966.1	966.1
Pref. Alt	1,663.7	1,663.7

[1/] Annual equivalent values at 7.75 percent.

5.2.3 M&I Pumpers

Seven SOR options propose drawdowns of one or all of the six reservoirs. These are SOS5b, SOS5c, SOS6b, SOS6d, SOS9a, SOS9c, and the Preferred Alternative.

In addition to commercial irrigation, M&I pumpers would be impacted by reservoir drawdowns at six project pools. The reservoirs are those behind Lower Granite, Lower Monumental, Little Goose, Ice Harbor, John Day, and Grand Coulee dams. The impact on these reservoir pumpers was evaluated by estimating the pumping plant modification cost plus the increased annual operation, maintenance, and pumping power cost. These estimates were presented in chapter 4, Alternatives and Their Impacts.

Drawdowns at the six reservoirs result in annual equivalent pumping cost increases (including modification) ranging from $2.1 million under SOS5b to $4.7 million annually under the Preferred Alternative. The increased pumping cost for the Preferred Alternative reflects the relatively high modification and pumping cost for the John Day M&I pumping stations. Table 5–5 is a comparison of the incremental increases in pumping cost between alternative plans and the Base Case and the No Action Alternative. Figure 5–4 illustrates the incremental increases in annual equivalent pumping cost.

As with irrigation, discounting for time of occurrence and expressing the value as an annual equivalent with a 100 year period of analysis, tends to mask the immediate impact on individual entities when a particular drawdown option is implemented.

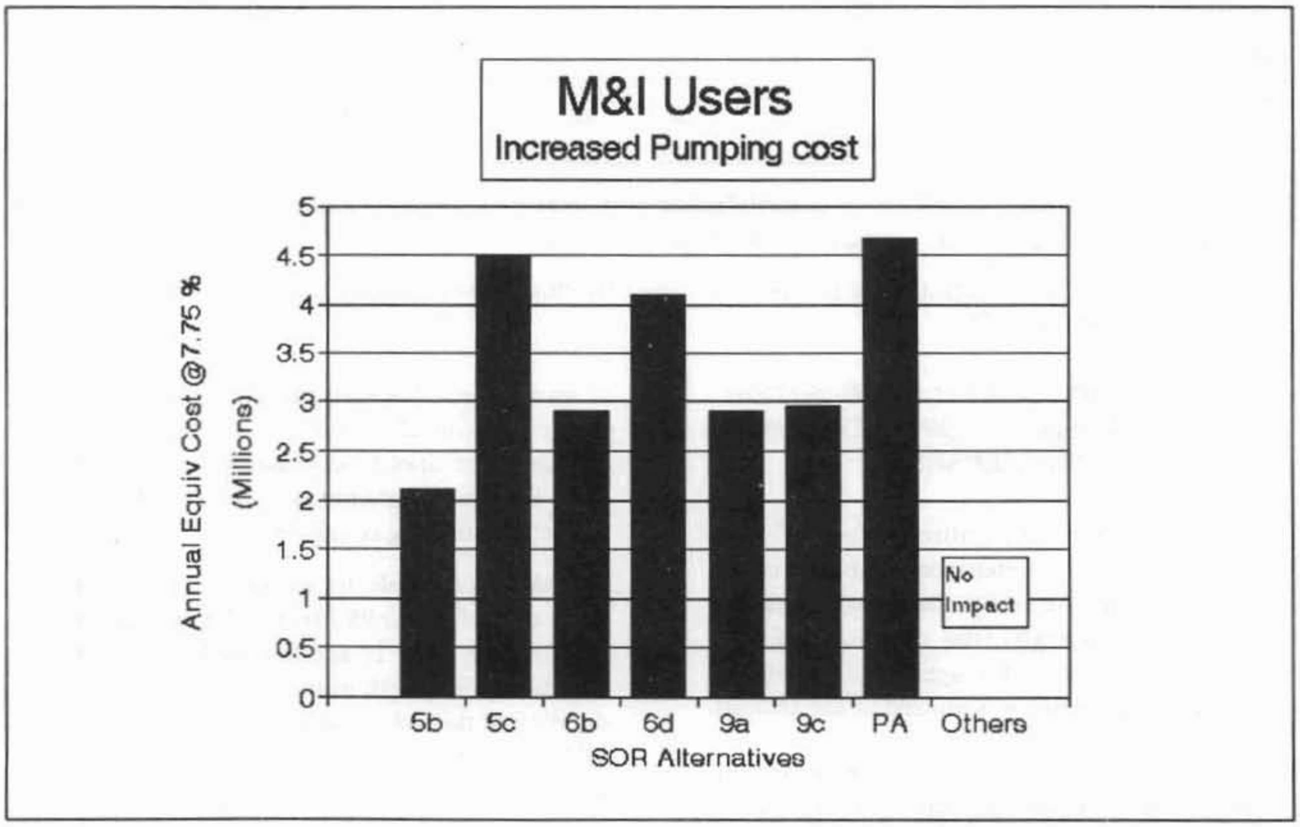

Figure 5–4. M&I Pumpers

Table 5–5. Increased Annual Equivalent Pumping Cost – M&I Pumpers [1/] [2/]

Study No.	Increase in Pumping Cost Between Alternative And: Base Case SOS1a $1,000 [1/]	No Action Alternative SOS2c $1,000 [1/]
SOS1a	0	0
SOS1b	0	0
SOS2c	0	0
SOS2d	0	0
SOS4c	0	0
SOS5b	2,111.1	2,111.1
SOS5c	4,483.8	4,483.8
SOS6b	2,921.6	2,921.6
SOS6d	4,100.5	4,100.5
SOS9a	2,920.6	2,920.6
SOS9b	0	0
SOS9c	2,957.8	2,957.8
Pref. Alt	4,670.3	4,670.3

[1/] Annual cost includes: Amortization of modification cost, increased operation and maintenance, and the increased pumping cost. Annual equivalent values at 7.75%

[2/] Modification of pump facilities for pumpers on Lower Granite, Lower Monumental, Little Goose, Ice Harbor, and John Day.

5.3 ECONOMIC VIABILITY OF IRRIGATION AND M&I PUMPING OPERATION UNDER DRAWDOWN SCENARIOS

Estimates of pump modification cost and the increased operation, maintenance and power costs were made using the best available information. Information from engineering consultants with hands–on knowledge of designing and installing river pumping systems was utilized in the analysis.

Operation and maintenance costs were increased over customary engineering rates or charges for the 4 lower Snake reservoirs to reflect the additional wear on pumps and motors because of the possibility of increased sedimentation –– both deposited and in suspension. However, irrigation and M&I pumps have not historically been operated for extended periods under drawdown situations. Accordingly, there is some uncertainty as to the actual long term impact on pumping operations.

Drawdown proposals, for example, range from approximately 32 to 95.7 feet at Ice Harbor and 6.5 feet for John Day. In addition to the depth of drawdown, the length of the pumping season and the duration of the drawdown also affects pumping cost. SOR alternatives propose drawdowns of 2.5 months, 4.5 months, and year–round.

The greater the drawdown the greater the increase in pumping cost – resulting in a decrease in farm income in the case of commercial irrigation. And, in the case of an M&I utility, the increase in cost is added to the rate base and passed on to consumers.

5.3.1 Impact of Drawdown on Economic on Viability of Irrigation Pumpers – Ice Harbor and John Day

Commercial irrigation would only be affected by drawdowns at Grand Coulee, Ice Harbor, and John Day. The impact on irrigators receiving water from FDR Lake (Coulee) is relatively small and was presented in Chapter 5.2.1.

Chapter 4 showed 5 of the 13 alternatives for Ice Harbor with increased pumping cost ranging from $1.1 million to $3.1 million (SOS5c). which is equivalent to $30 to $84 per acre. Seven of the 13 alternatives for John Day showed increased pumping cost ranging from $651 thousand up to $1.7 million for the Preferred Alternative, which is equivalent to $5 to $12 per acre. John Day has a larger irrigated acreage and smaller pumping cost increase than Ice Harbor which results in a significantly lower cost per acre. To facilitate comparison between categories of farm inputs, pumping costs are normally expressed on a per acre or per acre foot basis.

While it could be hypothesized that an annual cost increase of $5 per acre could be accommodated by most irrigators over the long run, a pumping cost increase of $84 per acre is a significant impact to the viability of individual farming operations. Other things being equal, the impact on Ice Harbor irrigators is more severe than on John Day irrigators.

As an illustration of the relative significance of the pumping cost increase under the "worst case" scenario, based on crop enterprise studies for the area, an $84 per acre cost increase in pumping cost represents the following percentage of the estimated variable crop production cost for representative crops: alfalfa – 33.7%, potatoes – 4.9%, wheat – 45.5%, corn – 23.2%, and apples – 3.7%.

Irrigation pumpers at these reservoirs, like other farmers, have little capability to pass pumping cost increases on to consumers. Accordingly, in the short–run, and in the absence of direct reimbursement from other sources, the increase in pumping cost could be expected to come from operating income in the form of a reduced return to operator labor, management, or capital investment.

In the long–run, irrigation farming, like any enterprise, must earn a return sufficient to keep resources (land, labor, capital, and management) in production –– compared to returns in alternative investments.

Irrigation Crop Production Criteria

Individual irrigators have varying production cost and profitability based on differences in their capital structure (debt–equity relationships), crop production cost, cropping, yields, as well as exogenous variables. As such, there would be a range in variation as to how individual irrigators would respond to increased pumping cost.

Production theory indicates that in the short run, producers must cover variable cost in order to continue their operations. In the long run, however, all costs (fixed and variable) must be covered. Under drawdown situations irrigators must obtain financing capability to cover short term operating loans and finance the pump modification cost itself, and over time continue to replace capital assets, such as tractors, sprinkler systems. etc.

The following responses, or a combination thereof could be expected under drawdown situations, depending on the relative magnitude of the increase in pumping cost.

a. Continue to operate and accept a lower return to operator labor, management, and equity capital. And possibly make internal changes in the production mix and crop mix to increase production efficiencies.

b. Sell the irrigated farmland, possibly at a lower price. In which case the farm value will be recapitalized at a lower value so that expected returns equates with costs.

c. Lease out the farm to other operators. which assumes the new operator has a lower capitalization structure and/or a higher operating profit margin.

d. Consolidate operations with other farmers with the goal of achieving greater production efficiencies.

e. Return some or all of farm to dryland farming or grazing.

Changes in Crop Production Practices

Observation of typical irrigation pumpers on the Ice Harbor and John Day pool indicate an already high level of irrigation application technology, capital investment, and production practices. Also, due to the nature of the soils in the mid–Columbia area, crop rotation requirement for potatoes and vegetables, and above average water delivery cost, the cropping flexibility is somewhat limited. However, in the long–run things can change, as evidenced by the relatively recent introduction of growing hybrid poplar trees for wood pulp production under irrigation in the mid–Columbia area..

Discussions with agricultural economists in the PNW and the results of price–elasticity of demand studies for electricity in the PNW indicate that in the short–run irrigators would not make significant changes in cropping or the input mix in response to increased pumping cost.

It is recognized that in the long–run irrigators may respond to any increase in production cost, including pumping cost, by changing their agronomic practices, cropping patterns, and adopting different technologies, including water application amounts. These changes occur over time in an ongoing attempt to optimize their position on the production function.

This is especially relevant for larger changes in cost that may trigger or induce changes in the production mix and cropping pattern. An increase in pumping costs would be one of the changes that would induce such changes in the production mix and cropping patterns. Discussion with agricultural economists in the PNW confirm that these production mix and cropping changes will occur faster and to a greater extent given larger increments of change in production cost than for smaller ones. Price elasticity of demand studies indicate that in the short–run farmers are relatively unresponsive to external changes in production cost (elasticity less than 1.0). In other words, a 10 percent increase in electrical pumping rates would lead to a less than 10 percent decrease in the demand for electricity.

A joint study conducted by Northwest Economic Associates and Washington State University indicate electricity price elasticities for the short–run of –.49 as the regional average, and for the long–run price elasticities varied from .66 to –1.32 with a weighted regional average of –.81. Both estimates were made using an econometric model. The study also estimated price elasticity of demand for electricity by PNW irrigators using a mathematical programming model. The results of the programming model indicated that the short–run demand for electricity by irrigators is inelastic (low elasticities). Also, the elasticities for small price increases (0–33%) are lower in absolute values than those for large price increases (34–100%). The elasticity at the lowest price increase for the region was estimated at –.14, with state–level elasticities ranging from –.08 for Washington to –.33 for Montana.

Accordingly, a 95+ foot drawdown at Ice Harbor is likely to induce a greater change in the production mix and cropping patterns and in the overall ownership patterns and capital structure of operators than the 6.5 foot drawdown at John Day, other things being equal.

The Preferred Alternative proposes a 6.5 foot drawdown of John Day which impacts irrigation and M&I pumper from that reservoir. The 4 lower Snake reservoirs are only drawn down to within the normal operating range of pumps, –– no pumping cost impacts were identified. The monetary impacts on John Day irrigation and M&I pumpers was presented in chapters 4 and 5. The response of individual irrigation pumpers to pumping cost increases under the Preferred Alternative depends on the capital/debt structure and the crop production efficiency of the individual. And as previously discussed, the impact on John Day pumpers would not be as great as on Ice Harbor irrigators under SOS5c. Any response by irrigation pumpers to an increase in pumping cost is played out in a dynamic environment interacting with other variables like commodity markets and production cost conditions in the PNW, the nation, and indeed in the world market.

5.4 MITIGATION FOR IMPACTS ON IRRIGATION AND M&I PUMPERS

As discussed in the above sections, several SOR alternatives would adversely impact irrigation pumping from reservoir pools behind John Day, Ice Harbor, and Grand Coulee, and M&I pumping from John Day and the 4 lower Snake River projects. Under the Preferred Alternative, only irrigation and M&I pumpers on the John Day pool would be affected.

Methods or ways to avoid or lessen the impact on irrigation and M&I pumpers is referred to as mitigation. Irrigation pumpers, in particular, have little or no opportunity to pass on the increased cost to customers or other users. Therefore, in reality, the only way to mitigate is for other entities to assume the increased cost. Several of the impacted commercial M&I pumpers may be able to pass on the increased cost in the form of rate increases or product prices. Non commercial M&I pumpers, like the Corps of Engineers wildlife irrigation systems, and public parks, would seek additional appropriations. In which case, the particular state or national taxpayers assume the cost.

It is not the purpose of this section to recommend specific mitigation. However, if mitigation is recommended as part of the EIS Record of Decision the question becomes one of how to externalize or pass on the increased cost, and who should be required to participate.

If the increased pumping cost are externalized and paid for by others, such as system electrical ratepayers or taxpayers, then pump owners are essentially insulated from the cost increase, and the associated indirect impacts affecting changes in cropping patterns, irrigation technology, on–farm work force, etc.

The dynamics and interrelationship of crop production costs and cropping patterns, crop practices, and the farm income position was discussed in Part 5.3. Of course, in the long–run, exogenous variables can also effect cropping patterns and practices.

If the pump modification and increased operating costs are assumed by irrigation pump owners, the increased production cost could induce changes in cropping patterns, irrigation technology, on farm work force, and agrinomic practices in varying degrees.

5.4.1 Adverse Effects on Irrigation Pumpers

The relative importance and affects of pumping cost increases (pump modification and pumping) on farm profitability was discussed in Part 5.3. Adverse effects for potential mitigation are discussed as follows.

Grand Coulee (FDR Reservoir)

The irrigation pumping cost differences among SOR alternative plans is relatively small. In comparison to the Base Case, irrigation pumping cost under some alternatives is actually reduced, including the Preferred Alternative. Accordingly, it is assumed that mitigation to irrigators is not required.

However, as discussed in section 5.2.1 if a Grand Coulee operation other than the Preferred Alternative is implemented, there is concern by project operators of the operability of the pumping units at Coulee. Under SOS 9a for example, the pumping units at Coulee are operated at the head differentials and for extended periods of time. Although pump modification was not considered necessary, operators are concerned about the possibility of increased wear and the ability to meet full irrigation demand during the peak season of critical water years is uncertain.

John Day

Presently, there are 139,500 acres irrigated from the John Day pool. Pumping cost increases for those SOR alternatives with drawdown range from $5 to $12 per acre, which is the annual equivalent cost of pump modification and the increased annual operation, maintenance, and power cost. The largest increase in pumping cost is under the Preferred Alternative with a pumping cost increase of $12 per acre on an annual equivalent basis (@7.75 %). It was assumed that a $12 per acre cost increase would not, by itself, significantly change cropping patterns and practices. The more significant and immediate impact is the initial pump modification investment required to maintain operability under drawdown conditions.

Ice Harbor

Presently, there are 35,389 acres irrigated from the Ice Harbor pool. Pumping cost increases for those SOR alternatives with drawdown range from $30 to $84 per acre on an annual equivalent basis (@7.75 %). There is no drawdown of the Ice Harbor pool under the Preferred Alternative. With a $84 per acre cost increase under other alternatives, several potential changes in irrigation farming operations may occur, including the possible reversion of some farms to dryland farming. These scenarios were detailed in Part 5.3.

As the Preferred Alternative does not propose drawdown of Ice Harbor, irrigation pumpers are not directly affected.

For both John Day and Ice Harbor, if an alternative with drawdown is selected, adverse impacts on irrigation pumpers could be fully avoided by assigning the pump modification cost and the increased operation, maintenance, and power costs to other entities. Impacts could be lessened by requiring other entities to assume the pump modification cost.

5.4.2 Adverse Effect on M&I Pumpers

M&I pumping is by local water systems, golf courses, fish hatcheries, sand and gravel companies, and government agencies operating parks and irrigating wildlife areas. It is assumed that these operations will continue under drawdown alternatives.

The Preferred Alternative proposes drawdown of John Day only, and not the four lower Snake River projects.

Adverse effects on commercial M&I pumpers could be avoided by assigning the pump modification cost and increased operation, maintenance, and power costs to other entities. Adverse impacts on non commercial M&I pumpers would probably be compensated for by seeking additional appropriations from local, state, and national governments.

CHAPTER 6

LIST OF PREPARERS

Irrigation and M&I interests were represented by a 31 member team know as the "Irrigation and M&I Work Group." The Work Group included people with a wide array of experience and interest in irrigation and M&I water supply. Most of the Work Group consisted of agricultural economists, irrigation water management and utilization specialists, and agricultural engineers. The members of the Irrigation/M&I Work Group are listed in table 6–1.

The appendix was written under direction of the Irrigation/M&I Work Group Coordinator. Information on irrigated acreages, irrigation water diversions, and net irrigation depletions was provided by the AG Crook Company, under contract with BPA. Work Group members provided valuable input in scoping and defining the analysis, formulation, and screening of irrigation/M&I alternatives, evaluation of potential irrigation alternatives as possible inclusion into the final SOR alternative operating strategies, scoping and defining the analysis for full scale analysis of the selected operating strategies, and technical review of the appendix.

Individuals directly responsible for preparing this appendix, including those providing major input and review are shown in table 6–2.

Table 6–1. Members of Irrigation/M&I Work Group

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Table 6–2. List of Preparers and Contributors

Name	Education/Years of Experience	Experience and Expertise	Role In Preparation
Bonneville Power Administration			
Bob Shank	B.S. Biology MRP Environmental Science 11 years	Multipurpose resource planning and evaluation. NEPA compliance	Scoping and formulation of irrigation alternatives. Appendix scoping and review.
Corps of Engineers			
Jim Fredericks Economist	B.S. Economics 6 years	Economic analysis of water resources development projects.	Increased pumping costs for irrigation and M&I pumpers. Appendix analysis/review. Appendix writing.
Frank McDonald	M.S. Industrial Engineering Regional Economist Professional Engineer 19 years	Economic analysis of water resources development projects.	Formulation of irrigation alternatives.
Individual			
Dick Erickson	Manager, East Columbia Basin I.D., B.S. Agricultural Engineering Professional, Engineer 19 years	Irrigation System Management Maintenance and operations. Public Administration.	Irrigation data – water use and acreages formulation of irrigation alternatives.
State of Idaho			
Dr. Charles Brockway University of Idaho Research and Extensions	B.S. Civil Engineering M.S. Civil Engineering Ph.D. Water Resource Engineering 31 years	Hydrology – Ground–water and surface water systems. Water Systems – design, evaluation, and management.	Hydrology – Snake River Basin. Formulation of irrigation alternatives.
Alan Robertson, IDWR Supervisor/Hydrology	B.S. M.S. Agricultural Engineering	Hydrology – surface and ground water. Irrigation.	Hydrology of Irrigation. Formulation of irrigation alternatives.
US Bureau of Reclamation			
Allen Reiners Economist	B.S. Agricultural Economics M.S. Agricultural Economics 27 years	Economic Justification Analysis – Financial Analysis Repayment and Contracts	Irrigation and M&I Work Group Coordinator Economics Work Group Appendix preparation and writing.
Harold Ward Economist	B.S. Agricultural Economics M.S. Agricultural Economics 37 years	Economic Justification Analysis – Water Resources Financial	Irrigation and M&I Work Group Coordinator (retired) Economics Work Group Appendix writing. Retired December 1992.
Harry Taylor Engineer	B.S. Civil Engineering 22 years	Water Operations – Hydrology	Operation Studies Grand Coulee Pumping Requirements
Eldon Johns	MS Agricultural Hydrology	Water Rights – Irrigation	Water Rights, Technical Review SNAG. Appendix writing.
Allen Powers	B.S. Natural Resources Management, M.S. Earth Science Education	Water Management	Irrigation Management. Appendix Review.

CHAPTER 7

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[1]"Screening Analysis: A Summary, The Columbia River System", Columbia River System Operation Review (SOR) Interagency Team, August 1992.

[2]Ibid.

[3]"Screening Analysis – Volume 1, Description and Conclusions, Columbia River System Operation Review, Columbia River System Operation Review (SOR) Interagency Team, August 1992.

[4]Source: "1990 Level Modified Streamflow, 1928–1989," Columbia River and Coastal Basins, Prepared for Bonneville Power Administration by A.G. Crook Company, April 1993.

[5]Note: Relift project pumping occurs at various locations on the Columbia Basin project. The alternative operating strategies would not effect this pumping. A small amount of Columbia Basin Project water is pumped from the McNary pool near Burbank, Washington site, which would not be affected by alternative strategies.

[6]Impacts at Coulee do not include those associated with a non operating 1,700 acre irrigation project on Indian reservation land. Land were formerly served by water pump from Coulee (FDR) – upper end of reservoir.

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