Formal Consultation Package
for Relicensing

Hells Canyon Project
FERC No. 1971

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Formal Consultation Package
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Hells Canyon Project
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I.
Introduction

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I. INTRODUCTION

I.
INTRODUCTION

1.1.
Contents of Formal Consultation Package

This is the Formal Consultation Package for relicensing of Idaho Power Company's (IPC) Hells Canyon Project - Federal Energy Regulatory Commission (FERC) Project No. 1971. Prepared in accordance with 18 CFR § 16.8, this package contains:

- detailed maps showing existing project boundaries, if any; proper land descriptions of the entire project area by township, range and section, as well as by state, county, river, river mile, and closest town; and also showing the specific location of all existing and proposed project facilities, including roads, transmission lines and any other appurtenant facilities,
- a general engineering design of the existing project and any proposed changes, with a description of any existing or proposed diversion of a stream through a canal or a penstock,
- a summary of the existing operational mode of the project and any proposed changes,
- identification of the environment to be affected, the significant resources present and the applicant's existing and proposed environmental protection, mitigation and enhancement plans, to the extent known at that time,
- streamflow and water regime information, both existing and proposed, including drainage area, natural flow periodicity, monthly flow rates and durations, mean flow figures illustrating the mean daily streamflow curve for each month of the year at the point of diversion or impoundment, with location of the stream gauging station, the method used to generate the streamflow data provided, and copies of all records used to derive the flow data used in the applicant's engineering calculations,
- detailed descriptions of any proposed studies and the proposed methodologies to be employed, and
- appendices of related materials.

Before an application for a new license is filed, FERC regulations require that an applicant consult with the relevant federal, state and interstate resource agencies and any Indian tribe that may be affected by the project. Specifically, the agencies to be included are the National Marine Fisheries Service (NMFS), the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), the United States

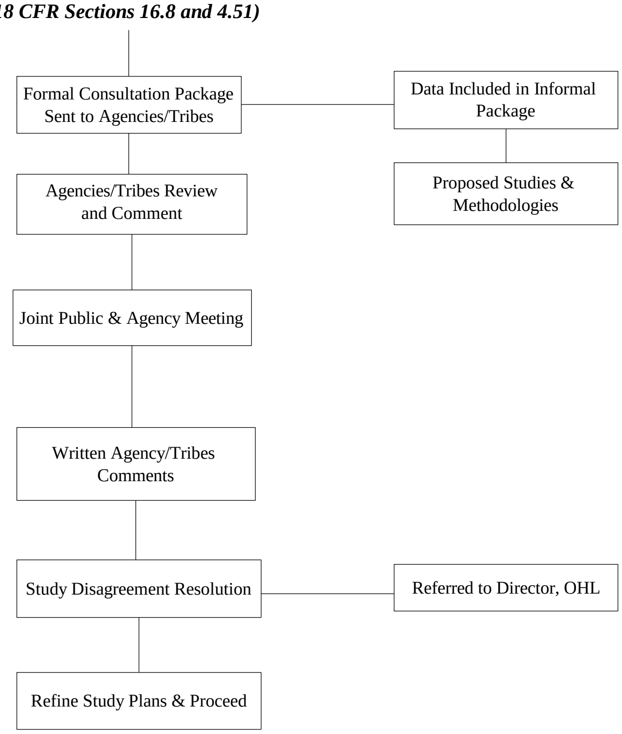
Environmental Protection Agency (EPA), the federal agency administering any United States lands or facilities utilized or occupied by the project, the appropriate state fish and wildlife agencies, the certifying agency under Section 401(a)(1) of the Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. 1341(c)(1), and State Historic Preservation Offices. The FERC-required consultation process is as follows:

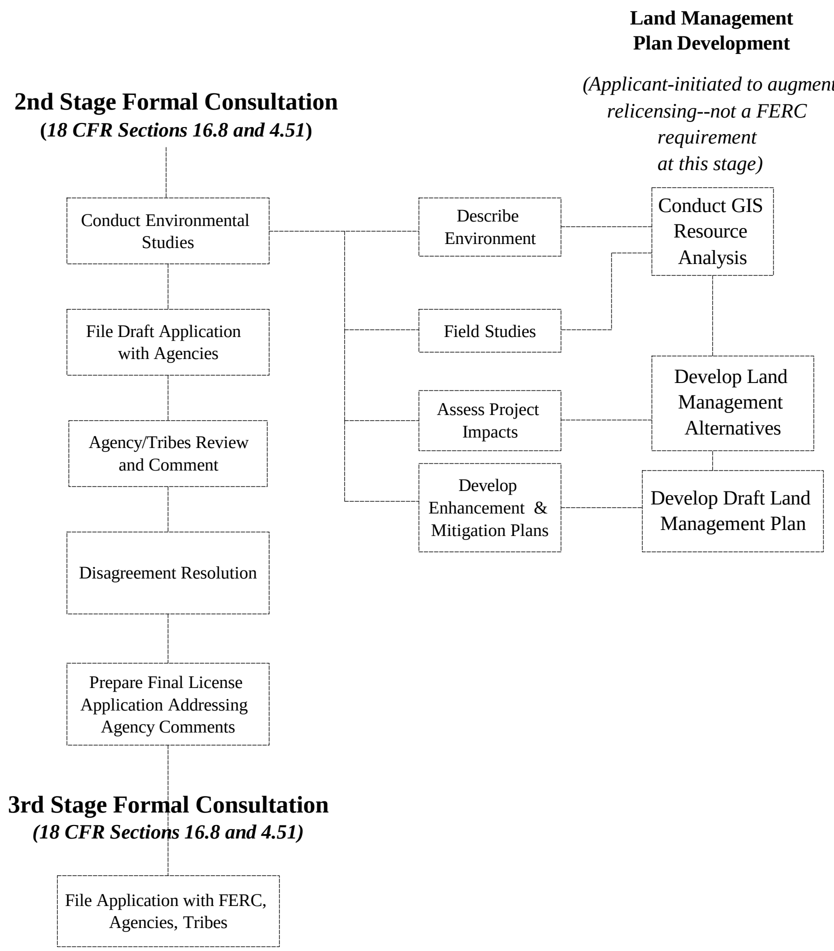
AN OVERVIEW OF THE FERC-REQUIRED RELICENSING CONSULTATION PROCESS:

1st Stage Formal Consultation

("Formal" Consultation refers to that required by FERC Regulations)

(18 CFR Sections 16.8 and 4.51)





This Formal Consultation Package responds to FERC requirements for first-stage consultation. Following refinement of study plans in 1997, second-stage consultation for the Hells Canyon Project begins with the execution of studies and continues through the distribution of the draft license application to agencies and tribes, and the preparation of the final license application. The final license application must be filed with the FERC, agencies, and tribes no later than July 31, 2003, two years prior to expiration of the current license on July 31, 2005.

1.2. Collaborative Process for Relicensing Consultation

In addition to the consultation required by the FERC, IPC elected to consult informally with agencies, tribes, nongovernmental organizations, and the public through a collaborative process as described below. The descriptions of proposed studies in Section VIII of the Formal Consultation Package were developed by participants in the collaborative process and generally represent a consensus to date. One major non-consensus issue, the need for pre-construction studies (related to resource conditions that pre-existed the project), emerged from collaborative process discussions. Information regarding this issue may be found in Sections IX and Appendix XIII.D of the Formal Consultation Package.

The collaborative process provides a way to involve stakeholders early in the relicensing process, during the pre-filing period, so that issues can be evaluated and addressed effectively. It is intended to increase the likelihood of consensus on relicensing issues and to help strike an appropriate balance between project operations and the protection, mitigation and enhancement of resource values. The collaborative process was designed to meet all FERC requirements, and to enhance the traditional process by providing more and better opportunities for stakeholders to communicate and cooperate.

The collaborative process grew out of the IPC-sponsored Agency Review Team meeting on February 6, 1996. The meeting focused on ways to improve communication and cooperation in the relicensing process. Subsequently, representatives from IPC, the USFWS, the Idaho Office of the Attorney General, and Idaho Rivers United were designated to draft a collaborative process document (Appendix XIII.B) that the larger group of agencies, tribes and nongovernmental organizations ultimately endorsed.

IPC is one of many Collaborative Team members. The extensive list of participants includes representatives from federal, state and local government, tribes, nongovernmental organizations, the public, and IPC customers (the list of parties who submitted a written commitment to participate and the current list of interested parties are attached to Appendix XIII.B).

As part of the collaborative process, IPC and agency resource specialists formed Work Groups to address aquatic, terrestrial, recreation, aesthetic, and economic issues. Since February 1996, the Collaborative Team and most Work Groups have met monthly to identify issues (Appendix XIII.C) and develop study proposals (Section VIII). The Collaborative Team also sponsored a series of public meetings to obtain input on relicensing issues (public comments are included in the list of issues in Appendix XIII.C).

IPC provides a professional facilitator and support staff for the Collaborative Team, in addition to the IPC staff members who actively participate in the development and implementation of the process. It is IPC's intention to sponsor the collaborative process throughout the pre-filing consultation period for the Hells Canyon Project, as long as stakeholders continue to participate in this forum.

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II.
MAPS

Detailed maps of the Hells Canyon Project, FERC Project No. 1971, are included as Figures 2-2.1 through 3-15 in Section XII. The maps show existing project boundaries, land descriptions of the entire project area by township, range and section, as well as by state, county, river mile and closest town. The maps also show the location of existing facilities including roads, transmission lines and other appurtenant facilities. No changes in project boundaries are proposed at this time.

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III.
Engineering Design

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III. ENGINEERING DESIGN

III.
ENGINEERING DESIGN

3.1.
Brownlee Development - FERC No. 1971-01

The Brownlee Development is located at river mile (RM) 284.6 of the Snake River on the Idaho-Oregon border approximately 20 miles northwest of Cambridge, Idaho. It is the uppermost development of the three-dam Hells Canyon Project which includes the Brownlee, Oxbow, and Hells Canyon Developments. Brownlee Dam is 12.4 river miles upstream of Oxbow Dam and 37.6 river miles upstream of Hells Canyon Dam. The nearest upstream dam is the Swan Falls Project, which is 172.7 river miles upstream. The Brownlee Development was originally completed in 1958. The general plan of the Brownlee Development is shown in Figure 3-1.

3.1.1.
Project Structures

3.1.1.1.
Dam

Brownlee Dam is a 1,380-foot-long earth and rockfill structure with an upstream sloping core and filter zones, and downstream rock shell. The dam has a maximum height of 395 feet and a crest width of 35 feet at elevation 2090, with a 7-foot added camber at the center of the dam. The upstream sloping core and filter zones are founded on the underlying basalt rock. Portions of the upstream and downstream rockfill shells are founded on the original streambed sand, gravel, and boulders. The upstream face of the dam has an average slope of 3:1 below elevation 2060 and a slope of 2:1 above elevation 2060. The downstream face has a slope of 1.4:1 down to elevation 1850, with a berm at the downstream toe. No changes to the dam are proposed. Plan and cross-section views of the dam are shown on Figures 3-1 and 3-2, respectively.

3.1.1.2. Spillway

The spillway is a concrete gravity structure located on the left (in Oregon) abutment of the dam in a cut in the basalt rock. The spillway is approximately 190 feet wide and has a foundation elevation of 1922, an ogee crest elevation of 2027, and a top bridge deck elevation of 2090. The structure contains four crest gates, three low-level outlet gates, and a 173-foot-wide concrete-lined chute that discharges into the Snake River. The steel gates consist of four 32-foot-wide by 50-foot-high radial crest gates and three 23-foot-wide by 23-foot-high low-level radial outlet gates. The crest gate ogee elevation is 2027, while the low-level outlet gate sill elevation is 1938. In the closed position, the crests of the spillway gates are at elevation 2077, which is the normal maximum reservoir elevation. Reinforced concrete piers, 15 feet wide, are spaced between the crest gate bays and support the crest gates, the top bridge deck, and the gate hoisting equipment. The spillway capacity is 307,300 cubic feet per second (cfs) at normal maximum reservoir elevation 2077. No changes to the spillway are proposed. The spillway section is shown in Figure 3-3.

3.1.1.3. Intake and Penstocks

The intake structure is of reinforced concrete and is located on the right (in Idaho) abutment of the dam in a cut in the basalt rock. The intake structure is approximately 275 feet long and 165 feet high from foundation to top deck, and contains five intakes fitted with trash racks, gate guides, and connections to five penstocks. A 16-foot-wide by 30-foot-high sliding headgate is provided for each intake to allow dewatering of the penstocks when desired. The intakes for Units 1 through 4 are connected to their respective generating units by four 512-foot-long steel penstocks 24 feet in diameter. A 660-foot-long steel penstock 28 feet in diameter connects the Unit 5 intake to the fifth generating unit. All five penstocks are constructed in tunnels driven through the basalt rock with concrete placed in the annular space between the rock and the steel penstock. No changes to the intakes or penstocks are proposed. Details of the intake and penstocks are shown in Figures 3-3 and 3-5.

3.1.1.4. Powerhouse

The reinforced concrete powerhouse contains five generating units and is located immediately below the right abutment in a cut in the basalt rock. The powerhouse is approximately 390 feet long and varies in width from 104 feet at Units 1 through 4 to 137 feet at Unit 5. The powerhouse also contains a 300-ton gantry crane and a 400-ton gantry crane, which are used for assembly and disassembly of the generating units. No changes to the powerhouse are proposed. Powerhouse plans and sections are shown in Figure 3-4.

3.1.1.5. Tailraces

The Brownlee project has two separate tailrace channels: one channel carries water discharged from Units 1 through 4 while the second channel carries water discharged from Unit 5. Both tailrace channels are unlined and are excavated in basalt rock. The channel serving Units 1 through 4 is approximately 800 feet long, averages 250 feet in width, and has an average water depth of 25 feet. The channel serving Unit 5 is approximately 1,350 feet long, varies in width from approximately 46 feet at the powerhouse to 130 feet where it enters the Snake River, and varies in depth from approximately 75 feet at the powerhouse to 35 feet where it enters the Snake River. The lower half of the Unit 5 tailrace channel originally served as the diversion tunnel outlet channel during construction of Units 1 through 4. No changes to the tailrace channels are proposed. Both tailrace channels are shown in plan view in Figure 3-1. The Unit 5 tailrace channel is also shown in Figure 3-5.

3.1.2. Reservoir

Brownlee Reservoir extends from Brownlee Dam upstream approximately 58 miles on the Snake River.

General reservoir data are as follows:

Location	Snake River RM 284.6 (dam)
Length	58 miles
Reservoir Water Surface Elevations:	
Normal Maximum	2077.0 feet msl
Minimum	1976.0 feet msl
Surface Area	14,621 acres at elevation 2077.0
Total Storage	1,420,062 acre-feet
Usable Storage	975,318 acre-feet
Usable Draft	101.0 feet

No changes in the reservoir elevation, area, or volume are proposed for this project.

3.1.3. Turbines And Generators

The powerhouse contains five vertical Francis-type turbines. Each turbine is directly connected to a vertical-shaft, three-phase generator operating at 60 cycles per second. The generators are self-cooling with cooling water supplied from the reservoir. The turbines and generators for Units 1, 2, 3, and 4 are identical and were installed in 1958. The Unit 1 and 2 generators were rewound in 1972; the generators for Units 3 and 4 were rewound in 1973. The turbine and generator for Unit 5 are significantly larger than those of the other four units and were installed in 1980. No changes to the turbines and generators are proposed for this project. A summary of the existing turbine and generator data is presented below.

	Units 1, 2, 3, & 4	Unit 5
Turbine		
Type	Vertical Francis	Vertical Francis
Nameplate Net Head	250 feet	240 feet
Nameplate Output	144,000 hp	301,609 hp (computed)
Hydraulic Capacity @ Nameplate Net Head & Output	5,675 cfs	11,800 cfs
Generator		
Nameplate kVA	100,111 kVA	250,000 kVA
kW (calculated)	90,100 kW	225,000 kW
Power Factor	90%	90%
Voltage	13.8 kV	13.8 kV

3.1.4. Appurtenant Equipment

3.1.4.1. Mechanical

Governing equipment for the turbines consists of a dual cabinet actuator serving Units 1 and 2, a second dual cabinet actuator serving Units 3 and 4, and a single cabinet actuator serving Unit 5. No changes to the mechanical equipment are proposed.

3.1.4.2.
Electrical

The main power transformers are located on downstream side of the top deck of the powerhouse. The four main transformers for Units 1, 2, 3, and 4 are 230,000/13,800-volt, three-phase, forced oil and air cooling (FOA) type units rated at 116,000 kVA. The main transformer for Unit 5 is a 230,000/13,800-volt, three-phase, FOA type unit rated at 256,700 kVA at 55☜C and 287,500 kVA at 65☜C. Local service power for the station is supplied by five three-phase 13,800/480-volt transformers, one from each of the five generators. The local service transformers from Units 1 through 4 are rated at 500 kVA each while the local service transformer from Unit 5 is rated at 1,000 kVA. Standby local service is provided by one 2,500-kVA three-phase 12,500/480-volt transformer from a nearby distribution line. No changes to the electrical equipment are proposed.

3.1.4.3.
Transmission Lines

Each step-up transformer at the Brownlee powerhouse is connected to IPC’s transmission system at Brownlee switchyard by a 230-kV line which is approximately 0.25 miles long. Brownlee switchyard is interconnected to IPC’s transmission system by the transmission lines described on the following page.

Name of Line	Voltage	Length
Boise-Brownlee-Baker (Figures 2-6.1.1, 2-6.1.2, 2-6.2.1, 2-6.2.2, 2-7)		
Operated as Brownlee-Boise Bench No. 1 and 2 (904),	230 kV (two circuits)	100.1 miles southeast to Boise, ID on steel lattice towers
and Paddock-Ontario (904),	230 kV (two circuits)	23.1 miles on steel lattice towers
and Brownlee-Quartz Junction (903)	230 kV	43.2 miles west on two pole wood structures
Boise-Brady No. 2 (Figures 2-8.1.1, 2-8.1.2, 2-8.2.1, 2-8.2.2, 2-8.2.3, 2-8.2.4)		
Operated as Boise Bench-Midpoint No. 2 (906),	230 kV	105.2 miles southeast from Boise to Midpoint substation
and Borah-Brady No. 2 (923),	230 kV	4.0 miles southest from Boise to Midpoint substation
and Midpoint-Adelaide-Borah No. 2 (951)	345 kV	77.9 miles east from Midpoint substation to Adelaide substation
Brownlee-Boise Bench No. 3 and 4 (911) (Figures 2-9.1, 2-9.2.1, 2-9.2.2)	230 kV (two circuits)	102.6 miles southeast to Boise, ID on steel lattice towers
Boise Bench-Midpoint No. 3 (912) (Figures 2-10.1, 2-10.2.1, 2-10.2.2, 2-10.2.3)	230 kV (two circuits)	106.6 miles southeast from Boise to Midpoint substation

No changes to the transmission lines are proposed.

3.2.
Oxbow Development - FERC No. 1971-02

The Oxbow Development is located at RM 272.2 of the Snake River on the Idaho-Oregon border approximately 27 miles west of New Meadows, Idaho. It is the middle development of the three-dam Hells Canyon Project which includes the Brownlee, Oxbow, and Hells Canyon Developments. Oxbow Dam is 12.4 river miles downstream of Brownlee Dam and 25.2 river miles upstream of Hells Canyon Dam. The Oxbow Development was originally completed in 1961. The general plan of the Oxbow Development as it currently exists is shown in Figure 3-6.

3.2.1.
Project Structures

3.2.1.1.
Dam

Oxbow Dam is a 960-foot-long earth and rockfill structure with upstream sloping and filter zones, and downstream rock shell. The dam has a maximum height of 209 feet and a crest width of 40 feet at elevation 1820, with a 5-foot added camber at the center of the dam. The upstream sloping core and filter zones are founded on underlying metamorphic rock. Portions of the upstream and downstream rockfill shells are founded on the original streambed materials. The upstream face of the dam has a slope of 2.5:1. The downstream face of the dam has a slope of 1.4:1 down to elevation 1709, with a berm at the downstream toe. An access road is present on the downstream face of the dam between the crest and the toe. No changes to the dam are proposed. Plan and cross-section views of the dam are shown on Figures 3-7 and 3-8, respectively.

3.2.1.2. Spillways

The Oxbow development has two spillways with a combined capacity of 300,000 cfs. The principal spillway is a concrete gravity structure located on the left (in Oregon) abutment of the dam in a cut in the basalt rock. The spillway is approximately 128 feet wide and has a foundation elevation of 1720, an ogee crest elevation of 1755, and a top bridge deck elevation of 1820. The structure contains three 32-foot-wide by 50-foot-high radial gates and a 112-foot-wide concrete lined chute that discharges into the Snake River. In the closed position, the crests of the spillway gates are at elevation 1805, the normal maximum reservoir elevation. Reinforced concrete piers, 8 feet wide, are spaced between the gate bays and support the radial gates, the top bridge deck, and the gate hoisting equipment. At a 5-foot reservoir surcharge elevation of 1810, the spillway capacity is 150,000 cfs. The current minimum streamflow below the dam of 100 cfs is passed through the spillway via four valves located on the skid plate of spillway gate number 1. No changes to the spillways are proposed. The spillway section is shown in Figure 3-8.

The emergency spillway at Oxbow is located on the right (in Idaho) abutment of the dam and consists of a 450-foot-long erodible fuse plug embankment structure and a 75-foot-wide concrete-lined chute that discharges to the Snake River. The fuse plug embankment is constructed with upstream sloping core and filter zones and both upstream and downstream rock fill shells. The fuse plug is founded on a concrete sill at elevation 1785 and has a crest elevation that varies from elevation 1812 to 1814, or 6 to 8 feet lower than the crest elevation of the main dam. The upstream face of the fuse plug embankment has a slope of 2.25:1 and the downstream face has a slope of 1.5:1. A pilot channel, 10 feet wide at elevation 1809, is designed to start the erosion of the fuse plug. At a 5-foot reservoir surcharge elevation of 1810, the fuse plug spillway capacity is

150,000 cfs when completely washed out. No changes to the fuse plug spillway are proposed. The fuse plug emergency spillway section is shown in Figure 3-8.

3.2.1.3. Intakes and Penstocks

The intake system consists of a reinforced concrete power tunnel intake structure, two concrete-lined power tunnels, two reinforced concrete surge tanks, and four steel penstocks. The power tunnel intake is located on the left (in Oregon) bank of Oxbow reservoir approximately 2,400 feet upstream of Oxbow dam. The power tunnel intake consists of two structures, each 76 feet wide by 106 feet high, with their centerlines located 122 feet apart. Each intake is fitted with trash racks, stoplog slots, and connection to a concrete-lined power tunnel. The power tunnels are horseshoe-shaped, with 36-foot diameters, and are 781 and 841 feet long. The two power tunnels are excavated into the basalt and are concrete-lined for their entire length. A 50-foot deep surge tank, 130 feet in diameter, is located at the downstream end of each tunnel. At the surge tanks, each tunnel divides into two 23-foot-diameter steel penstocks. The inlet to each penstock has an 18-foot-wide by 30-foot-high wheeled gate which is used to dewater the penstocks when desired. The penstocks are 173 feet long and convey flow to the four generating units. All four penstocks are constructed in tunnels driven through the basalt with concrete placed in the annular space between the rock and the steel penstock. No changes to the intakes or penstocks for the main powerhouse are proposed. Details of the intake and penstocks are shown in Figure 3-9.

3.2.1.4. Powerhouse

The reinforced concrete powerhouse contains four generating units and is located on the left side (in Oregon) of the Snake River immediately below the surge tanks. The powerhouse is approximately 276 feet long and 106 feet wide, and contains a 230-ton gantry crane which is used for assembly and disassembly of the generating units. No changes to the powerhouse are proposed. Powerhouse plans and sections are shown in Figure 3-10.

3.2.1.5. Tailrace

The Oxbow powerhouse discharges flow directly into the river. As a result, there is no specific tailrace channel. This configuration is shown in Figures 3-6 and 3-9.

3.2.2. Reservoir

Oxbow Reservoir extends from Oxbow Dam upstream approximately 12 miles to the toe of Brownlee Dam on the Snake River. General reservoir data are as follows:

Location	Snake River RM 272.2 (dam)
Length	12 miles
Reservoir Water Surface Elevations:	
Normal Maximum	1805.0 feet msl
Minimum	1795.0 feet msl
Surface Area	1,150 acres at elevation 1805.0
Total Storage	53,386 acre-feet
Usable Storage	11,100 acre-feet
Usable Draft	10.0 feet

No changes in the reservoir elevation, area, or volume are proposed for this project.

3.2.3. Turbines And Generators

The existing powerhouse contains four vertical Francis-type turbines. Each turbine is directly connected to a vertical shaft, three-phase generator operating at 60 cycles per second. The generators are self-cooling with cooling water supplied by the reservoir. The turbines and generators for all four units are identical and were installed in 1961. The generators for Units 1, 2, 3, and 4 were rewound in 1991, 1990, 1989, and 1988, respectively. No changes to the turbines and generators are proposed for Units 1, 2, 3, or 4. A summary of the existing, and proposed, turbine and generator data is presented below:

	Units 1, 2, 3, & 4
Turbine	
Type	Vertical Francis
Nameplate Net Head	115 feet
Nameplate Output	73,000 hp
Hydraulic Capacity @ Nameplate Net Head & Output	6,100 cfs
Generator	
Nameplate kVA	52,778 kVA
kW (calculated)	47,500 kW
Power Factor	90%
Voltage	13.8 kV

3.2.4.
Apurtenant Equipment

3.2.4.1.
Mechanical

Governing equipment for the existing turbines consists of a dual cabinet actuator serving Units 1 and 2 and a second dual cabinet actuator serving Units 3 and 4. No changes to the mechanical equipment are proposed.

3.2.4.2.
Electrical

Two main power transformers are located on the downstream side of the top deck of the powerhouse. One transformer serves Units 1 and 2 while the second transformer serves Units 3 and 4. Each of the two main transformers are 230,000/13,800-volt, three-phase, FOA type units rated at 122,000 kVA at 55 ☜C rise. Local service power for the station is supplied by four 750-kVA, three-phase, 13,800/480-volt transformers, one from each generator. Standby local service is provided by one 500-kVA, three-phase, 12,500/480-volt transformer from a nearby distribution line. No changes to the electrical equipment are proposed.

3.2.4.3. Transmission Lines

Each step-up transformer at the Oxbow powerhouse is connected to IPC's transmission system at Oxbow switchyard by a 230-kV line which is approximately 0.15 miles long. Oxbow switchyard is interconnected to IPC's transmission system by the following transmission lines:

Name of Line	Voltage	Length & Type
Oxbow-Brownlee (905) (Figure 2-11)	230 kV (two circuits)	10.4 miles south to Brownlee switchyard on steel lattice towers
Oxbow-Pallette Junction (907) (Figure 2-12)	230 kV (two circuits)	20.1 miles north on steel lattice towers to Pallette Junction
Pallette Junction-Divide Creek (Figure 2-13)		
Operated as Pallette Junction-Imnaha (908),	230 kV	24.6 miles north from Pallette Junction to Imnaha substation
and Imnaha-Divide Creek (909)	230 kV	20.2 miles north from Imnaha to Divide Creek subdivision

No changes to the existing transmission lines are proposed.

3.3.
Hells Canyon Development - FERC No. 1971-03

The Hells Canyon Development is located at RM 247.0 of the Snake River on the Idaho-Oregon border approximately 23 miles southwest of Riggins, Idaho. It is the lowermost development of the three-dam Hells Canyon Project which includes the Brownlee, Oxbow, and Hells Canyon Developments. Hells Canyon Dam is 25.2 river miles downstream of Oxbow Dam and 37.6 river miles downstream of Brownlee Dam. The Hells Canyon Development was completed in 1967. The general plan of the Hells Canyon Development is shown in Figure 3-11.

3.3.1.
Project Structures

3.3.1.1.
Dam

Hells Canyon Dam is a 910-foot-long concrete gravity dam with integral spillway and intake sections. The dam has a maximum height of 330 feet and a crest width of 27 feet at elevation 1695. The upstream face of the dam is vertical. The downstream face of the dam is vertical from the crest down to elevation 1660 and a slope of 0.75:1 below elevation 1660 to the toe. No changes to the dam are proposed. Plan, elevation, and section views of the dam are shown in Figures 3-11 and 3-12.

3.3.1.2. Spillway

The spillway is integral to and is located in the center of the concrete gravity dam. The spillway consists of three crest gates, two low-level outlet gates, a 159-foot-wide spillway chute, and a concrete roller bucket energy dissipator at the downstream end of the chute below tailwater. The left wall of the spillway chute forms the end wall of the powerhouse. The steel gates consist of three 43-foot-wide by 50-foot-high radial crest gates and two 23-foot-wide by 25-foot-high low-level radial outlet gates. The crest gate ogee elevation is 1638 while the low-level outlet gate sill elevation is 1549. In the closed position, the crests of the spillway gates are at elevation 1688, the normal maximum reservoir elevation. Reinforced concrete piers, 15 feet wide, are spaced between the crest gate bays and support the crest gates, the top bridge deck, and the gate hoisting equipment. At a 5-foot reservoir surcharge elevation of 1693, the spillway capacity is 300,000 cfs. No changes to the spillway are proposed. The spillway section is shown in Figure 3-12.

3.3.1.3. Intakes and Penstocks

The intake is integral to the concrete gravity dam and consists of three intake openings fitted with trash racks, gate guides, and connection to three steel penstocks. A 20-foot-wide by 41-foot-high wheel gate and gate hoist structure are provided at each intake for dewatering the penstocks when desired. The intakes are connected to their respective generating units by three 164-foot-long steel penstocks, 24 feet in diameter. The steel penstocks are encased in the concrete gravity dam. No changes to the intakes or penstocks are proposed. Details of the intake and penstocks are shown in Figure 3-12.

3.3.1.4.
Powerhouse

The reinforced concrete powerhouse contains three generating units and is located immediately adjacent to the downstream side of the concrete gravity dam on the left (in Oregon) abutment. The powerhouse is approximately 196 feet long. The powerhouse also contains a 400-ton gantry crane which is used for assembly and disassembly of the generating units. No changes to the powerhouse are proposed. Powerhouse plans and sections are shown in Figure 3-13.

3.3.1.5.
Tailrace

The Hells Canyon powerhouse is located directly adjacent to the downstream side of the dam and discharges flow directly into the Snake River. The river bed was excavated at a 6:1 slope down to the powerhouse draft tube elevation. This configuration is shown in Figures 3-11 and 3-12.

3.3.1.6.
Hells Canyon Dam Fish Trap

The Hells Canyon Dam Fish Trap is a reinforced concrete structure located directly downstream of Hells Canyon powerhouse on the Oregon side of the Snake River. The fish trap was completed in 1984 and is part of the Hells Canyon Settlement Agreement (1980). Salmon and steelhead returning to spawn are trapped in the fish trap and transported to IPC hatcheries for spawning. The fish trap is shown in plan and section views in Figures 3-14 and 3-15.

3.3.2. Reservoir

Hells Canyon Reservoir extends from Hells Canyon Dam upstream approximately 25 miles to the Oxbow powerhouse on the Snake River. General reservoir data are as follows:

Location	Snake River RM 247.0 (dam)
Length	25 miles
Reservoir Water Surface Elevations:	
Normal Maximum	1688.0 feet msl
Minimum	1678.0 feet msl
Surface Area	2,412 acres at elevation 1688.0
Total Storage	167,720 acre-feet
Usable Storage	23,060 acre-feet
Usable Draft	10.0 feet

No changes to the reservoir elevation, area, or volume are proposed.

3.3.3. Turbines And Generators

The powerhouse contains three vertical Francis-type turbines. Each turbine is directly connected to a vertical-shaft, three-phase generator operating at 60 cycles per second. The generators are self-cooling; cooling water is supplied by the reservoir. The turbines and generators for all three units are identical and were installed in 1968. The generators for Units 1, 2, and 3 were rewound in 1987, 1985, and 1986, respectively. No changes to the turbines and generators are proposed. A summary of the existing turbine and generator data is presented below:

	Units 1, 2, and 3
Turbine	

Type	Vertical Francis
Nameplate Net Head	210 feet
Nameplate Output	195,000 hp
Hydraulic Capacity @ Nameplate Net Head & Output	9,000 cfs

Generator

Nameplate kVA	145,000 kVA
kW (calculated)	130,500 kW
Power Factor	90%
Voltage	14.4 kV

3.3.4. Appurtenant Equipment

3.3.4.1. Mechanical

Governing equipment for the turbines consists of three single cabinet actuators, each serving a single turbine. No changes to the mechanical equipment are proposed.

3.3.4.2. Electrical

The main power transformers are located on upstream side of the top deck of the powerhouse. The three main transformers for Units 1, 2, and 3 are 230,000/14,400-volt, three-phase, FOA type units rated at 166,667 kVA at 55☜C rise and 186,667 kVA at 65☜C. rise. Local service power for the station is supplied by two 1,000-kVA, three-phase, 14,400/480-volt transformers, one from Generator 1 and one from Generator 2. Standby local service is provided by one 1,000-kVA, three-phase, 69,000/480-volt transformer from a nearby distribution line. No changes to the electrical equipment are proposed. The Hells Canyon switchyard is installed on a steel framework mounted on the left downstream side of the dam at elevation 1617.

3.3.4.3. Transmission Lines

The Hells Canyon plant switchyard is connected to IPC's transmission system by the following transmission lines:

Name of Line	Voltage	Length & Type
Hells Canyon-Pallette Junction (910) (Figure 2-14)	230 kV (two circuits)	8.3 miles west on steel lattice towers
Pallette Junction-Enterprise (913) (Figure 2-15)	230 kV	29.6 miles west from Pallette Junction to Enterprise Oregon
Pine Creek - Hells Canyon (Figure 2-16)		
Operated as Oxbow-Hells Canyon (945)	69 kV	21.9 miles south to Pine Creek substation on single wood pole structures

No changes to the transmission lines are proposed.

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IV.
Operation

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4.1.
Hells Canyon Complex Qualitative Discussion Of Operations

The three-dam Hells Canyon Complex has always been a multiple-use facility; however, the initial primary purpose for construction of the project was power generation. Over the past decade or so, the framework for operations at the Hells Canyon Complex has changed quite significantly as a result of restrictions and requirements for flood control, anadromous fish spawning and protection, and recreation.

After meeting the requisite license conditions and environmental restrictions, the driving forces for generating power at the Hells Canyon Complex are the markets for power, amount of energy being bought and sold, and the project inflows, which include the Snake River, Burnt River, Wildhorse River, Pine Creek, and Powder River flows. Ancillary service goals, which include load shaping, load following, voltage control, and spinning reserves, are also operational objectives of the Hells Canyon Complex. The three Hells Canyon Complex plants are operated in close coordination so as to operate in the most efficient manner possible within the bounds of the requisite license and environmental restrictions. This typically involves increasing generation during the daytime hours and decreasing generation during the nighttime hours in order to meet the daily load shape. Because the hydraulic capacities of the Oxbow and Hells Canyon plants are significantly less than that of the Brownlee plant, Oxbow and Hells Canyon reservoirs are often drafted at night in order to receive the increased Brownlee outflows during the daytime hours.

More detailed information regarding the specific operation of each of the three plants is included in Sections 4.2, 4.3, and 4.4.

Brownlee Reservoir, the reservoir furthest upstream within the Hells Canyon Complex, has a useable storage capacity of 980 thousand acre-feet. Because of its large storage capacity and its position at the upstream end of the Hells Canyon Complex, operations at Brownlee drive operations of the entire three-dam complex and make Brownlee the focus of flood control, anadromous fish operations, and recreational issues. On a year-round basis, the Hells Canyon Complex operates under project license restrictions as well as anadromous fish protection restrictions pursuant to the 1980 Hells Canyon Settlement Agreement. The creation of water rental pools in 1979 also influences Hells Canyon Complex operations. Each of these requirements is discussed in more detail below.

4.1.1. Navigation Requirements

Article 43 of the Hells Canyon issuing license states,

> *"The project shall be operated in the interest of navigation to maintain 13,000 cfs flow in the Snake River at Lime Point (river mile 172) a minimum of 95% of the time, when determined by the Chief of Engineers to be necessary for navigation. Regulated flows of less than 13,000 cfs will be limited to the months of July, August, and September, during which time operation of the project would be in the best interest of power and navigation, as mutually agreed to by the Licensee and the Corps of Engineers. The minimum flow during periods of low flow or normal minimum plant operations will be 5,000 cfs at Johnson's Bar, at which point the maximum variation in river stage will not exceed one foot per hour."*

In August of 1988, IPC and the U.S. Army Corps of Engineers (COE) agreed to a minimum flow of at least 6,500 cfs when 13,000 cfs could not be met at Lime Point during July, August, and September without drafting Brownlee Reservoir. This minimum flow has been in effect since that time, except in 1992.

In that year, which was the lowest water year on record since 1960, Brownlee Reservoir inflows averaged just over 6,000 cfs during June, July, and August.

4.1.2. Anadromous Fish Recovery and Protection

Anadromous fish operations of the Hells Canyon Complex have been guided primarily by the Endangered Species Act and the Fall Chinook Recovery Plan. The Hells Canyon Settlement Agreement (1980), the Proposed Recovery Plan for Snake River Salmon and subsequent Biological Opinion of the National Marine Fisheries Service (NMFS), and the Northwest Power Planning Council's Fish and Wildlife Program also guide policies regarding anadromous fish species.

The Endangered Species Act, adopted in 1973, guides policies influencing river operations for anadromous fish on the Snake and Columbia Rivers by mandating that species listed as *threatened* or *endangered* be protected. The Fall Chinook Recovery Plan, adopted in 1991, provides an operational framework for the Hells Canyon Complex that supports the objectives of the Endangered Species Act.

On February 14, 1980, the Hells Canyon Settlement Agreement between the NMFS, the Idaho Department of Fish and Game (IDFG), the State of Oregon Department of Fish and Wildlife (ODFW), the Washington Department of Fisheries (WDF), the Washington Department of Game (WDG), and IPC was signed. It states:

> "*In years subsequent to 1982, Licensee will attempt to operate Project No. 1971 in such a manner as to reduce adverse effects on anadromous fish spawning, rearing and out-migration below the Project, consistent with the provisions of its license for Project No. 1971 and its obligations as a public utility.*

> *Licensee and Petitioners shall meet at least annually to exchange information and discuss possible Project operations to reduce adverse effects on anadromous fish below the Project. All parties to the proceedings in FERC Docket No. E9579 shall be invited to attend and participate.*"

The Hells Canyon Settlement Agreement marked one of the earliest interagency cooperative attempts at managing river operations for anadromous fish on the Snake and Columbia Rivers.

During 1994, the NMFS developed a draft biological opinion, an implementation plan pursuant to the proposed recovery plan, which serves to identify *threatened* and *endangered* species of fish in accordance with the Endangered Species Act. The biological opinion also provides a multi-year water management plan for fish passage survival.

IPC currently participates in the recovery and protection of anadromous fish by contributing water from Brownlee Reservoir for flow augmentation, passing and shaping federal water, and providing spawning flows and redd protecting flows. IPC also participates in meetings of the technical management team, an interagency group consisting of the COE, the Bureau of Reclamation (BLM), the NMFS, the Bonneville Power Administration (BPA), USFWS and others, including the four Northwest states and affected Native American tribes. This group meets to recommend river operations for anadromous fish and cooperates in moving water throughout the region, including the Hells Canyon Complex, to meet flow targets at Lower Granite and The Dalles Dams (federal dams not subject to FERC licensing requirements).

4.1.3. Flood Control Requirements

Article 42 of FERC License No. 1971 license states in part that:

> *"In the interest of flood control the licensee shall operate the project as follows:*
>
> *(a) The total live storage space of about 1,000,000 acre-feet between elevation 1976 and elevation 2077 mean sea level will be made available for flood control use if and as required.*
>
> *(b) The reservoir level elevation will be no higher than elevation 2034 by 1 March of each year to provide about 500,000 acre-feet of storage space for flood control use at that time each year.*
>
> *(c) Additional storage space required up to 500,000 acre-feet will be obtained by evacuation as necessary during the month of March in a manner to insure availability on or before 1 April of the total storage capacity needed for flood control, as estimated by the Corps of Engineers. This space will be retained until capture of flood flows is requested by the Corps of Engineers, subject to possible involuntary storage as may be required due to temporary inflows in excess of outlet capacity, or until refilling in the interest of power output is authorized by the Corps of Engineers. In the event of involuntary storage, full capacity will be regained as soon as possible.*
>
> *(d) During the flood storage period controlled outflow will be as requested by the Corps of Engineers. Daily outflow of 30,000 acre-feet, as a minimum, will be permitted when required for power purposes."*

Consistent with this requirement, the Reservoir Control Center, COE, North Pacific Division, is responsible for defining flood control requirements and coordinating these requirements with IPC. Runoff volumes and streamflow forecast data used by the COE are provided by the National Weather Service, Northwest River Forecast Center, in Portland, Oregon.

Since the Hells Canyon license was issued, the COE has developed rule curves to guide the determination of necessary flood control space. These rule curves resulted from additional studies and the subsequent improved understanding of the floods on the Columbia and Snake Rivers. The rule curves are shown on the COE's Table 6-2, last revised December, 1988, which is included in Section XI, Table 4-1.

The rule curves reflect the variations in water distribution that occur throughout the Columbia River system. When the Snake River contributes a relatively small fraction of the total flow forecast at The Dalles, the flood control requirement is relatively small. As the Snake River contribution increases, the space requirement increases. When the forecast at The Dalles is very high, Brownlee requirements increase even when the Snake River component is relatively low.

COE does not require adherence to the license requirement to provide about 500,000 acre-feet of space by March 1 each year. Instead, when the rule curves require less than 500,000 acre-feet, COE provides a letter describing the reduced space requirements and IPC notifies FERC of the reduced space requirements.

During the spring runoff, implementation of the rule curves is coordinated between IPC and COE. The RFC produces streamflow forecasts for the Columbia River at The Dalles, and for Brownlee Reservoir inflow. The forecast for The Dalles is in millions of acre-feet (MAF) for the April through August period. The forecast for Brownlee, also in MAF, is for the April through July period. These two values are used in the rule curve table to determine the amount of space needed in Brownlee Reservoir for flood control. The coordination occurs if interpolation of the values in the table is desirable to determine the implementation date of changing space requirements.

Flood control requirements conflict with efforts to provide more flow augmentation water from the upper Snake River to assist in movement of juvenile fish through the lower Snake River reservoirs. Higher flows may be needed to aid fish movement at the same time that flows are reduced to refill Brownlee Reservoir. Current COE policy is to use Brownlee Reservoir flood control space primarily to regulate floods on the lower Columbia River. Whenever possible, lower Snake River floods are regulated using Dworshak

Reservoir. Limiting the use of Brownlee to system flood protection allows the COE to compare Brownlee space requirements to the entire amount of space available in the entire Columbia River system. If space can be made available at Grand Coulee Dam, the Corps “shifts” the Brownlee space requirement to Grand Coulee, allowing IPC to maintain Brownlee Reservoir at a higher elevation. This provides higher flows in the Snake River during the fish migration season.

4.1.4. Water Rental Pools

In 1979, the State of Idaho passed legislation enabling surplus water to be rented from water banks, or reservoirs. IPC has since been able to lease water from American Falls Reservoir. The Payette River Basin began participating in the water rental pool system in 1990. The rental pools have been significant in the hydropower operations on the Snake River in that they have changed the summertime flow patterns on the river. The leasing of water results in up to 3,000 cfs of additional river flow during the summer and has been a source for augmenting Snake River flows. It also has had the effect of reducing river flows during the winter.

Since the construction of the Hells Canyon Complex, there has been a significant increase in operating restrictions. The majority of these restrictions relate to the spawning and protection of anadromous fish species. Operations at Brownlee with regards to navigation, flood control, and anadromous fish have been reinterpreted, changed, or adapted, particularly throughout the last decade. Flood control and anadromous fish operations are heavily influenced by the type of water year, along with other considerations. Anadromous fish operational plans have varied each year since they were initiated. Predicting operational plans for the Hells Canyon Complex is equally complex. Sections 4.2, 4.3, and 4.4 contain more specific operational information for each of the three Hells Canyon Complex developments.

4.2. Brownlee Development - FERC No. 1971-01

4.2.1. Method Of Operation

No changes to the existing method of operation are proposed for the Brownlee Development.

4.2.1.1. Manual/Automatic

The Brownlee power plant is manually operated; operators are on duty 24 hours per day. IPC is currently considering changing the on-duty operation to either 8 or 16 hours per day. During off hours, operators will be on call to respond to alarms.

4.2.1.2. Plant Factor

Based upon generation records from 1959, the first full year of operation, through 1995, the plant factor is 46.8 percent.

4.2.1.3. Operating Mode

The Brownlee power plant is normally operated to meet the daily load shape and real time changes in load for the IPC system. Units are brought on line and are loaded or taken off-line to conform to IPC system load requirements. In general, units are brought on-line during the highest demand periods during the day and are taken off-line during the lower demand periods of the night. At least one unit operates during the periods of lowest demand. Brownlee Reservoir can be operated over a 101-foot range from elevation 1976 to 2077 msl.

The hydraulic flow through the plant and the exact combination of units operated during any given time are influenced by the following:

4.2.1.31.
Ancillary Services

Ancillary services provided by Brownlee power plant include:

- Load Shaping - Operation of units necessary to meet the scheduled system load.
- Load Following - Operation of units necessary to respond to unscheduled real time changes in system load.
- Voltage Control - Operation of units necessary to maintain correct system voltage.
- Reserves (spinning) - Units are unloaded (depressed) or partially loaded to maintain the required spinning reserve for the system.

4.2.1.3.2.
Operational Restrictions

The restrictions discussed in Section 4.1, pertaining to navigation, anadromous fish operations, flood control, and water rental pools, influence operations.

4.2.2.
Capacity And Energy

No changes to the existing capacity and energy output of the Brownlee Development are proposed. Existing capacity, energy, and supporting information are provided below.

4.2.2.1.
Dependable Capacity

For the Hells Canyon Complex, dependable capacity is defined as the ability to meet the one-hour peak demand under critical water conditions. The peak demand on Idaho Power's system occurs in the months of January and July. Because the July peak occurs at a period of lower flow than does the January peak, July was used as the critical month for estimating the dependable capacity of all three developments in the Hells Canyon Complex.

Critical water conditions for the Hells Canyon Complex were taken as the conditions which occurred during the year 1992, which had the lowest average inflow for the period of record and was preceded by two years with the fourth and fifth lowest average inflows of record.

For the Brownlee Development, the dependable capacity under July 1992 water conditions is estimated to be 668 MW.

4.2.2.2.
Annual Energy

Based upon the period from January 1959 through December 1995, the average annual energy production at the Brownlee power plant is 2,401 MWh.

4.2.2.3.
Supporting Data

4.2.2.3.1.
Flow Data

Engineering calculations are based on inflow to Brownlee Reservoir. Total inflow to Brownlee Reservoir is not measured directly, but is calculated from stream flow records of the Snake River below Hells Canyon Dam, Pine Creek below Oxbow Dam, and Wildhorse River below Brownlee Dam, and from daily changes in reservoir storage within the three-dam complex.

The period of record utilized is from 1965 through 1995. The minimum, mean, and maximum Brownlee inflows for this period are 4,172 cfs, 19,894 cfs, and 84,721 cfs, respectively. A more detailed description of stream flow data is included in Section VI of this document.

4.2.2.3.2.
Reservoir Area, Capacity, and Rule Curve

Reservoir area and capacity curves are presented in Section XII, Figure 4-1. Refer to Section 4.1.1.3. for discussion on the flood control requirements for Brownlee Reservoir. The current rule curve is attached as Table 4-1 in Section XI. No changes in reservoir characteristics are proposed.

4.2.2.3.3.
Hydraulic Capacity

The hydraulic capacity of the turbines for Units 1 through 4, as shown on the manufacturer's expected performance curves, is approximately 5,675 cfs each at nameplate net head and output. The hydraulic capacity of the Unit 5 turbine, as shown on the manufacturer's expected performance curves, is approximately 11,800 cfs at nameplate net head and output. This results in a hydraulic capacity of the plant, at nameplate net head and output, of approximately 34,500 cfs. However, efficiency tests conducted in 1988 indicate that the turbines, at maximum generation at a gross head of 273 feet, are capable of passing approximately 35,000 cfs.

4.2.2.3.4.
Tailwater Rating Curve

A tailwater rating curve is presented in Section XII, Figure 4-2.

4.2.2.3.5.
Capacity versus Head

A capacity versus head curve for the Brownlee Development is presented in Section XII, Figure 4-3. This curve is based upon information from the turbine manufacturer's expected performance curves.

4.2.2.3.6.
Power Utilization

All generation at the Brownlee power plant is utilized to meet IPC system load requirements.

4.3.
Oxbow Development - FERC No. 1971-02

4.3.1.
Method Of Operation

No changes in the method of operation of the power plant at Oxbow Dam are proposed at this time.

4.3.1.1.
Manual/Automatic

The Oxbow power plant is manually operated. Operators are on duty 24 hours per day. IPC is currently considering changing the on-duty operation to either 8 or 16 hours per day. During off-hours, on-call operators will respond to alarms.

4.3.1.2.
Plant Factor

Based upon generation records for the period from 1962, the first full year of operation, through 1995, the plant factor is 65.9 percent.

4.3.1.3.
Operating Mode

Operation of the Oxbow power plant is closely coordinated with the operation of the upstream Brownlee plant. Oxbow Reservoir typically functions as a re-regulating reservoir for Brownlee outflows, since the nameplate hydraulic capacity of the Oxbow plant is approximately 10,000 cfs less than that of the Brownlee plant. Oxbow Reservoir can be operated between elevations 1795 and 1805 msl). It is typically drafted during the night and refilled the following day by Brownlee outflows. Drafting can vary from zero to eight feet.

The Oxbow power plant is normally operated to meet the daily load shape and real time changes in load for the IPC system. Units are brought on line and are loaded or taken off-line as required by IPC system load needs. In general, units are brought on-line during the highest demand periods during the day and are taken off-line during the lower demand periods of the night. At least one unit operates during the periods of lowest demand.

The hydraulic flow through the plant and the exact combination of units operated during any given time are influenced by the following:

4.3.1.3.1. Ancillary Services

Ancillary services provided by Oxbow power plant include:

- Load Shaping - Operation of units necessary to meet the scheduled system load.
- Load Following - Operation of units necessary to respond to unscheduled real time changes in system load.
- Voltage Control - Operation of units necessary to maintain correct system voltage.
- Reserves (spinning) - Units are unloaded (depressed) or partially loaded to maintain the required spinning reserve for the system.

4.3.1.3.2.
Operational Restrictions and Brownlee Outflows

The restrictions discussed in Section 4.1, pertaining to navigation, anadromous fish operations, flood control, and water rental pools, influence Brownlee outflows and Oxbow Plant operations.

4.3.2.
Capacity And Energy

No changes to the existing capacity and energy output of the Oxbow Development are proposed. Existing capacity, energy, and supporting information are provided below.

4.3.2.1.
Dependable Capacity

For the Hells Canyon Complex, dependable capacity is defined as the ability to meet the one-hour peak demand under critical water conditions. The peak demand on Idaho Power's system occurs in the months of January and July. Because the July peak occurs at a period of lower flow than does the January peak, July was used as the critical month for estimating the dependable capacity of all three developments in the Hells Canyon Complex.

Critical water conditions for the Hells Canyon Complex were taken as the conditions which occurred during the year 1992, which had the lowest average inflow for the period of record and was preceded by two years with the fourth and fifth-lowest average inflows of record.

For the Oxbow Development, the dependable capacity under July 1992 water conditions is estimated to be 216 MW.

4.3.2.2. Annual Energy

Based upon the period from January 1962 through December 1995, the average annual energy production at the Oxbow power plant is 1,098 MWh.

4.3.2.3. Supporting Data

4.3.2.3.1. Flow Data

Flow into the Oxbow Development is dependent upon discharges from the upstream Brownlee plant. Due to the variable operation of Brownlee, IPC does not maintain specific flow data and flow duration curves for the Oxbow Development. As a result, IPC utilizes the upstream Brownlee inflows as the inflow data for the entire Hells Canyon Complex. Refer to Section 4.1.2.3. for information regarding Brownlee inflows.

4.3.2.3.2. Reservoir Area, Capacity, and Rule Curve

Reservoir area and capacity curves are presented in Section XII, Figure 4-4. No reservoir rule curve exists for Oxbow Reservoir. No changes in reservoir characteristics are proposed.

4.3.2.3.3.
Hydraulic Capacity

The hydraulic capacity of the turbines for Units 1 through 4, as shown on the turbine manufacturer's expected performance curves, is approximately 6,100 cfs each at nameplate net head and output. This results in a hydraulic capacity of the plant, at nameplate net head and output, of approximately 24,400 cfs. However, efficiency tests conducted in 1990 indicate that the turbines are capable of passing more water. The 1990 test results indicate that the hydraulic capacity of the plant, at the point of maximum generation, is approximately 28,000 cfs.

4.3.2.3.4.
Tailwater Rating Curve

The Oxbow power plant discharges directly into Hells Canyon Reservoir. Since the Oxbow plant tailwater is dictated by Hells Canyon Reservoir elevation, there is no specific tailwater curve associated with the Oxbow plant. Hells Canyon Reservoir has historically operated between elevations 1683 and 1688 msl; hence, the Oxbow plant tailwater normally falls within that range.

4.3.2.3.5.
Capacity versus Head

A capacity versus head curve for the existing Oxbow power plant is presented in Section XII, Figure 4-5. This curve is based upon information from the turbine manufacturer's expected performance curves.

4.3.2.3.6.
Power Utilization

All generation at the Oxbow power plant is utilized to meet IPC system load requirements.

4.4.
Hells Canyon Development - FERC No. 1971-03

4.4.1.
Method Of Operation

No changes to the existing method of operation are proposed for the Hells Canyon Development.

4.4.1.1.
Manual/Automatic

The Hells Canyon power plant is manually operated; Operators are on duty 24 hours per day. IPC is currently considering changing the on-duty operation to either 8 or 16 hours per day. During off-hours, operators will be on-call to respond to alarms.

4.4.1.2.
Plant Factor

Based on power generation records from 1968, the first full year of operation, through 1995, the plant factor is 66.7 percent.

4.4.1.3.
Operating Mode

The Hells Canyon plant is primarily operated in accordance with Article 43 of the existing FERC license, which requires that the maximum variation in river stage not exceed one foot per hour at the Johnson Bar gauge. This gauge is located 17.6 river miles downstream of Hells Canyon Dam.

The Hells Canyon plant is typically block-loaded in increments in a manner that follows the general daily load shape. Units are typically ramped up to, and operated at, their peak efficiency point to ensure adherence to the 1-foot-per-hour maximum variation in river requirement. In general, units are brought on-line during the highest demand periods during the day and are taken off-line during the lower demand periods of the night. At least one unit always operates during the periods of lowest demand. Hells Canyon Reservoir can be operated over its top 10 feet (elevation 1678 to 1688 msl); however, it is typically operated within the top 5 feet.

The hydraulic flow through the plant and the exact combination of units operated during any given time are influenced by the following:

4.4.1.3.1. Ancillary Services

Ancillary services provided by Hells Canyon power plant include:

- Load Shaping - A limited amount of load shaping is available within the constraints of the one-foot-per-hour variation in river stage.
- Voltage Control - Operation of units necessary to maintain correct system voltage.
- Reserves (spinning) - Units are unloaded (depressed) or partially loaded to maintain the required spinning reserve for the system.

4.4.1.3.2. Operational Restrictions

The restrictions discussed in Section 4.1, pertaining to navigation, anadromous fish operations, flood control, and water rental pools, influence Brownlee outflows and Hells Canyon plant operations.

4.4.2. Capacity And Energy

No changes to the existing capacity and energy output of the Hells Canyon Development are proposed. Existing capacity, energy, and supporting information are provided below.

4.4.2.1. Dependable Capacity

For the Hells Canyon Complex, dependable capacity is defined as the ability to meet the one-hour peak demand under critical water conditions. The peak demand on Idaho Power's system occurs in the months of January and July. Because the July peak occurs at a period of lower flow than does the January peak, July was used as the critical month for estimating the dependable capacity of all three developments in the Hells Canyon Complex.

Critical water conditions for the Hells Canyon Complex were taken as the conditions which occurred during the year 1992, which had the lowest average inflow for the period of record and was preceded by two years with the fourth and fifth-lowest average inflows of record.

For the Hells Canyon Development, the dependable capacity under July 1992 water conditions is estimated to be 437 MW.

4.4.2.2. Annual Energy

Based upon the period from January 1968 through December 1995, the average annual energy production at the Hells Canyon power plant is 2,289 MWh.

4.4.2.3. Supporting Data

4.4.2.3.1. Flow Data

Flow into the Hells Canyon Development is dependent upon discharges from the upstream Brownlee and Oxbow plants. Due to the highly variable operation of Brownlee, IPC does not maintain specific flow data and flow duration curves for the Hells Canyon Development. As a result, IPC utilizes the upstream Brownlee inflows as the inflow data for the entire Hells Canyon Project. Refer to Section 4.1.2.3. for information regarding Brownlee inflows.

4.4.2.3.2. Reservoir Area, Capacity, and Rule Curve

Reservoir area and capacity curves are presented in Section XII, Figure 4-6. There is no rule curve for Hells Canyon Reservoir. No changes in reservoir characteristics are proposed.

4.4.2.3.3. Hydraulic Capacity

The design hydraulic capacity of the turbines for Units 1 through 3, as shown on the turbine manufacturer’s expected performance curves, is approximately 9,000 cfs each at nameplate net head and output. This results in a hydraulic capacity of the plant, at nameplate net head and output, of approximately 27,000 cfs. However, efficiency tests conducted in 1988 indicate that the turbines are capable of passing more water. The 1988 test results indicate that the hydraulic capacity of the plant, at the point of maximum generation, is approximately 30,500 cfs.

4.4.2.3.4.
Tailwater Rating Curve

A tailwater rating curve is presented in Section XII, Figure 4-7.

4.4.2.3.5.
Capacity versus Head

A capacity versus head curve for the Hells Canyon Development is presented in Section XII, Figure 4-8. This curve is based upon information from the turbine manufacturer's expected performance curves.

4.4.2.3.6.
Power Utilization

All generation at the Hells Canyon power plant is utilized to meet IPC system load requirements.

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V.
Affected Environment and Significant Resources

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V. AFFECTED ENVIRONMENT AND SIGNIFICANT RESOURCES

V.
AFFECTED ENVIRONMENT AND SIGNIFICANT RESOURCES

5.1.
General Description of the Locale

5.1.1.
Study Area

Hells Canyon is situated in west-central Idaho and northeastern Oregon (Figure 2-1) (approximately RM 351 to 188). The Snake River, a major tributary to the Columbia River, is the focal point of Hells Canyon. Its generally northward flow forms part of the boundary between Idaho and Oregon. IPC's Hells Canyon Complex is located on the Snake River in the southern portion of Hells Canyon where it forms three reservoirs: Brownlee, Oxbow, and Hells Canyon. The Snake River is unimpounded in the reach below Hells Canyon Dam, although flows may be controlled by the three-dam complex.

Population centers located within a 100-mile radius of some portion of Hells Canyon include Boise, Cambridge, Council, Fruitland, Grangeville, Lewiston, Nampa, Payette, Riggins, and Weiser on the Idaho side; and Baker City, Enterprise, Halfway, Huntington, La Grande, Ontario, and Richland on the Oregon side.

The Hells Canyon Project is situated within and across the political boundaries of Adams, and Washington Counties in Idaho, and Wallowa Malheur and Baker Counties in Oregon. State agencies with direct responsibility for fish and wildlife management are the Idaho Department of Fish and Game (IDFG) and the Oregon Department of Fish and Wildlife (ODFW). These agencies also administer several areas within Hells Canyon specifically for wildlife habitat.

Federal agencies, including the U.S. Department of Interior (USDI), Bureau of Land Management (BLM), and U.S. Department of Agriculture (USDA), Forest Service (USFS), are responsible for managing the majority of public land in Hells Canyon. These areas fall within the jurisdictional boundaries of the Wallowa-Whitman National Forest, Oregon; Payette National Forest, Idaho; Nez Perce National Forest, Idaho; Cascade Resource Area (RA) of the Boise District, BLM-Idaho; Cottonwood RA of the Coeur d'Alene District, BLM-Idaho; Baker RA of the Vale District, BLM-Oregon; and Northern Malheur RA of the Vale District, BLM-Oregon. Other agencies with natural resource jurisdiction in the greater project area include the USDI National Marine Fisheries Service (NMFS), USDI Bureau of Indian Affairs (BIA), USDI Fish and Wildlife Service (USFWS), and Idaho and Oregon state agencies.

Several special management areas also occur in Hells Canyon and are directly administered by the USFS. These include the Eagle Cap Wilderness in Oregon, Hells Canyon Wilderness in Idaho and Oregon, the HCNRA (HCNRA) in Idaho and Oregon, the Wild and Scenic Imnaha River in Oregon, the Seven Devils Scenic Area in Idaho, and the Wild and Scenic Snake River.

For discussion purposes, the area upstream and downstream from Hells Canyon Dam is divided into five reaches, as described in the following paragraphs. Reaches were delineated based on distinct geomorphic features, river characteristics, and legal project boundaries. Generally, the lateral extent of these reaches includes all lands within 0.5 miles of each shoreline above Hells Canyon Dam and all lands within

0.25 miles of each shoreline below Hells Canyon Dam, however, the lateral extent of the study area may vary depending on the resources being studied. The study area below Hells Canyon Dam is restricted because it is extremely difficult to access. The five reaches are:

- Upstream of Brownlee Reservoir to the Weiser Bridge (approximately 12 miles; RM 351.2 to 339.2).
- Brownlee Reservoir (approximately 55 miles; RM 339.2 to 284.6).
- Oxbow Reservoir (approximately 12 miles; RM 284.6 to 272.2).
- Hells Canyon Reservoir Reach (approximately 25 miles; RM 272.2 to 247.0).
- Downstream of Hells Canyon Dam to the confluence of the Snake and Salmon Rivers (approximately 59 miles, RM 247.0 to 188.2).

In the upstream reach, the Snake River is a low-gradient (0.2 to 0.4 m/km) river, with several island complexes. Agricultural impacts are apparent with high amounts of irrigation returns causing higher turbidities and increased nutrient loading. This reach is surrounded by farmland and rural development on flat to gentle topography. Stream substrates are small, with fines and sand to medium-sized cobbles prevalent throughout (Johnson *et al.* 1992). Flows in the Snake River are regulated by several hydroelectric facilities above RM 458, and three major tributary rivers: the Boise River, which enters the Snake River at RM 394 and is regulated by two flood-control dams; the Payette River, which enters the Snake River at RM 365.5; and the Weiser River, which enters just upstream of the Weiser Reach at RM 351.8. Although this reach is geomorphically distinct and is surrounded by different land uses than the other study reaches, its inclusion in the study area may provide insight into some of the physical and biological factors potentially influencing downstream reaches.

Brownlee Reservoir is a steep-sided reservoir with a maximum depth approaching 300 feet near the dam.

Large rock outcrops occur throughout the entire length. Shoreline substrates are often complex and quite variable. Some areas are dominated by sand; other areas are characterized by bedrock and small to medium-sized cobbles and boulders of angular basalt. Shoreline slopes in the range of 20 to 30 percent are most common. Brownlee has the potential of 100-foot drawdowns over winter as regulated by the U.S. Army Corps of Engineers (COE) for flood control purposes. One of the most dominant habitat features of Brownlee is the transition zone of riverine habitat to lacustrine habitat, typical of large mainstem storage reservoirs. The zone is especially pronounced by the reduction in turbidities along a longitudinal gradient in Brownlee. Brownlee serves as a sedimentation basin, with waters of notably lower turbidity leaving the Hells Canyon system.

Oxbow Reservoir is a small run-of-the-river reservoir surrounded by moderate to steep topography (20 to 75 percent slopes). The Snake River from the tailrace of Brownlee Dam to the mouth of Wildhorse Creek (1 mile downstream) is a high-velocity narrow channel. Oxbow is relatively narrow and shallow, with maximum depths approaching 100 feet. Shorelines are primarily basalt outcrops and talus, except for alluvial fans created by small tributaries.

Hells Canyon Reservoir is a run-of-the-river reservoir with maximum depths approaching 200 feet. The unique design of the Oxbow powerhouse and dam renders a 2-mile stretch of the original river channel from Oxbow Dam to the outflow of the powerhouse with a minimum flow of 100 cfs. This creates a backwater-type area that is relatively shallow with low velocities. Indian Creek enters the Snake River in this reach. Shorelines in the reservoir are generally very steep, with substrates primarily of basalt outcrops and talus slopes.

The Snake River in the downstream reach is a high-gradient river (1.8 m/km) with a wide diversity of aquatic habitat including numerous large rapids, shallow riffles, and deep pools. Substrates are highly diverse, ranging from large basalt outcrops and boulders to cobble/sand bars. Since construction of the Hells Canyon Dam, a loss of sand bars has been documented, caused by large clear water floods during the 1964 through 1973 time period (Grams and Schmidt 1991). This unimpounded reach of the Hells Canyon is considered to be the deepest gorge in North America. The Hells Canyon reach is surrounded at the upstream end by nearly vertical cliff faces. At the mouth of Granite Creek, approximately 7 miles below Hells Canyon Dam, the river elevation is 1480 feet msl and the canyon depth is 7,913 feet. The canyon becomes somewhat wider near Johnson Bar (RM 230), with moderate to steep topography continuing to the Salmon River.

Several transmission lines are associated with Project No. 1971. These are described in Section III. Maps of transmission lines are contained in Section XII.

5.1.2. Physiography

Hells Canyon is the deepest and one of the most rugged river gorges in the continental United States. It ranges between 2,000 feet to 3,000 feet in depth from Weiser to Oxbow Dam. Below Oxbow Dam, the river enters a narrow, steep-sided chasm that is up to 5,500 feet deep. From the confluence with the Grande Ronde River, the Snake River then flows onto a lava-filled basin and through a much shallower canyon to Lewiston, Idaho (U.S. Dept. Energy 1985). The elevation of the Snake River near Weiser, Idaho is about 2090 feet msl, descending to about 910 feet msl at the confluence of the Salmon River, about 59 miles below Hells Canyon Dam.

Throughout the canyon, topography is generally steep and broken with slopes often dominated by rock outcrops and talus slopes. At the deepest points of the canyon, the walls rise almost vertically. Canyon walls are deeply dissected by numerous side canyons which contain tributaries to the Snake River. The upper reaches of the canyon walls are formed by the Seven Devils Mountains to the east and the Wallowa Mountains to the west. These mountains form a series of jagged peaks reaching almost 10,000 feet with sub-alpine and alpine conditions (USDA 1990) to the west.

5.1.3. Geology

Hells Canyon consists of a series of folded and faulted metamorphosed sediments and vulcanics overlain uncomformably by nearly horizontal flows of Columbia River basalt. This basalt group covered much of eastern Washington, northern Oregon, and adjacent parts of Idaho (Bush and Seward 1992). The older rocks in the series are Permian to Jurassic in age and represent at least two episodes of island arc volcanism and adjacent marine sedimentation similar to that found today in the Aleutian Islands west of Alaska. These rock units represent old island arc chains that were sequentially “welded” to the west coast of North America during the late Paleozoic and early to mid-Mesozoic eras by subduction of a tectonic plate beneath the North American Continental tectonic plate (Asherin and Claar 1976, U.S. Dept. Agriculture 1994).

In more recent geologic time, Hells Canyon was formed through erosion, by the Snake River, of the Blue Mountains in Oregon and Seven Devils Mountains in Idaho (U.S. Dept. Energy 1985). The Snake River has existed from the Pliocene and probably cut to its present level during the Pleistocene. During the Pleistocene, glacial meltwater provided abundant runoff for down-cutting, while regional uplifting created weak points in the 2,000- to 3,000-foot-thick basalt plateau that overlaid the Blue and Seven Devils Mountains. Resulting erosion formed the currently observed drainage pattern that established the Snake River (U.S. Dept. Energy 1985). Northeast-trending, high-angle fault patterns characterize the extensive Snake River fault system running throughout the study area (Fitzgerald 1982).

Besides basalt, other rock types also are present within the study area. Extensive limestone outcrops are found in some tributary drainage areas and local granitic outcrops also occur.

5.1.4. Soils

The soils throughout Hells Canyon are composed primarily of Columbian River basalt, covered in most areas with a thin mantle of residual soils from weathered native rock. Isolated areas contain deposits of windblown silt. Unconsolidated materials include ash-loess from the Mount Mazama eruption of 6,900 years ago, river sands and gravel deposited during the Bonneville floods of 15,000 years ago, and more recent colluvium and talus. The amount of soil cover declines northward through Hells Canyon; near Hells Canyon Dam (RM 247), most rock faces are nearly vertical with little soil cover (U.S. Dept. Agriculture 1994).

Most soil complexes are well drained and vary from very shallow to moderately deep. Loams are the dominant textural class and vary from very stony to silty, often with a clay subsoil component (Natural Resources Conservation Service 1995).

5.1.5. Climate

From late fall to early spring, the climate of west-central Idaho and eastern Oregon is typically influenced by cool and moist Pacific maritime air. Periodically this westerly flow is interrupted by outbreaks of cold, dry, continental air from the north which is normally blocked by mountain ranges to the east. During the summer months, a Pacific high-pressure system dominates weather patterns, resulting in minimal precipitation and more continental climatic conditions overall (Ross and Savage 1967).

Hells Canyon is located in the High Desert region and is significantly influenced by the rain shadow of the Cascade Mountain range. The area is considered to be arid to semi-arid with warm-to-hot, dry summers and relatively cold winters (Harker *et al.* 1993). Lower elevations in Hells Canyon are generally milder during winter (warmer temperatures and less snow accumulation) than surrounding areas. Conversely, areas at higher elevation have more precipitation and cooler temperatures than the immediate canyon area.

Climatological records from Brownlee Dam (RM 284.6) indicate that the canyon bottom area is dry with seasonal temperatures ranging from lows of about minus 12 degrees C in January, to highs of about 43 degrees C in July. Temperatures below freezing are normally experienced from mid-November through mid-April. The average annual precipitation ranges from about 380 to 500 mm (15 to 20 inches) depending on elevation. Nearly 45 percent of the average annual precipitation at Brownlee (406 mm (16.25 inches)) falls during the November through January winter months. This is strongly contrasted by rainfall from July through September, when only about 9 percent of the yearly average is recorded. Average annual evapotranspiration is estimated to be about 1,300 mm (52 inches).

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5.2. Water Use and Quality

5.2.1. Water Uses

The primary uses of waters of the Snake River within and upstream of the project area include agriculture, hydropower, recreation, fish and wildlife habitat, industrial and municipal water supply, and aesthetics (Tables 5-1 and 5-2). There are 14 mainstem hydroelectric projects on the river with a combined generating capacity of 1793 megawatts.

The Idaho Department of Health and Welfare Rules and Regulations, Title 1, Chapter 2, Water Quality Standards and Wastewater Treatment Requirements (State Standards) protect beneficial uses of the state's waters. Water quality of Brownlee, Oxbow and Hells Canyon reservoirs is to be protected for the designated uses of domestic water supply, agricultural water supply, cold-water biota, salmonid spawning, and primary and secondary recreation. The Snake River is also to be protected for future use as a cold-water biota habitat and salmonid spawning habitat.

5.2.2. Existing Water Quality

Water quality conditions in a system are the function of complex natural and man-made causes and of the resulting interactions in both time and space (Sanders *et al.* 1983). Water quality is the result of societal activities, and the natural hydrologic cycle (Petts 1984). In the Snake River Basin, geology, precipitation, and water and land use by humans have the greatest effect on water quality (Laird 1964). The Snake River within the study area consists of free-flowing riverine habitats (from approximately RM 458 to 339 and

RM 247 to 180), impounded run-of-the-river reservoirs (approximately RM 285 to 247), and a large storage reservoir (approximately RM 339 to 285).

Impoundment in reservoirs induces physical, chemical, and biological changes within the impounded water and subsequent discharges (Petts 1984). Reservoir morphometry, stratification dynamics, and water movements all influence physical and chemical patterns in the reservoir system. Reservoir characteristics such as shoreline stability, water level fluctuations, flushing rates, sedimentation rates, turbidity, and principal nutrient sources make reservoirs unique from natural lakes (Thornton 1990). Milligan *et al.* (1983) classified Brownlee, Oxbow, and Hells Canyon reservoirs as meso eutrophic. Brownlee and Hells Canyon reservoirs thermally stratify during summer months with resulting hypolimnetic anoxia (Ebel and Koski 1968). Brownlee Reservoir has a substantial effect on the downstream system in part due to the deep water releases. Typically, summer water temperatures coming out of Brownlee Reservoir are cooler than inflowing water temperatures, and fall outflow water temperatures are warmer than inflow temperatures (Ebel and Koski 1968).

Predominant water quality impacts in the study area are from nonpoint-source activities (IDHW and IDFG 1989). Nonpoint-source activities which have been identified as accounting for the majority of impacts include agriculture, forest practices, construction, and hydrologic/habitat modifications. Sediment and nutrients are the primary pollutants affecting water quality in the study area. Cold-water biota and salmonid spawning are partially supported, and other beneficial uses are potentially at risk upstream of Brownlee Reservoir (IDHW and IDFG 1989). In Brownlee, Oxbow, and Hells Canyon reservoirs, cold-water biota are partially supported, but salmonid spawning is not supported. Below Hells Canyon Dam, all beneficial uses are reported to be fully supported.

Preliminary data collected by IPC since 1990 and unpublished USFWS data from 1990 indicate that the study area upstream of RM 315 typically shows summer chlorophyll levels well in excess of the 0.015 mg/l level identified by the State of Oregon as a level that may impair beneficial uses in reservoirs and rivers. A more complete discussion of chlorophyll levels and seasonal trends can be found in the aquatic plants section of this report.

Low dissolved oxygen levels occur in the upper end of Brownlee Reservoir during the summer months (IPC unpublished data). In July 1990, approximately 10 miles of the reservoir experienced hypoxic conditions that resulted in fish mortality. In 1991, the hypoxic zone was less extensive, and fish mortality appeared limited to young-of-the-year fishes.

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5.3.
Aquatic Resources

5.3.1.
Historic Resident Fish Community

5.3.1.1.
Native Species

Little information is available on the distribution and abundance of the native resident fish of the Snake River and its tributaries prior to development of the Hells Canyon Complex. As with most western and northwestern systems (Wydoski and Bennett 1981), the endemic species complex was small. Simpson and Wallace (1978) identified 15 species representing five families of fish that were native to the Snake River drainage in the Hells Canyon Complex area, primarily composed of cyprinids and catostomids (Table 5-3).

White sturgeon (*Acipenser transmontanus*) are native to the Snake and Columbia river basin. Although sturgeon are known to exhibit extensive up- and downstream movements and many populations are anadromous (Simpson and Wallace 1978), little is known of white sturgeon abundance, movements, or degree of anadromy in pre-dam Hells Canyon (Coon 1978; Stanford 1942). Swan Falls Dam, constructed in 1901, may have been the first barrier to upstream movements of sturgeon, and the beginning of population fragmentation. Swan Falls Dam (RM 458) was construted with a fish ladder designed for salmon passage, however, the use of the ladder by sturgeon had not been documented (Stanford 1942). Sturgeon are rarely observed in other facilities containing fish ladders (Coon 1978). The construction of C.J. Strike Dam (RM 494) in 1952 imposed an additional barrier to upstream movements. Downstream barriers began on the

Columbia River in 1937, with the construction of Bonneville Dam, followed by McNary Dam in 1957 (Figure 2-1). By the time Hells Canyon Complex was completed in 1967, The Dalles (1957) and Priest Rapids (1961) dams on the Columbia River, and Ice Harbor (1962) on the Lower Snake River had also been constructed, further restricting extensive movements (Table 5-4). Extensive movement is not necessary for sturgeon survival, and populations persist in these isolated reaches. Many portions of the Snake River were subject to overharvest, and more restrictive fishing regulations began to evolve. By 1970, only catch and release fishing was allowed in the Idaho and Oregon sections of the Snake River (Cochnauer 1983).

Of the native resident salmonids, mountain whitefish (*Prosopium williamsoni*) were common and fairly abundant throughout the Snake River drainage and its tributaries (Simpson and Wallace 1978). Other native salmonids include the bull trout (*Salvelinus confluentus*) and redband trout (inland rainbow trout; *Oncorhynchus mykiss gibbsi*). Redband trout are an ill-defined group of inland rainbow trout that includes interior populations of the Columbia, Fraser, and Sacramento river basins, as well as the ancient lake basins of the northern Great Basin (Currens 1996, Behnke 1992). Bull trout represent Idaho’s only native char. Redband trout and bull trout demonstrate a complex of different life history forms. Both species had various resident and migratory forms, including anadromy for redband trout throughout much of the range (Behnke 1992, Currens 1996). Stanford (1942) reported of widespread plantings of rainbow trout throughout the Snake River drainage, so it is likely that hatchery strains of rainbow trout influenced the fishery and populations of resident rainbow trout fairly early.

The native complex of cyprinids and catostomids was common throughout the Snake River (Stanford 1942; Simpson and Wallace 1978). Although no sculpins were mentioned in Stanford (1942), there were likely two species of cottids present in the reach (Simpson and Wallace 1978) (Table 5-3).

5.3.1.2. Introduced Species

During the late 1800s and continuing through the 1940s and 1950s, widespread introductions of centrarchids, cyprinids, ictalurids, and percids were made throughout the west and northwest (Lampman 1946; Wydoski and Bennett 1983). During the same period, extensive reservoir development helped create favorable environments for many successful self-sustaining populations of introduced fish. Stanford (1942) reported successful introductions of brown bullheads (*Ictalurus nebulosus*), channel catfish (*I. punctatus*), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis spp*.) and carp (*Cyprinus carpio*) in the Snake River. Smallmouth bass (*Micropterus dolomieu*) were introduced into parts of the middle Snake River as early as the late 1800s (Munther 1970), with continued introductions through 1950 (Keating 1970). Bell (1961) reported observing spawning smallmouth bass in Brownlee Reservoir shortly after the reservoir was filled. These early introductions of warm-water stocks generally received light fishing pressure throughout the northwest (Henderson and Foster 1956). In addition to these warm-water introductions, eastern brook trout (*Salvelinus fontinalis*) were introduced to many smaller tributaries throughout the west, including many tributaries in Hells Canyon (Indian Creek, Wildhorse River).

5.3.2. Historic Anadromous Fish Community

5.3.2.1. Historic Distribution

Upwards of one million adult anadromous Pacific salmon and steelhead (*Oncorhynchus spp*.) were produced in the Snake River and its tributaries in their natural undeveloped condition from the present-day Hells Canyon Dam (RM 247) site to Shoshone Falls (RM 615)(Armour 1990). Runs of spring chinook salmon (*O. tshawytscha*) were present in most of the major tributaries to the Snake River, including the Powder, Wildhorse, Burnt, Malheur, Owhyee, Weiser, Boise, Bruneau, and Malad rivers as well as Pine, Indian, Salmon Falls, and Rock creeks (Matthews and Waples 1991). Summer chinook salmon were present in the Payette River, as were sockeye salmon (***O.*** *nerka*). A run of coho salmon may have been present in the Bruneau River prior to irrigation developments (Armour 1990). Fall chinook primarily inhabited the mainstem Snake River, with highest abundance upstream of the present-day Hells Canyon site (Haas 1965; Armour 1990; Waples *et al.* 1991). Steelhead were probably present in most of the major and many of the minor tributaries associated with the Snake River (Haas 1965; Armour 1990).

Another anadromous fish that was present prior to Hells Canyon Dam construction was the Pacific lamprey (*Entosphenus tridentatus*). The historic range of lamprey overlapped that of Pacific salmon and steelhead, and probably extended up the Snake River to Shoshone Falls, including many tributaries (Simpson and Wallace 1978). Stanford (1942) reported observations of lampreys passing through the Swan Falls Dam fish ladder.

5.3.2.2. Tributary and Mainstem Development

The abundance and distribution of anadromous fish above the present-day Hells Canyon Complex were affected by losses of habitat due to dam construction, irrigation, and mining activities prior to construction of the complex (Armour 1990). At the completion of Brownlee Reservoir in 1958, four mainstem Columbia River dams had also been completed, including Bonneville, The Dalles, McNary and Grand Coulee (Table 5-4). At the completion of Hells Canyon Dam in 1967, two additional mainstem dams below Hells Canyon were complete: Priest Rapids (Columbia River) and Ice Harbor (lower Snake River; Table 5-4). However, even prior to construction of Bonneville Dam in 1937, portions of most of the major tributaries to the Snake River above the present-day Hells Canyon Complex, including the Boise, Malheur, Payette, Owyhee, Powder, and Burnt Rivers, were blocked by dams primarily intended for irrigation (Table 5-4). These upper tributary dams resulted in partial or total depletion of fish runs in these drainages (Haas 1965). Swan Falls Dam was constructed with a ladder in 1901, however, the design was ineffective, and salmon were not able to pass the dam (Stacy 1991). In 1922, the ladder was modified, but was still ineffective, and rendered Swan Falls Dam the upstream mainstem barrier to salmon migration (Stacy 1991). At the completion of the Hells Canyon Complex, anadromous runs were estimated at 24,000 fall chinook, 4,100 spring chinook, and 10,000 steelhead (Armour 1990).

5.3.3. Current Fish Resources

5.3.3.1. Resident Fish

The present-day species list of native resident fish of the Snake River from Swan Falls Dam to below Hells Canyon Dam probably does not differ from the pre-dam Hells Canyon era described above (Table 5-3). However, the distribution, abundance, and integrity of different life history strategies of various species has changed significantly. Very little information is available on present-day distribution and abundance of native fish, probably because of the non-game status of the majority of these fish (i.e. cyprinids and catostomids). White sturgeon continue to persist in isolated reaches; however, current population status in many of the reaches remains unknown and is assumed to be depressed. The reach below Hells Canyon Dam probably contains the healthiest white sturgeon population in Idaho (Hanson *et al.* 1992). All small tributaries capable of supporting fish contain redband trout (IDFG 1991). Bulltrout have been documented in several tributaries to the Snake River and some evidence exists that bull trout may use the reservoirs when temperature conditions are favorable (IPC unpublished data). The role of the reservoirs in supporting life stages or life history strategies of native salmonids remains unknown.

Many species of introduced fishes are well established in the study area and provide important fisheries (Mabbott and Holubetz 1990). Warm-water gamefish in the Hells Canyon study area primarily include self-sustaining populations of centrarchids, ictalurids, and percids (Table 5-3). Introduced centrarchids include smallmouth bass, largemouth bass, white crappie (*Pomoxis annularis*), black crappie (*P. nigromacultus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), and warmouth (*Chaenobryttus gulosus*). Introduced ictalurids include channel catfish, blue catfish (*Ictalurus furcatus*), brown bullhead, black bullhead (*I. melas*), tadpole madtom (*Noturus gyrinus*), and flathead catfish (*Pylodictis olivaris*). Yellow perch (*Perca flavescens*) is the only percid present in the system. The only introduced cyprinid prevalent throughout the study area is the common carp. Many of the smaller tributaries such as Indian Creek and Wildhorse Rivers support self-sustaining populations of eastern brook trout.

Two species of crayfish have been reported to occur in the Hells Canyon area: *Pacifastacus leniusculus*, and *P. gambeli* (Bennett and Dunsmoor 1986; Dunsmoor 1990). *P. leniusculus* is probably the most common throughout the Hells Canyon study area (Dunsmoor 1990). Another species of crayfish, *P. connectens*, is reported to be present in Idaho and Oregon (Pennak 1989), but no confirmation of their presence in the Hells Canyon area can be found. Crayfish were reported to be fairly abundant in Oxbow and Hells Canyon reservoirs; however, relatively low numbers occur in Brownlee Reservoir (Dunsmoor 1990).

Two known commercial fishing efforts have occurred in the Hell Canyon Complex. Common carp have been fished commercially to varying degrees in Brownlee Reservoir. Crayfish have also supported a commercial fishery in Oxbow and Hells Canyon Reservoirs.

5.3.3.2. Anadromous Fish

The present-day distribution of anadromous fish in the Hells Canyon area is restricted to below Hells Canyon Dam, and includes stocks of chinook salmon (spring, summer, fall), steelhead, and Pacific lamprey. Abundance of all anadromous stocks has declined precipitously throughout the entire Snake River basin (Raymond 1988, Matthews and Waples 1991, Waples *et al.* 1991). Causes of decline are varied (Chapman *et al.* 1991), but include poor land management practices (Chapman *et al.* 1991), high mortalities of juvenile downstream migrants at hydroelectric facilities (Raymond 1988, Chapman *et al.* 1991), loss of historical spawning habitat (Chapman *et al.* 1991, Irving and Bjornn 1981, Horner and Bjornn 1981*a*, 1981*b*), and harvest (Chapman *et al.* 1991). Snake River spring/summer chinook and fall chinook were listed as *threatened* on April 22, 1992. In 1994, the listing for spring/summer chinook and fall chinook was reclassified to an *endangered* status under an emergency rule (NOAA 1995). The NMFS reports evidence of substantial gene flow between Snake River stocks of spring and summer chinook salmon, and considered them as one group under the Endangered Species Act (Matthews and Waples 1991). Snake River stocks of fall chinook were found to be reproductively isolated from other forms, and listed separately under the ESA (Waples *et al.* 1991; Matthews and Waples 1991). Bull trout and Snake River steelhead are listed as *candidate* species under the ESA. Little is known of present-day Pacific lamprey abundance or distribution (Simpson and Wallace 1973). Pacific lamprey are listed as *endangered* by the Idaho Department of Fish and Game (CDC 1994).

Five principal sub-basins below Hells Canyon Dam, Clearwater, Grande Ronde, Salmon, Imnaha, and Tucannon, produce spring or summer chinook. (Matthews and Waples 1991). Of these five, the Salmon and Imnaha subbasins are tributary to the Snake River in Hells Canyon. The Grande Ronde is a tributary near the lower end of the Hells Canyon Reach near the city of Asotin, Washington (Figure 2-1). There are also two small streams below Hells Canyon Dam (Granite and Sheep Creeks) that provide limited spawning and rearing for spring and/or summer chinook (IDFG 1992, Matthews and Waples 1991). Because these stocks use tributaries of the Snake River for spawning and rearing, the Snake River serves only as a corridor for upstream-migrating adults or downstream-migrating juveniles. As such, operation of the Hells Canyon Complex has the potential to influence migrations, at least above the mouth of the Salmon River and partially to the upper end of Lower Granite Reservoir. Water releases from Brownlee Reservoir have been used for flow augmentation to aid downstream and upstream passage through the Lower Snake reservoirs. Currently, there is much debate over the benefits of flow augmentation and other options to aid migration (Chapman *et al.* 1991). Spring and summer chinook have been heavily supplemented and influenced by hatchery propagation throughout their present range (Matthews and Waples 1991). A hatchery spring chinook run presently migrates up to Hells Canyon Dam, where the fish are trapped and moved to the Rapid River Fish Hatchery (see Current Hatchery Operations).

Snake River stocks of fall chinook salmon are restricted to the mainstem Snake River below Hells Canyon Dam, as well as the lower portions of the Imnaha, Grande Ronde, and Clearwater rivers (Waples *et al.* 1991). The majority of present-day natural spawning occurs in the mainstem Snake River between Hells Canyon Dam and Asotin, Washington (Irving and Bjornn 1981; Waples *et al.* 1991; Chapman *et al.* 1991). The operation of the Hells Canyon Complex influences to a large extent, environmental conditions present during spawning, incubation, and much of the early life history of fall chinook, particularly from Hells Canyon Dam to the mouth of the Salmon River (Figure 2-1).

Recent hatchery propagation included considerable efforts to maintain brood stock of Snake River origin for production in the Lower Snake River Compensation Program (LSRCP) at the Lyons Ferry Hatchery. Lyons Ferry Hatchery was intended to offset losses of anadromous fish due to the construction of four lower Snake River Dams (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) (Waples *et al.* 1991). An egg bank program was started by temporarily transplanting a portion of the fall chinook run to the Kalama River until construction was complete at Lyons Ferry (Bugert and Hopley 1989). Hatchery releases in the lower Snake River from the egg bank program were made beginning in 1979 and continued through 1985. The egg bank program was terminated when Lyons Ferry Hatchery carried out the brood stock operations for Snake River fall chinook in 1984.

Fall chinook counts have increased recently at Ice Harbor Dam, however, counts of fall chinook at Lower Granite Dam have remained under 1,200 fish since 1975, with a low of 335 in 1990 and a high in 1993 of 1170 (Waples *et al.* 1991). These counts at Lower Granite Dam provide an indication of naturally spawning fall chinook in Hells Canyon. Recent estimates of hatchery and wild fish show a downward trend in the number of wild fish arriving at Lower Granite Dam (Waples *et al.* 1991). The genetic integrity of wild Snake River fall chinook is in question because of such low numbers and the higher numbers of hatchery-reared fish over Lower Granite (IDFG 1992). Aerial redd counts of the spawning areas in Hells Canyon (since 1987) have also declined from 66 redds observed in 1987 to 32 redds observed in 1990 (Glen Mendel, Washington Department of Fisheries, LSRCP, memorandum to Phil Groves, IPC, dated 25 Feb, 1992). Beginning in 1991, more intensive searches for redds were initiated in a cooperative effort with IPC, USFWS, and the Washington Department of Fisheries (WDF), and beginning in 1993, intensive deep water redd searches were also initiated. Redd counts were highest in 1993, with a total of 126 redds in the Snake River (Groves and Chandler 1996).

5.3.3.3. Free-Flowing Hells Canyon

Research in the free-flowing reach of the Snake River from Hells Canyon Dam to Lewiston, Idaho has primarily focused on white sturgeon and anadromous fish. The white sturgeon population in Hells Canyon is one of the healthiest populations in Idaho (Cochnauer *et al.* 1985). Coon (1978) estimated between 8,000 and 12,000 sturgeon larger than 0.5 m (20 inches) residing in the Hells Canyon reach. Sturgeon of less than 1.0 m (40 inches) total length comprised 86 percent of the sturgeon captured, suggesting successful reproduction in the reach. Lukens (1984) reported similar findings in follow-up investigations during 1983 and 1984.

Recent research efforts on anadromous fish below Hells Canyon Dam are focusing on fall chinook. In 1991, IPC initiated an interim recovery plan for fall chinook (IPC 1991) which calls for stable flows during the period of fall chinook spawning in Hells Canyon (late October through early December). Upon completion of spawning, flows released from Hells Canyon Dam are maintained at or above the stable flow level established during the spawning period until chinook fry emerge from the gravel (April through May). IPC is evaluating the recovery plan by determining fall chinook spawning time, habitat use, and habitat availability at differing discharges in a cooperative study with the USFWS and WDF (Groves *et al.* 1992; Rondorf *et al.* 1991; Glen Mendel, WDF, pers. comm.). The USFWS is also focusing on describing fall chinook emergence, rearing, and downstream migrational characteristics of fall chinook (Rondorf *et al.* 1991). WDF is conducting further research to evaluate the genetic makeup and hatchery contributions of natural spawning that occurs in Hells Canyon (Lee Blankenship, WDF, pers. comm.).

IDFG evaluated the resident fishery, primarily focusing on smallmouth bass and channel catfish populations as well as evaluating the success of rainbow trout stocking in Hells Canyon (Lukens 1986). Smallmouth bass are one of the most sought-after resident fish in the Hells Canyon area, and provide an important fishery (Lukens 1986). Earlier work on smallmouth bass focused on movements, distribution, growth rates, and food habits (Munther 1970; Keating 1970). Much of this work focused on the lower portion of the river, below the mouth of the Salmon River.

5.3.3.4. Hells Canyon Reservoir

Very little research has been conducted on Hells Canyon Reservoir, with the exception of regional efforts by IDFG and ODFW. Welsh and Reid (1970, 1971) documented fishery inventories and creel surveys on Hells Canyon Reservoir.

White sturgeon were reported absent from Hells Canyon Reservoir in 1967 (Welsh and Reid 1971). However, ODFW reported a capture of seven white sturgeon during their June 1992 sampling efforts (Ray Beamesderfer and Ruth Farr, ODFW, memorandum to Jeff Zakel, ODFW, 24 June, 1992). Based on size, all fish collected were probably trapped in the reach at the closure of Hells Canyon Dam, with the exception of one passive integrated transponder PIT (passive integrated transponder) -tagged fish released by IDFG. Earlier in 1992, Oregon State Police reported capture of two small white sturgeon by anglers.

The 1991 to 1995 IDFG Fisheries Management Plan describes the agency's management direction for Hells Canyon Reservoir. It states that IDFG will strive to:

1) maintain a limited fishery with hatchery steelhead,
2) stock kokanee salmon (*Oncorhynchus nerka*) and fall subcatchable rainbow trout, and
3) perform a creel survey to assess angler satisfaction with newly stocked fish.

Additional efforts will be made to inventory many of the tributaries to the reservoir, including Indian Creek (Figure 2-1) to assess densities of fish and habitat conditions. Management priority will be given to redband trout in these tributaries.

5.3.3.5. Oxbow Reservoir

Past research on Oxbow Reservoir has been similar to that of Hells Canyon Reservoir. Welsh and Reid (1970, 1971) documented fishery inventory and creel survey by IDFG. Rohrer (1984) reported collecting 71 smallmouth bass, the largest being 380 mm (15 inches), during one electrofishing effort. Recent regulation changes for smallmouth bass by IDFG and ODFW were intended to promote a quality-sized bass fishery in Oxbow. A slot limit was imposed in 1992, forbidding harvest on 12-inch to 16-inch bass and imposing a lower bag limit.

Sturgeon probably still persist in Oxbow Reservoir. Welsh and Reid (1971) found 29 white sturgeon in the upstream end of Oxbow Reservoir (Brownlee tailrace). However, recent efforts by ODFW found no white sturgeon during fall sampling in 1992 (Ray Bemesderfer and Ruth Farr, ODFW, memorandum to Jeff Zakel, ODFW, 7 October, 1992). IDFG reported the collection of one large white sturgeon (164-cm (64-inch) fork length, aged at 29 yrs.) and a second smaller fish caught by an angler in 1992.

The 1991 to 1995 Fisheries Management Plan for Idaho describes the agency's management direction for Oxbow Reservoir. It states that IDFG will strive to:

1) increase rainbow trout stocking using subcatchables,
2) perform creel survey to assess angler exploitation and effectiveness of trout stocking, and
3) evaluate potential regulation alternatives for a trophy bass management.

Wildhorse River will be inventoried to assess fish densities and habitat similar to Indian Creek.

5.3.3.6. Brownlee Reservoir

Brownlee Reservoir supports one of the most popular fisheries in Idaho and eastern Oregon (Mabbott and Holubetz 1990), and has received much attention in recent years relative to Oxbow and Hells Canyon. Prior to the 1980s, fishery research on Brownlee Reservoir was directed towards passage of Pacific salmon and the salmonid fishery. Ebel and Koski (1968) investigated possible impacts of the reservoir on salmon migration. Goodnight (1971) primarily focused on availability of suitable habitat for salmonids. He also completed a survey of the fisheries and limnology of Brownlee Reservoir. IDFG initiated research in 1983 in response to increased angler interest in the warmwater fishery and the apparent decline in the quality of the smallmouth bass fishery in Brownlee Reservoir (Rohrer 1984; Rohrer and Chandler 1985). A detailed food habits study of smallmouth bass in the lower half of Brownlee followed this research (Bennett and Dunsmoor 1986; Dunsmoor 1990). Zooplankton was found to be of high importance in the diets of all sizes of smallmouth bass, a discovery that prompted consideration of forage species introductions into Brownlee (Dillon and Myers 1990a, 1990b).

According to a 1990 creel census by IDFG (Mabbott and Holubetz 1990), trout were the preferred targeted species in winter, while crappie were targeted in the summer. Black and white crappie comprised 65 percent of the total catch and harvest; bass comprised only 28 percent. The balance consisted of trout (1 percent), yellow perch (2 percent), bluegill (1 percent) and channel catfish (2 percent).

White sturgeon have been found in the upper end of the reservoir (Mabbott and Holubetz 1989). In July 1990, high nutrient loading, combined with low in-flows, created extremely low levels of dissolved oxygen in the upper end of Brownlee, killing 28 sturgeon as well as a number of other fish species.

The 1991 to 1995 IDFG Fisheries Management Plan describes the management direction for Brownlee Reservoir. It states that IDFG will strive to:

1) evaluate bass regulations on size and number to enhance opportunities to catch large bass;
2) conduct experimental stocking of 8-inch to 10-inch largemouth bass;
3) develop cooperative management agreement with ODFW and IPC concerning shared stocking of fingerling and catchable rainbow trout;
4) reduce drawdown for flood control in January through March and confine drawdown to April and May to enhance the resident fisheries; and
5) document current bass growth and need for additional forage.

In 1991, IPC initiated research on the resident fish in Brownlee, primarily to address potential effects of water-level fluctuations on resident fish populations. This research is part of IPC’s evaluation of operational guidelines of the Hells Canyon Complex as part of the fall chinook interim recovery plan (IPC 1991). Although much of this plan focuses on fall chinook recovery, evaluating impacts to resident fisheries and recreation in the Hells Canyon Complex reservoirs is also an essential part of the recovery plan evaluation.

Water-level fluctuations may have varying impacts on all fish species, depending on the timing. Resident fish of primary concern in Brownlee Reservoir are smallmouth bass, black and white crappie, channel catfish, and rainbow trout. Present studies focus on the effects of water-level fluctuations on spawning and year-class strength of smallmouth bass and crappie, with some attention on identifying possible sites and timing of channel catfish spawning.

5.3.3.7. Swan Falls Dam to Brownlee Reservoir

Little information is available on resident fish in the Swan Falls to Brownlee Reservoir reach of the Snake River. Largescale suckers dominate the nongame fish followed by chiselmouth (*Acrocheilus alutaceus*) and bridgelip suckers (*Catostomus columbianus*). Smallmouth bass, whitefish, and channel catfish dominated the game fish composition (IPC unpublished data).

IDFG conducted limited white sturgeon investigations in the early 1980s from Swan Falls Dam to Marsing. In 763 setline hours and 877 rod and reel hours of fishing, only one sturgeon was captured (Lukens 1982). However, Reid and Mabbott (1987) fished 789 rod and reel hours and captured 42 sturgeon in the same reach. Reid and Mabbott (1987) concluded that white sturgeon may not be as depressed as previously indicated.

5.3.4. Aquatic Habitat

Aquatic habitats are extremely varied from Swan Falls Dam (RM 458) to the mouth of the Salmon River (RM 188). The Snake River at Swan Falls Dam passes through a narrow high-walled canyon. The river channel is uniformly narrow, with a relatively deep channel. The stream gradient is 0.8 m/km, with swift currents and occasional rapids. Large boulder fields and rock outcrops are common through the reach, with little evidence of agriculture or recreational impacts. Near the town of Melba, Idaho, the Snake River leaves the narrow canyon environment and becomes a low-gradient (0.2 to 0.4 m/km) river, with numerous island complexes. Influences of agricultural impacts become apparent with high amounts of irrigation returns causing higher turbidities and increased nutrient loading. Stream substrate becomes smaller, with fines, and sand to medium-sized cobbles prevalent throughout. This habitat extends downstream to the upper end of Brownlee Reservoir (RM 339).

Brownlee Reservoir is a steep-sided reservoir, approximately 55 miles long, with a maximum depth approaching 300 feet near the dam. Large outcrops are prevalent throughout the entire length. Shorelines substrates are often complex and quite variable, with areas dominated by sand to areas dominated by bedrock and small to medium-sized cobbles and boulders of angular basalt. Shoreline slopes ranges of 20 to 30 percent are most common (IPC, unpublished data). One of the most dominant habitat features of Brownlee is the transition zone of riverine habitat to lacustrine habitat, typical of large mainstem reservoirs. The zone is especially pronounced by the reduction in turbidities along a longitudinal gradient in Brownlee. Turbidities increase from Swan Falls Dam to the upper end of Brownlee from agricultural runoff. Brownlee serves as a sedimentation basin, with notably lower-turbidity waters leaving the Hells

Canyon system. Brownlee has the potential for 100 foot drawdowns in the winter for flood control purposes, as regulated by the COE.

Oxbow Reservoir is a small run-of-the-river reservoir, approximately 12 miles long. The Snake River from the tailrace of Brownlee Dam to the mouth of Wildhorse Creek (1 mile) is a high-velocity narrow channel. Oxbow is relatively narrow and shallow, with maximum depths approaching 80 to 100 feet. Daily fluctuations upwards of 5 feet may occur. Shorelines are primarily basalt outcrops and talus, except for areas of alluvial input from small tributaries.

Hells Canyon Reservoir is approximately 22 miles long, and approaches a maximum depth of 200 feet. The unique design of the Oxbow powerhouse and dam renders a 2-mile stretch of the original river channel, from Oxbow dam to the outflow of the powerhouse, with a minimum flow of 100 cfs. This creates a backwater area that is relatively shallow with low velocities. Indian Creek enters the Snake River in this reach. Shorelines in the reservoir are generally very steep, with substrates primarily of basalt outcrops and talus slopes.

The Snake River below Hells Canyon Dam is a high-gradient river (1.8 m/km) with a wide diversity of available habitat, including numerous large rapids, shallow riffles, and deep pools. Substrates are highly diverse, ranging from large basalt outcrops and boulders to cobble/sand bars. Since construction of Hells Canyon Dam, a loss of sand bars has been documented due to large clear water floods between 1964 and 1973 (Grams and Schmidt 1991). Turbididty is usually low, unless influenced by storm events in the tributaries, especially the Salmon and Grande Ronde rivers.

5.3.5. Macroinvertebrate Communities

Macroinvertebrate (aquatic invertebrates retained by a U.S. Standard No. 30 sieve) populations and communities within an aquatic environment can serve as indicators of productivity, habitat value and quality, and sources of habitat degradation. The use of biological indicators to identify chemical conditions in an aquatic environment is a well-established technique (Cole 1983). Macroinvertebrate community size and structure can be important information in evaluating data related to vertebrate aquatic populations. Benthic macroinvertebrate communities are commonly used as indicators of the quality and health of aquatic habitats.

The benthic macroinvertebrate communities in the Snake River from Swan Falls Dam to Brownlee Reservoir are dominated by taxa characteristic of fine sediments and organic/nutrient enrichment (e.g. 12 percent of the organisms collected were hydropsychids, 14 percent of the organisms were dipterans and the Ephemeroptera consisted mainly baetids and tricorythids) (IPC unpublished data). The benthic samples collected upstream of Brownlee Reservoir indicate that sand and fine sediment deposition are likely the single most important source of biological impairment in that reach of the river. The benthic fauna downstream of Swan Falls Dam indicate greater impairment of the aquatic habitat than upstream in the middle Snake River (upstream of King Hill). Benthic sampling of major tributaries to the Snake River within the study area indicates that the Owyhee, Boise, Malheur, Payette, and Weiser rivers are obviously degraded and likely contribute to the degraded state of the mainstem Snake River. The Burnt and Powder rivers are less severely degraded, and the Wildhorse River and Pine Creek showed the highest biological integrity of the tributaries sampled. Freshwater zooplankton (free-floating, open-water aquatic animals) generally can be classified into four groups: the Protozoans, the Rotifera, the Cladocera, and the Copepoda

(Cole 1983). Most of the Protozoans are nannoplankters (too small to be trapped by standard plankton nets) and are relatively unknown, or treated as phytoplankton. Dunsmoor (1990) found Copepods (Cyclopoida) were dominant in the spring and fall, and Cladocerans (Daphnia spp.) dominated in the summer. IPC sampled zooplankton in Brownlee Reservoir in 1991 and found several preliminary longitudinal trends in surface water of the reservoir in August. In general, large-body species within the major groups were more prevalent at downstream sites than upstream. Copepoda species tended to dominate in the lower end of the reservoir, and Cladocera species were more prevalent in the upper end. Rotifera were more prominent in the upstream half of the reservoir than the downstream half. Welsh and Reid (1970) found Copepoda species dominant in Oxbow Reservoir, and described Hells Canyon Reservoir as having similar zooplankton distribution.

5.3.6. Aquatic Plants

Aquatic flora in the study area include periphyton and phytoplankton (algae) and submerged vascular plants (macrophytes). Algae species can be classified into major groups including blue green algae (Cyanophyta), green algae (Chlorophyta), diatoms and yellow brown algae (Chrysophyta), dinoflagellates (Pyrrhophyta), euglenoids (Euglenophyceae), and Chryptophyta. Certain algal associations can be useful indicators of trophic state, however, the physiological foundation for evaluating lake productivity or elucidating causal mechanisms underlying the composite growth of algae is very superficial (Wetzel 1983).

Cyanophyta species dominate in relative abundance at all stratified sites in Brownlee Reservoir. Cyanophyta species characteristically dominate stratified, eutrophic systems because of their ability to move vertically through the water column in response to nutrient and light conditions. At the upper end of the reservoir where stratification was not found, Chlorophyta and Chrysophyta species dominated in the more riverine type areas. Chrysophyta species typically dominate in low-light, mixed-water bodies such as the upper end of Brownlee Reservoir.

Chlorophyll (an indicator of phytoplankton biomass) sampling in the Snake River upstream of Brownlee Reservoir in 1990, and in Brownlee, Oxbow, and Hells Canyon reservoirs in 1991 indicates that chlorophyll levels are extremely high during the summer months in the upper end of Brownlee Reservoir and the river upstream of the reservoir. The mean chlorophyll level found in the river upstream of Brownlee Reservoir from April 1990 to April 1991 was 48 ug/l. Maximum levels exceeded 338 ug/l. From March 1991 to December 1991, chlorophyll levels at the head end of Brownlee Reservoir (Fairwell Bend) averaged 65 ug/l. The values are well in excess of the 15 ug/l criteria set by Oregon as nuisance phytoplankton levels. The average value for surface water at Brownlee Dam for the same time period was 7 ug/l, with water being discharged from the dam averaging 2 ug/l. Values of surface water in Oxbow and Hells Canyon reservoirs averaged 7 and 10 ug/l respectively, and water being discharged from Hells Canyon Dam averaged 2 ug/l.

Information on submerged vascular plants is not available. Species found in the study area are likely similar to species identified in the Snake River upstream of C.J. Strike Dam. Species commonly found upstream of the study area include *Potomogeton spp., Zannichellia palustris*, *Lemna spp*., *Ceratophyllum demersum*, *Elodea spp*., and *Myriophyllum spp*. Water level fluctuations in the Brownlee, Oxbow, and Hells Canyon reservoirs likely limit the growth of aquatic macrophytes in the impoundments.

5.3.7.
Threatened or Endangered Species

Snake River spring/summer chinook and fall chinook were listed as *threatened* on April 22, 1992. In 1994, the listing for spring/summer chinook and fall chinook was reclassified to an *endangered* status under an emergency rule (NOAA 1995). The NMFS reports evidence of substantial gene flow between Snake River stocks of spring and summer chinook salmon, and considered them as one group under the Endangered Species Act (Matthews and Waples 1991). Snake River stocks of fall chinook were found to be reproductively isolated from other forms, and listed separately under the ESA (Waples *et al.* 1991; Matthews and Waples 1991). Bull trout and Snake River steelhead are listed as *candidate* species under the ESA.

5.3.8.
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5.4. Wildlife Resources

5.4.1. Historic Habitat Conditions and Wildlife Resources

The Hells Canyon area has been inhabited by humans for at least 12,000 years (Daubenmire 1970). The earliest indications of wildlife species inhabiting Hells Canyon are related to those big game species successfully hunted by these prehistoric peoples. This is evidenced by large ungulate remains, which may have been an important food source, being commonly found at archeological campfire sites. For example, the Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) was the most common large mammal recovered at the Hells Canyon Creek Rockshelter (Pavesic 1971).

However, the large mammals associated with the Ice Ages became extinct as the North American climate warmed. These species were replaced by modern forms, such as the American bison (*Bison bison*) and pronghorn antelope (*Antilocapra americana*), which inhabited the area in historic times. As the megafauna became less abundant in the warming climate, aborigines became more dependent on fishing. As a result, villages became concentrated along streams where salmon and lampreys could be readily obtained (Daubenmire 1970).

These early Americans, including the Nez Perce Tribe, that inhabited the Pacific Northwest's intermountain region prior to European settlement, often wintered in Hells Canyon. Generally, these peoples lived in an environment offering a variety and abundance of natural food resources at different times of the year. For example, the Nez Perce harvested root crops from spring through early fall. Hunting was practiced in the fall, along with berry and nut collecting. Salmon was a major food component throughout much of the year.

After horses were introduced from the great plains around 1730, the Nez Perce increased their hunter-gatherer activities to include hunting expeditions into Montana to obtain bison, which had disappeared from the Pacific Northwest about 1800 (Van Vuren 1987).

Little is actually known about the status of wildlife species and their habitat in Hells Canyon during pre-settlement times. The Lewis and Clark expedition, in 1805, was the first time Europeans entered the Hells Canyon area. This marked the beginning of the earliest recorded information on the natural resources of the Snake River. Hunt and Crook of the Pacific Fur Company, who entered Hells Canyon in 1812, were also early explorers of the Snake River. This party almost starved before they were able to leave Hells Canyon. Wildlife was apparently scarce, because the Hunt and Crook party was only able to kill a single bighorn sheep. In 1834, Captain Bonneville led a party into Hells Canyon and suffered a similar fate. Sightings of mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) were infrequent in the journals of these and other early explorers of Hells Canyon. Scarcity of game in the Nez Perce territory was mentioned for the years 1804, 1805, and 1841. This may have led to abandonment of the canyon by the Nez Perce in the early 1900s (Pavesic 1971).

Centuries before the arrival of white settlers, ungulate grazing pressure on native vegetation was probably of little significance. Large herds of ungulates apparently were never an integral part of the steppe communities in the northwest, as they were in the Great Plains. Grazing by large mammals was limited to relatively small populations of deer, elk, pronghorn, and bison. The American bison, which was on the western edge of its range, is generally believed not to have been a significant herbivore on the shrub-steppe vegetation (Galbraith and Anderson 1971). However, medium-sized mammals, such as lagomorphs and rodents, were probably significant grazers of shrub-steppe and grassland areas (Yensen 1982). Sage grouse

(*Centrocercus urophasianus*), which was common in shrub-steppe environments in historic times, was a potentially important avian grazer of shrub-steppe vegetation. Insects and arthropods are actually the dominant consumers of primary plant production and may consume as much as 70 percent of this plant matter (Rogers *et al.* 1988).

Once the Nez Perce acquired horses, intensive grazing probably took place adjacent to villages along the Snake River (Daubenmire 1970). Widespread impacts to steppe vegetation due to horses, however, were likely to be localized because horses were closely herded. Fire and grazing were apparently of limited importance in shrub-steppe vegetation before settlement by whites and grazing by their livestock (Daubenmire 1970, Heady 1968).

Most of the inland northwest was settled by the mid-to-late 1800s. By 1880, Hells Canyon and vicinity was quickly homesteaded as a result of the Nez Perce War of 1877 and subsequent forceful removal of these Native Americans. The discovery of gold and the resulting influx of white settlers are attributed to causing this war. With the settlement of Hells Canyon, large numbers of cattle were introduced into the area's rangelands and grazed until the 1920s. At this time, cattle grazing was mostly replaced by sheep grazing (Tisdale 1986*a*). By the 1940s, however, a shift back to cattle occurred and numerous cattle feedlots were developed along the Snake River (Asherin and Claar 1976). In addition to grazing livestock, early settlers planted orchards of apricots, cherries, and peaches along the Snake River. Grain crops were grown on fields above Hells Canyon.

Franklin and Dyrness (1988) summarized the impacts of white settlement on the shrub-steppe vegetation in the Northwest. It is known that the introduction of cattle and domestic sheep had a profound impact on the native steppe and shrub-steppe vegetation in the Inland Northwest. Cattle were introduced to these shrub-steppe areas in 1834 and domestic sheep about 1860 (Daubenmire 1970). The latter were generally more abundant until 1940. During 1860 through 1870 and 1892 to 1893, cattle and sheep populations rapidly expanded, respectively (Galbraith and Anderson 1971). Lands not used for crop production were subjected to various degrees of grazing and overgrazing by livestock. Under this heavy livestock use, the range quickly became overgrazed and generally deteriorated (Tisdale 1986*b*). Overgrazing was already considered to be a serious problem in the early 1900s.

The inability of native plant species to endure heavy grazing pressure, or to rebound after grazing pressure was released, probably reflects their evolutionary development free of significant ungulate grazing. Introduced exotics, notably cheatgrass (*Bromus tecterum*) impaired, impeded, and may have even arrested recolonization of the range by native shrubs and grasses. Range conditions generally improved from 1900 to 1950 (Chohlis 1952). Also, fire was never used to the significant extent by Native Americans in shrub-steppe environments, compared to forested regions where fire was used in conjunction with hunting.

The shrub-steppe vegetation in the northwest has been extensively changed by man through cropping, irrigation, livestock grazing, and introduction of exotic plants. The most productive lands are almost entirely under cultivation. Although large-scale changes in shrub steppe and grassland communities in Hells Canyon and its vicinity have taken place through man’s domestic stock growing activities, the basic wildlife habitat relationships may largely be unchanged.

5.4.2. Current Habitat Conditions

Public lands in Hells Canyon and vicinity are administered principally by the BLM and the USFS. The Boise and Vale Districts of the BLM are responsible for managing much of the public lands in the southern portions of Hells Canyon. The Cascade Resource Area, located in the Boise District, manages public lands in Ada, Adams, Boise, Canyon, Gem, Payette, Valley, and Washington counties of Idaho. Northern Malheur and Baker Resource Areas are managed by the BLM's Vale District, which manages public lands in Malheur, Baker, Union, and Wallowa counties of Oregon.

The Northern Malheur Resource Area encompasses 1.9 million acres and the Baker Resource Area has 0.43 million acres. Most of these areas are located in the Blue Mountains Physiographic Region. However, the northwest portion is included in the Columbia Basin Physiographic Region. The vegetation in the two resource areas is the product of widely varying elevations, topography, climate, soils, and land use patterns. The existing plant communities range from low-elevation shrub-steppe desert and grasslands to high-elevation coniferous forest and subalpine communities. Vegetation types consist of perennial grasses (*Poa* spp.), big sagebrush (*Artemisia tridentata*), bunchgrass (*Stipa spp*.), big sagebrush/annual grass, and mixed shrub plant communities that occur on mid- and lower-elevation intermountain rangelands (USDI 1986).

On 85 percent of those lands administered for grazing, the ecological condition has been evaluated. These rangeland condition classifications describe how closely the present plant community on a range site resembles the potential climax plant community. Only three percent of the area was considered to be in climax; 23 percent was in late successional stage; and 61 percent was in middle and early successional stages. This evaluation also suggested that 50 percent of the range was in static condition, 39 percent was improving, and 11 percent was deteriorating (USDI 1986).

Riparian zones in these resource areas are critically important because they are biologically diverse and are considered a lifeline of biological systems in the region. Riparian areas are those land areas that can be classified by the presence of vegetation that requires free or unbound water (USDA 1990*a*). In Hells Canyon, riparian zones are generally narrow (less than 10 m (33 feet)) and comprise less than 1 percent of the total land managed by the BLM. About 80 percent of these riparian zones have been inventoried, and most of the habitat is in good or fair condition. The apparent trend is static (USDA 1990*a*).

The Cascade Resource Area manages 0.48 million acres on the east side of the Snake River. These public land holdings contain both scattered tracts and large blocks of land. This resource area is located in the Intermountain Sagebrush Province, and more specifically the sagebrush-wheatgrass section (Bailey 1995). Eleven vegetation cover types were described for this area and ranged from low-elevation shrub-steppe desert and grasslands to lower coniferous forest. The sagebrush-grass cover types entail 75 percent of the resource area’s managed lands. Ninety percent of these lands were rated in fair (47 percent) to poor (43 percent) condition (USDI 1987). Wildfires in 1986 resulted in cover changes on 95,516 acres. The major change related to the loss of the sagebrush/bitterbrush (*Purshia tridentata*) component. Vegetation condition ratings were conducted over approximately 198 drainage km (123 miles). Woody riparian vegetation was rated in good condition along 63 percent of the drainage miles and rated in fair condition along 28 percent of drainage kilometers surveyed.

USFS lands, comprising most public lands in the northern reaches of Hells Canyon, are managed as part of the Payette and Nez Perce National Forests in Idaho, and the Wallowa-Whitman National Forest in Oregon. The Wallowa-Whitman National Forest is situated in the northeast corner of Oregon and the west-central edge of Idaho. It lies within Wallowa, Union, Baker, Malheur, Umatilla, and Grant Counties in Oregon, and Adams and Nez Perce Counties in Idaho.

Wide ranges in elevation and precipitation provide distinctly different physical environments across the Wallowa-Whitman National Forest. These environments are reflected as numerous vegetative types and communities. These vegetation types can be grouped under the Rocky Mountain Forest Province designation, and specifically the grand fir (*Abies grandis*) and Douglas fir (*Pseudotsuga menziesii*) Forest Section (Bailey 1995). Well-marked vegetational zones can be readily identified. The Alpine Physiographic Unit is found above 2266 m (7434 feet) and is characterized by alpine tundra and the absence of trees (USDA 1990*a*). The Subalpine Zone, dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*); the Mountain Zone, characterized by the dominance of ponderosa pine (*Pinus ponderosa*) and Douglas fir; and the Foothill (woodland) Zone, are lumped into Forested Uplands Physiographic Unit by the Wallowa-Whitman National Forest (USDA 1990*a*). The Grass-Shrub Uplands Physiographic Unit is found predominantly in the transition zones between Valley Lands and Forested Uplands Physiographic Units. Vegetation is composed of forbs, grasses, sagebrush, and other shrubs. Grasses common to this physiographic unit include bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), cheatgrass, and Sandberg bluegrass (*Poa sandbergii*). The Valley Lands Physiographic Unit is predominantly under private ownership and used for agriculture.

Within the Wallowa-Whitman National Forest, there are an estimated 15,360 km (9,523 miles) of streams and associated riparian areas. A stream habitat survey conducted in 1980 and 1981 ranked streams, stratified by stream class (from streams of significant size to intermittent streams), into three indicators of riparian health: stream bank stability, stream surface shaded, and stream-bed sedimentation (USDA 1990*a*). Slightly more than half of the streams have fair or better stream bank stability. Based on limited information, it appears that there is considerable room for improvement in shade-producing vegetation. Lastly, sedimentation does not appear to be a significant problem, but there appears to be room for improvement. Riparian areas are impacted by livestock for forage and cover, big game for browsing, recreationists, and road development (USDA 1990*a*). All of these factors have led to a degradation of riparian areas to a condition below its natural potential. In many cases, the impacts are permanent and the natural potential cannot be attained. Consequently, these areas are managed for an altered potential.

Of the approximately 2.3 million acres of the Wallowa-Whitman National Forest, approximately 1.3 million acres are classified as suitable for livestock grazing under controlled management conditions that supposedly will maintain or improve the range resources (USDA 1990*a*). The Hells Canyon National Recreation Area (HCNRA) is rugged and is suited primarily for sheep grazing. However, sheep grazing has proven to be unprofitable for several operators in recent years. Therefore, large allotments have not been fully grazed (USDA 1990*a*).

The Nez Perce National Forest is located entirely within Idaho County in north-central Idaho. There are 57,113 acres of HCNRA and 59,900 acres of Hells Canyon Wilderness in the Nez Perce National Forest. From 1975 to 1979, the HCNRA and Wilderness were jointly administered by the Nez Perce, Payette, and Wallowa-Whitman National Forests. Since 1979, the Wallowa-Whitman National Forest solely administers the HCNRA and Wilderness (USDA 1987). Therefore, reference is made to the Wallowa-Whitman National Forest Land and Resource Management Plan regarding the HCNRA and Wilderness rather than the Nez Perce National Forest Final Environmental Impact Statement (USDA 1987).

The Payette National Forest stretches nearly the full width of central Idaho, and is situated in Adams, Idaho, Valley and Washington counties. The forest contains a portion of the HCNRA, which is administered by the Wallowa-Whitman National Forest. Reference is made to USDA (1990*a*) concerning management of the HCNRA. Four management areas in the southwestern corner of the Payette National Forest are located in the immediate vicinity of Hells Canyon, namely the Seven Devils, Hornet, Cuddy Mountain, and Brownlee. Two of four physiographic vegetation units identified by the USFS also occur in the above mentioned management areas, namely, Forested Uplands and Grass-shrub Uplands (USDA 1990*b*). These physiographic units can be placed in two vegetation provinces: The Intermountain Sagebrush Province, Sagebrush-Wheatgrass Section; and the Rocky Mountain Forest Province, Grand fir-Douglas Fir Section (Bailey 1995). Riparian areas on the Payette National Forest are heavily influenced by past management activities. Historic activities affecting riparian and stream channel conditions on the west side include road construction, timber harvest, grazing, fire, mining, and recreation. Riparian areas on the west side of the national forest have been impacted by one or more of the above activities. This has resulted in loss of riparian areas, decline of desirable shrubby vegetation, invasion of undesirable forbs, and loss of wildlife habitat (USDA 1990*b*).

5.4.3. Current Wildlife Resources

Here wildlife is defined as all non-domesticated terrestrial animals, including those that may spend much of their life associated with water. The major categories of wildlife discussed are:

1) mammals,
2) birds,
3) reptiles and amphibians, and
4) terrestrial insects.

Nomenclature of vertebrates follows Banks *et al.* (1987) and Jones *et al.* (1992). This description focuses on those species of greatest concern to resource managers and the public because of their ecological, recreational, and/or economic value. The wildlife communities in Hells Canyon and vicinity are described from a regional perspective.

5.4.3.1. Non-game Birds

General information on the distribution of Idaho birds is presented by Stephens and Sturts (1991). Specific information on non-game birds in Hells Canyon and its vicinity is sparse. Only two books on Idaho ornithology, which contain very few references for Hells Canyon, are currently available (Larrison *et al.* 1967, Burleigh 1972). Relatively more species records, however, are available for Lewiston, Idaho (Burleigh 1972). An annotated species list is available for the Weiser Valley, which is south of Hells Canyon (Newhouse 1960). On the Oregon side of Hells Canyon, a bird species list is available for Union and Wallowa Counties from the Grande Ronde Bird Club. General information on distribution and status of Oregon's birds is presented by Gilligan *et al.* (1994).

In 1974, Asherin and Claar (1976) conducted bird surveys along the Snake River from Farewell Bend to the confluence of the Snake and Columbia Rivers. Forty-one transects were surveyed in upland and riparian vegetation during all four seasons. Three segments of Asherin and Claar's (1976) transects occur in Hells Canyon. These were: Brownlee Reservoir, Segment 1; Oxbow and Hells Canyon Reservoirs, Segment 2; and Hells Canyon Dam to the Snake-Salmon Rivers confluence, Segment 3. In Segment 1, 126 nongame bird species were identified; in Segment 2, 109 species; and in Segment 3, 92 species. The number of bird species utilizing riparian habitats increased from simple-structured vegetation to multi-structured vegetation (Asherin and Claar 1976). Riparian vegetation and forested uplands were of particular importance judged by the high number of species utilizing these cover types.

Riparian habitat is often structurally complex and, as a consequence, supports a diverse avifauna (Carothers *et al.* 1974, Asherin and Claar 1976, Knopf *et al.* 1988, Ohmart *et al.* 1988, Lee *et al.* 1989). Seventy-six passerine species were associated with riparian areas and adjacent uplands in Hells Canyon. Many of these are dependent on riparian habitats for food, cover, and nesting. Most bird species that nest in riparian habitats are neotropical migrants, which comprise between 60 percent and 85 percent of the landbirds (Knopf 1985, Dobkin and Wilcox 1986, Saab and Groves 1992). Probably most migrant landbirds in the western United States are associated with riparian habitats during the breeding season (Ohmart and Anderson 1986).

Woody riparian vegetation also provides cover and food during the winter season for a variety of small birds and may be critical to local populations during the stressful winter months (Lewke and

Buss 1977). A greater number and variety of bird species are attracted to riparian areas during migration than during the breeding season. Taylor (1989) reported 108 bird species sighted along the Snake River where it runs through Hells Canyon. Rare bird sightings in Idaho, including Hells Canyon, are summarized by Taylor and Trost (1987). Goatsucker (*Caprimulgidae*), swift (*Apodidae*), hummingbird (*Trochilidae*), kingfisher (*Ceryle alcyon*), and woodpecker (*Picidae*) species were also recorded.

Eleven bird species observed by Asherin and Claar (1976) were open-water or shorebirds. The most common were great blue heron (*Ardea herodias*), killdeer (*Charadrius vociferus*), spotted sandpiper (*Actitis macularia*), American avocet (*Recurvirostra americana*), ring-billed gull (*Larus delawarensis*) and California gull (*Larus californicus*).

No group of birds, with the notable exception of some upland game bird species, is being censused over a substantial portion of its range in either Idaho or Oregon (Groves and Melquist 1991, Marshall 1986). Systematic bird surveys are restricted to the Breeding Bird Survey (Robbins *et al.* 1986) and the Christmas Bird Counts (Root 1988). However, neither of these two surveys is conducted in or near Hells Canyon. Hence, the avifauna of many Idaho and Oregon counties is only superficially known (Taylor and Trost 1987). General information on Idaho bird distribution on a county-by-county basis can be found in Stephens and Sturts (1991). For Oregon, the avifauna of the Blue Mountains Province, which adjoins the Snake River, is reviewed by Marshall (1986) and Thomas (1979).

The following information is mainly based on Marshall's 1986 description. Two hundred and thirty bird species regularly use four selected community types in the Blue Mountains Province (coniferous forests, 34 percent; sagebrush steppe, 19 percent; riparian, 51 percent; and marshes, 37 percent). In high-elevation meadows, sandhill cranes (*Grus americana*) and, at one location, a small population of upland sandpipers (*Bartramia longicauda*), are known to nest. Likewise, the bobolink (*Dolichonyx oryzivorus*) breeds in small numbers. Riparian areas in the Blue Mountains support some eastern breeding passerines, (e.g., the veery *(Catharus fuscescens*), gray catbird (*Dumetella carolinensis*), and American redstart (*Setophaga ruticilla*). Pine grosbeaks (*Pinicola enucleator*) also nest in the Wallowa Mountains, which is the only known breeding area in Oregon. In Oregon, the spruce grouse (*Dendragapus canadensis*) appears to be restricted to this area. In winter, valleys in the province are frequented by Bohemian waxwings (*Bombycilla garrulus*), pine grosbeaks, rosy finches (*Leucosticte arctoa*), common redpolls (*Carduelis flammea*), American tree sparrows (*Spizella arborea*), and snow buntings (*Plectrophenax nivalis*).

Man has impacted avian wildlife in the Blue Mountains Province through forestry, grazing, and cultivation practices. Silvicultural and logging have probably had some of the greatest influences. Species such as the golden-crowned kinglet (*Regulus satrapa*), red-breasted nuthatch (*Sitta canadensis*) and Townsend's warbler (*Dendroica townsendi*) are associated mainly with old-growth stands. In contrast, the dusky flycatcher (*Empidonax oberholseri*), chipping sparrow (*Spizella passerina*), and ruby-crowned kinglet (*Regulus calendula*) are common in managed stands, with higher breeding densities than in old-growth stands. However, large trees are required for some species, such as the northern goshawk (*Accipiter gentilis*), great gray owl (*Strix nebulosa*), and pileated woodpecker (*Dryocopus pileatus*) (Bull 1987, Hayward and Escano 1989, Munts and Powers 1991). Requisite maintenance of snags of adequate size and density in managed forests to support these species presents a serious problem (Thomas 1979).

Relatively more general information is available on avian communities in shrub-steppe vegetation, although not specifically for the Hells Canyon area. Relationships between avian communities and vegetation structure and composition in the Great Basin desert have been investigated extensively (Rotenberry and Wiens 1980, 1989; Wiens 1991; Wiens and Rotenberry 1981). Studies and reviews have been published on non-game birds in shrub-steppe vegetation in southwestern and southern Idaho (Snake River Birds of Prey Natural Conservation Area: Wolfe and Montan 1975; Wolfe *et al.* 1976, 1977; USDI 1979; Smith *et al.* 1984; Rotenberry and Knick 1991; and the Idaho National Engineering Laboratory: Markham 1983, Reynolds 1981, Peterson and Best 1985, 1991*a,b*), and in south-central Washington (the Arid Land Ecology Reserve: Rickard *et al.* 1988, Brandt and Rickard 1992).

Several authors have estimated passerine bird densities in shrub-steppe environments. Wiens and Rotenberry (1981), in their extensive studies of shrub-steppe avian species, found that the sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), and sage thrasher (*Oreoscoptes montanus*) were widespread, while the black-throated sparrow (*Amphispiza bilineata*), loggerhead shrike (*Lanius ludovicianus*), rock wren (*Salpinctes obsoletus*), green-tailed towhee (*Pipilo chorula*), and gray flycatcher (*Empidonax wrightii*) were only locally abundant. Avian species associated with grasslands were horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), mourning dove (*Zenaida macroura*) and lark sparrow (*Chondestes grammacus*) (Knick and Rotenberry 1994). Medin (1990) estimated passerine bird densities in shadscale (*Atriplex confertifolia)* communities in east-central Nevada. He reported that the horned lark was the most common breeder, followed by the Brewer's sparrow, and sage thrasher. Horned larks were also the most common passerine species in a variety of shrub-steppe communities in southwestern Idaho (Smith *et al.* 1981, Rotenberry and Knick 1991, Knick and Rotenberry 1994), and south-central Washington (Rogers *et al.* 1988, Brandt and Rickard 1992). Other abundant species in southwestern Idaho were western meadowlark and sparrow species (Smith *et al.* 1984, Rotenberry and Knick 1991, Knick and Rotenberry 1994).

5.4.3.2. Upland Game Birds

Most upland game birds currently present in Hells Canyon are the result of translocation by state game agencies to establish huntable populations of exotic species suited to various habitats in and adjacent to Hells Canyon (Smith 1990). Introduced exotic species include California quail (*Callipepla californicus*), chukar partridge (*Alectoris chukar*), gray partridge (*Perdix perdix*), Merriam's wild turkey (*Meleagris gallopavo merriami*), and ring-necked pheasant (*Phasianus colchicus*). Native upland game birds, either currently or historically occurring in and/or adjacent to Hells Canyon, were primarily grouse species, and include blue grouse (*Dendragapus obscurus*), ruffed grouse (*Bonasa umbellus*), sage grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), and spruce grouse (*Dendragapus canadensis*). Mountain quail (*Oreortyx pictus*), also native, occur in restricted areas of Hells Canyon. The most common native, migratory upland game bird occurring in Hells Canyon primarily during spring, summer, and fall, is the mourning dove (*Zenaida macroura*) (Smith 1990). Common snipe (*Gallinago gallinago*), also classified as a migratory upland game bird, may occur to a limited degree in higher-elevation wet meadows or the restricted reservoir and riparian wetlands.

Information on numbers and distribution of upland game birds specifically in the vicinity of Hells Canyon is limited. Most information is restricted to surveys conducted by Asherin and Claar (1976). Upland game bird populations were surveyed during 1974 using line transects. Forty-one transects, situated between Farewell Bend and the confluence of the Snake and Salmon Rivers, were surveyed during all seasons of the year (Asherin and Claar 1976).

California Quail

Although other non-native quail species have been introduced into Hells Canyon or the surrounding areas, California quail are probably the most abundant (Smith 1990). Asherin and Claar (1976) observed California quail throughout areas adjacent to the reservoirs, but not below Hells Canyon Dam. They were most abundant in upland and riparian communities bordering Brownlee Reservoir. California quail comprise almost all of Idaho’s quail harvest. However, specific California quail population data for Hells Canyon are not currently available (Hemker 1994).

Availability of suitable winter cover, described as dense shrub vegetation, has been identified as limiting California quail distribution in Idaho. It is believed that snow conditions can reduce winter food availability, thus long-term trends in population abundance are a function of poor winter habitat quality. Further, many other factors are considered to affect habitat condition, including farming practices, livestock grazing, fires, and urban development (Smith 1990). Game managers generally consider that California quail in Idaho and Oregon are dependent on dense shrubs for roosting, escape cover, and winter cover. Therefore, riparian habitats are critical for viable California quail populations. Because of this dependence, the IDFG has adopted preservation and enhancement of riparian habitats as their primary management direction for quail species (Smith 1990).

Ring-necked Pheasant

Ring-necked pheasant populations were established in Idaho through introductions during the late 1800s and early 1900s. Populations increased relatively rapidly and all suitable habitats are believed to be occupied at various levels. Populations peaked in the 1950s and 1960s. Declines began in the early 1970s and gradually continued through the 1980s. Even with declines, pheasants are the most popular upland game bird in Idaho (Smith 1990).

Pheasants are closely associated with agriculture, with populations generally largest in areas with irrigated croplands. Riparian and wetland habitats near cultivated areas are critical to pheasant survival in Idaho, especially as winter cover. Lack of winter food and cover are important factors limiting pheasant populations in Idaho. Suitable nesting cover can also be limiting in certain areas. Changes in agricultural practices have been implicated in pheasant declines. Intensive farming has resulted in removal of non-crop cover (e.g., fencerows, ditch banks, and wetlands), increased burning, and more pesticide use. All these activities can be detrimental to pheasant populations. Urban development and sprawl is also reducing availability of suitable pheasant habitat (Smith 1990).

Pheasants are probably restricted to the southernmost portions of Hells Canyon. However, infrequent transients from adjacent agricultural areas may enter the study area. Asherin and Claar (1976) only observed pheasants along Brownlee Reservoir. Pheasants were most abundant in upland and riparian communities along upper reaches of Brownlee Reservoir. Because most habitats in Hells Canyon are probably unsuitable for pheasants, those pheasants observed were likely in close proximity to agricultural areas upriver of Brownlee Reservoir. Thus, pheasants observed near Brownlee Reservoir were probably the result of source populations occurring in these cultivated areas. Pheasant population data are not currently available for Hells Canyon (Hemker 1994).

Gray Partridge

Gray partridge were established first in Oregon and then Idaho through translocations in the early 1900s. Prior to releases, gray partridge dispersed into Idaho from Oregon and Washington. In Idaho, official releases started in 1921 and eventually resulted in establishment of this species in nearly every county (Smith 1990). Gray partridge were only locally abundant in Hells Canyon during 1974 (Asherin and Claar 1976). Although the species is generally associated with agricultural areas producing cereal grains, these birds are also found in shrub-steppe vegetation. Hence, their distribution will often coincide with chukars in the Hells Canyon area. Asherin and Claar (1976) reported the highest gray partridge numbers along Brownlee, Oxbow, and Hells Canyon Reservoirs. The medusahead (*Taenitherum caput-medusae*) and wildrye (*Elymus* spp.) annual grasslands, found extensively along upper Brownlee Reservoir, showed the highest densities of gray partridge compared to other vegetation types.

Gray partridge are seldom sought by hunters but are harvested incidentally to pursuits for other upland game species. As a result, gray partridge populations are generally believed to be harvested only lightly and could sustain higher levels of exploitation. Also, information on habitat requirements of gray partridge in Idaho is limited. This lack of information is currently inhibiting implementation of any habitat management programs specifically for this species (Smith 1990). The gray partridge population appears to be below historic levels, but overall the population is viable. No trend surveys are currently conducted for gray partridge in Hells Canyon, thus population status cannot be evaluated (Hemker 1994).

Chukar Partridge

Chukars were introduced into Nez Perce County, Idaho in 1933 and were considered to be established in all suitable habitat by 1957. Today, chukars occur in southwestern and mid-central Idaho, and eastern Oregon. The species is well adapted to annual grasslands created by wildfire and overgrazing (Smith 1990). Owing to their mobility, chukars have been observed in many varied habitat types (McKern 1976). However, optimal habitats have been described as steep, rocky canyons with exotic annual grass/forb cover and perennial springs. Wintering areas are generally at lower elevations and on south-facing slopes that are mostly snow-free. During summer and fall, distribution of chukars is highly associated with water sources (Smith 1990).

Oeklaus (1976) developed chukar-censusing techniques for Hells Canyon. However, since 1984 the IDFG has conducted helicopter surveys in late summer along a section of Brownlee Reservoir to monitor chukar population trends (Hemker 1994). Chukar populations adjacent to Brownlee Reservoir appear to experience extreme fluctuations, possibly due to severe winters and adverse weather conditions during the nesting season (IDFG 1990*a*). Asherin and Claar (1976) reported that chukars were the most widely distributed and abundant upland game species in Hells Canyon. Chukars are still probably the most common upland game bird in Hells Canyon and also the most important recreationally for hunting (Asherin and Claar 1976, USDOE 1985). However, the IDFG has identified a need for better data on the relationships between weather and trends of chukar populations so that hunting opportunities can more accurately be predicted (Smith 1990).

Forest Grouse

For management issues, the IDFG has grouped blue grouse, ruffed grouse, and spruce grouse into the single category of forest grouse. Relative abundance of these three species varies with habitats and geographic range. Generally, ruffed grouse are more abundant in the northern portions of Idaho, whereas blue grouse abundance increases to the south. Spruce grouse are widely distributed in Idaho but numbers are generally low (Smith 1990). Because forest grouse are often associated with riparian habitats, impacts to these habitats could be expected to impact grouse populations (Smith 1990).

Forest grouse provide much upland game bird hunting opportunity, with harvest exceeded by only pheasants and mourning doves. Further, it is believed that forest grouse populations are actually harvested at low rates and could sustain more exploitation. Forest grouse also have a high non-consumptive value because they are often easily approached during the breeding season and provide auditory and visual displays (Smith 1990).

Of the forest grouse possibly occurring in Hells Canyon, only the ruffed grouse was observed by Asherin and Claar (1976). In Hells Canyon, ruffed grouse were generally associated with riparian areas and moist sites throughout the year. Preferred habitats consist of a mixture of deciduous shrubs and trees and forb-producing areas (Smith 1990). Blue grouse occur throughout the forested habitats where Douglas fir is present. The species winters at high elevations in open Douglas fir stands, feeding on needles and berries. In the spring, both sexes move to lower elevations where they remain in mixed brush, shrub, and deciduous tree sites. Through the summer and fall, both blue and ruffed grouse females and broods use riparian areas and moist sites at lower elevations where they feed on forbs and insects (Smith 1990). Spruce grouse inhabit the southernmost extent of their range in Idaho and Oregon, and are sparsely distributed. The species is non-migratory and is usually associated with dense conifer stands (IDFG 1990*a*). Spruce grouse are considered sensitive in Oregon because of limited numbers and distribution potentially due to wildfire and logging (Marshall *et al.* 1996).

All three species of forest grouse are believed to occur at various densities and distributions within Hells Canyon. However, no specific information on population abundance or distribution of forest grouse is available for Hells Canyon. As a result, population status cannot be evaluated for any of these species at this time.

Sage Grouse

Sage grouse (*Centrocercus urophasianus*) historically occurred throughout sagebrush-dominated lowlands and mountain valleys in the southern portion of Idaho and the shrub-steppe-dominated areas in Oregon and Washington (Morse 1980, IDFG 1990*a*). Sage grouse occurred in areas north of the Payette River, in Adams, Washington, and Payette Counties. Large portions of this historical range have been lost to agricultural development and sagebrush eradication programs. Although sage grouse feed on forbs and insects and use a variety of habitats during summer, the species is entirely dependent on sagebrush from fall through spring.

Due to habitat alteration and population decline across their range, the status of sage grouse is currently of concern to wildlife managers. In response to declines, the western sage grouse subspecies occurring in Oregon was listed as a *candidate* for *threatened* or *endangered* listing (*C2*) in 1985 by the USFWS (Drut 1994). Because sage grouse were historically abundant in the shrub-steppe habitats of the western United States, efforts have recently been undertaken to understand causes for population declines (Willis *et al.* 1993). Populations have been documented to occur adjacent to the southern reaches of Hells Canyon in both Oregon and Idaho (Smith 1990, Willis *et al.* 1993). However, no information is currently available on sage grouse distribution or abundance specifically within Hells Canyon, with the exception of anecdotal sightings. Sage grouse populations in the BLM's Cascade Resource Area have experienced a generally steady decline, apparently due to a continual loss of habitat.

Columbian Sharp-tailed Grouse

Columbian sharp-tailed grouse were classified as a federal *C2* species (CDC 1994) by the USFWS because of distribution-wide declines. Columbian sharp-tailed grouse historically occupied much of the Pacific Northwest, including Hells Canyon and the intermountain region from central British Columbia south to California and Colorado (Marks and Marks 1987, USDI 1987). The species occupied most of the lower elevation sagebrush-grasslands in Idaho. Habitat alterations of native rangelands by livestock grazing and agriculture are thought to be the major factors in sharptail declines (Marks and Marks 1987, Smith 1990). Additionally, conversion of rangeland to cropland destroyed nesting and brood-rearing habitat, and deciduous shrubs that are crucial sources of winter food and year-round cover.

Currently, sharptails are considered to be extinct in Oregon, and in west-central Idaho are known to exist only as isolated populations (Miller and Graul 1980, Hemker 1994). East of Hells Canyon, small populations occur in Adams and Washington counties. Areas still occupied by sharptails are those with native grasses, forbs, and shrubs that have not been severely overgrazed. The remnant populations are small and scattered. The entire population is estimated at fewer than 300 birds. The largest known population in western Idaho is in the Sage Creek drainage. Small, scattered populations are also found near Council, Idaho (USDI 1987).

In the late 1980s, one population of sharptails in western Idaho was studied cooperatively by the IDFG and the BLM (Marks and Marks 1987). Trends in sharptail populations are unknown, with the exception of dancing ground counts in Washington County, Idaho. Attendance at these leks has remained relatively stable since 1988 (USDI 1987). The status of sharp-tailed grouse specifically in Hells Canyon is unknown. Like sage grouse, distributional information is restricted to anecdotal sightings.

Mountain Quail

Mountain quail are distributed from Vancouver Island, British Columbia south along the mountains of the Pacific coast to northern Baja Peninsula (AOU 1983, Spahr *et al.* 1991). Mountain quail are native to eastern Oregon and western Idaho, including Hells Canyon, although they were never recorded by Asherin and Claar (1976). Mountain quail are believed to be dependent on dense shrubby riparian vegetation for all life requisites (Smith 1990).

The status of mountain quail populations has become the focus of concern throughout the intermountain region. After 30 years of population declines in this region, the mountain quail was classified as a *species of special concern* by IDFG and as a *sensitive* species by the BLM and Regions 1 and 4 of the USFS. In 1991, the USFWS listed mountain quail as a *Category 2 (C2) candidate* species. They were listed as *C2* because detailed data on mountain quail distribution, abundance, life history, habitat use patterns, and population ecology of mountain quail is limited (Heekin and Reese 1995).

Little research has been conducted because of the bird's secretive behavior, low population densities, and use of dense vegetation in difficult terrain (Heekin and Reese 1995). However, population and distribution declines appear to be related to the overall loss of quality riparian habitats. Three factors were hypothesized to be responsible for mountain quail habitat loss:

1) loss of wintering areas because of dams and water impoundments on the Snake River,
2) increased agricultural activity along the Snake River, and
3) general deterioration of riparian areas due to grazing and fire (Smith 1990).

Specifically in Hells Canyon, however, Ormiston (1966) investigated mountain quail food habits, habitat use, and movement. More recently, Vogel (1994) assessed habitat suitability in selected tributaries of Brownlee Reservoir. Although mountain quail are now absent from this area, habitat appeared suitable for reintroduction efforts (Vogel 1994). Reese and Smasne (1996) also searched for mountain quail in areas studied by Ormiston (1966) in the HCNRA, but reported locating no quail. Although Reese and Smasne found no mountain quail, isolated populations are believed to exist elsewhere in the HCNRA (Stephens and Sturts 1991).

Merriam's Wild Turkey

Merriam's wild turkey is not native to Idaho or Oregon, but has been introduced into both states as a hunting resource. First introductions took place during the early 1960s. Introduced populations expanded rapidly during the mid- to-late 1960s (Smith 1990). Many populations apparently peaked during the mid-1970s, then stabilized at somewhat lower levels. Little is known about the habitat requirements of Merriam's turkey in Idaho, but habitat modifications have been suggested as possible contributing factors to reported declines (Edelmann *et al.* 1995).

Demand for wild turkey hunting has increased dramatically over the last three decades. This trend is projected to continue, which will place higher consumptive demands on turkey populations. Information on all aspects of Merriam's turkey demography, including reproductive capabilities, is needed to allow management of this resource at optimum productivity in response to the increasing levels of hunting (Edelmann *et al.* 1995).

Although Asherin and Claar (1976) did not observe wild turkeys in Hells Canyon in the mid-1970s, the birds are now present in isolated areas of Hells Canyon. Currently, no population data are available for Merriam's turkeys in Hells Canyon (Hemker 1994). Therefore, population status in Hells Canyon cannot be evaluated.

Mourning Dove

Because the mourning dove is migratory, it is officially managed by the USFWS under the Migratory Bird Treaty Act. Doves are adaptable to a variety of habitats. However, because they require water daily when rearing broods, riparian habitats are especially important. As a result, densities of nesting doves decrease with distance from free water. The species is the only upland game bird that nests in all of Idaho's counties (Smith 1990). Doves are generally ground-nesters in shrub-steppe vegetation, but will also use trees and shrubs in riparian habitats (Howe and Flake 1989). A single pair usually raises three broods in a nesting season in Idaho.

Breeding mourning dove populations have been monitored nationwide since 1953 using call-count surveys. Fifteen of these routes are located in Idaho. Dove populations nationwide, including populations in Idaho, are gradually declining. Habitat loss due to industrial and urban development and intensified agricultural practices are considered the main cause (Smith 1990). Asherin and Claar (1976) reported that mourning doves were present throughout Hells Canyon. The species showed little dependence on riparian areas in heavily forested sections. However, in sparsely forested or unforested areas, the species depends on riparian areas for nesting and roosting.

IDFG believes that large numbers of doves nest annually in Idaho, however, no estimates of breeding populations are available. Alteration of suitable nesting habitat may be affecting nesting and population trends downward in Idaho. Accordingly, a management strategy to encourage protection and enhancement of riparian areas, shelterbelts, hedgerows, and other preferred nesting sites has been developed (Smith 1990). Data on dove populations specifically occurring Hells Canyon are currently not available.

5.4.3.3. Waterfowl

The Snake River is centrally located in relation to waterfowl habitat areas of major concern in western North America (Bildstein *et al.* 1991). Much of the winter waterfowl habitat in eastern Oregon and Washington and western Idaho is associated with the Snake River and related impoundments. Development of impoundments along the Snake River has influenced the presence, characteristics, and habitat values of water bodies for waterfowl. Historically, strong currents in the river would have made flocking on open water a difficult strategy for avoiding hunting in the unimpounded system (Ball *et al.* 1989). However, rafting on open water is a dominant strategy today. Rivers widened and slowed by impoundment provide increased security, although waterfowl may be exposed to rough water during windy weather.

Asherin and Claar (1976) conducted waterfowl counts from the upper end of Brownlee Reservoir to the confluence of the Salmon River in January of 1974 and 1975. They reported that 29 species of waterfowl were present in Hells Canyon during at least some portion of the year. Low numbers of waterfowl were counted in both years, with a total of 1,405 and 1,429 individuals observed in 1974 and 1975, respectively (Table 5-5). The most commonly observed duck was the merganser. Nearly all mergansers counted were common mergansers (*Mergus merganser*), although a few hooded mergansers (*Lophodytes cucullatus*) were noted in Hells Canyon and Brownlee Reservoirs (Asherin and Claar 1976). The second most abundant waterfowl species was the goldeneye (Table 5-5). These were predominantly Barrow’s goldeneye (*Bucephala islandica*), but common goldeneye (*B. clangula*) was also present. Both mallards (*Anas platyrhynchos*) and Canada geese (*Branta canadensis*) were observed in relatively small numbers.

Asherin and Claar (1976) also conducted waterfowl nest surveys and brood counts in Hells Canyon during 1974 and 1975. Six species were known or suspected to nest in the area. These were Canada goose, mallard, northern pintail (*Anas acuta*), American wigeon (*Anas americana*), green-winged teal (*Anas crecca*), and common merganser.

Canada goose is the most numerous nester, with most nesting activity occurring on the islands of Brownlee Reservoir. During 1975, 191 Canada goose nests were reported for Brownlee Reservoir. Of these nests, 151 were successful and produced 741 goslings. The U. S. Department of Energy (USDOE) (1984) estimated that 200 or more pairs of Canada goose are likely to nest at Brownlee Reservoir. Only a few nests were located at Oxbow and Hells Canyon Reservoirs. Predation by coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and badger (*Taxidea taxus*) apparently account for many nest failures (Asherin and Claar 1976, USDOE 1984). Between Hells Canyon Dam and the confluence of the Snake River and Clearwater River, goose nesting activity was widely scattered and erratic from year to year (Asherin and Claar 1976).

The number of nesting pairs of Canada geese surveyed between Walter's Ferry to Farewell Bend increased from 289 in 1973 to 900 in 1981. Numbers have fluctuated between 1981 and 1990 but have remained largely stable. In 1990, 910 breeding pairs were counted along this section of the Snake River (IDFG 1990*b*). Based on data collected by Asherin and Claar (1976) at Brownlee Reservoir, the number of Canada goose nesting pairs may represent up to 20 to 25 percent of the number of known nesting pairs on the Snake River between Walter's Ferry and Farewell Bend.

The mallard was the only duck species for which nesting data were collected. Only a few mallard nests were found along Brownlee Reservoir. However, success of these nests was not determined. Mallard broods were the most numerous waterfowl broods noted after Canada goose broods throughout Hells Canyon. Common merganser broods were the only waterfowl broods observed in Hells Canyon and Oxbow Reservoirs. Between Hells Canyon Dam and the confluence of the Snake and Clearwater Rivers only common merganser broods were observed. Backwaters, eddy areas with a rocky shoreline, and interspersed sand bars are the preferred brooding habitat for the common merganser.

Little is known of staging areas for shorebirds in the interior of North America (Morrison and Meyers 1989). Shorebirds migrate through the Hells Canyon area for staging and feeding (Howe *et al.* 1989, Morrison and Meyers 1989, Taylor 1989). Small numbers of shorebirds pass through during fall migration and use the exposed mudflats along the Powder River (IPC, unpubl. data).

Colonial waterbirds occurring in Hells Canyon and vicinity include several species of gulls (*Larus spp*.), western grebe (*Aechmophorus occidentalis*), snowy egret (*Egretta thula*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodias*), and black-crowned night heron (*Nyctocorax nyctocorax*) (Asherin and Claar 1976). Small numbers of great blue herons, black-crowned night herons, and double-crested cormorants nest upstream of Brownlee Reservoir (IPC, *unpubl. data*).

5.4.3.4. Raptors

This group of species includes eagles, hawks, falcons, vultures, osprey, and owls. Raptors are a politically sensitive group of birds that receive much attention from both state and federal agencies (Olendorff *et al.* 1989). There are no raptor species endemic to shrub-steppe (Olendorff *et al.* 1989). In the Blue Mountains Province in Oregon, 17 species of diurnal raptors and 12 species of owls have been reported (Marshal 1986, Gilligan *et al.* 1994). Fourteen species of diurnal raptors nest in the Blue Mountains Region, including turkey vulture (*Cathartes aura*), osprey (*Pandion* *haliaetus*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern goshawk (*Accipiter gentilis*), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparvarius*), and prairie falcon (*Falco mexicanus*). Three nonbreeding species also present are rough-legged hawk (*Buteo lagopus*), merlin (*Falco columbarius*), and gyrfalcon (*Falco rusticolus*) (Marshall 1986). Eleven species of owls have been recorded to breed in the Blue Mountains region. They are the common barn owl (*Tyto alba*), flammulated owl (*Otus flammedus*), western screech-owl (*Otus kennicottii*), great-horned owl (*Bubo virginianus*), northern pygmy-owl (*Glaucidium gnoma*), burrowing owl (*Athene cunicularia*), barred owl (*Strix varia*), great gray owl (*Strix nebulosa*), long-eared owl (*Asia otus*), short-eared owl (*Asia flammeus*), and northern saw-whet owl (*Aegolius acadicus*) (Marshall 1986, Gilligan *et al.* 1994). The snowy owl (*Nyctea scandiaca*) is the only nonbreeding owl, and is infrequently observed (Marshall 1986, Gilligan *et al.* 1994).

Raptor nesting surveys were conducted in the Hells Canyon area in 1974 and 1975 (Asherin and Claar 1976). Eleven diurnal raptors, the peregrine falcon, northern goshawk, Cooper's hawk, sharp-shinned hawk, northern harrier, red-tailed hawk, Swainson's hawk, golden eagle, prairie falcon, American kestrel, and turkey vulture were found nesting. Four owls, the common barn owl, burrowing owl, great horned owl, and short-eared owl were also found nesting (Asherin and Claar 1976). The greatest diversity of diurnal and nocturnal raptors was recorded for Brownlee Reservoir (11 species), followed by Oxbow and Hells Canyon Reservoirs, and the river reach below Hells Canyon Dam to Johnson Bar (four species each). The American kestrel was the most numerous raptor nesting along the three Hells Canyon Project reservoirs, closely followed by the red-tailed hawk. A raptor survey was conducted in the HCNRA in 1990 (Levine and Erickson 1990). Thirty-one survey points were used to observe cliff sections to determine occupancy of nesting territories. These seven species of raptors were recorded, in order of frequency: golden eagle (27 pairs), American kestrel (10 pairs), red-tailed hawk (7 pairs), northern goshawk (3 pairs), great-horned owl (2 pairs), Cooper's hawk (1 adult), prairie falcon (1 pair), and turkey vulture (1 pair).

The number of golden eagle nesting pairs located was considered to be conservative (Levine and Erickson 1990). Isaacs and Opp (1991) reported on numbers, distribution and productivity of golden eagles in Oregon over the period 1965 through 1982. Fifteen nesting attempts were recorded for Baker and seven for Wallowa County. These numbers seem to be very low compared to the numbers of golden eagle pairs recorded along the Snake River corridor by Levine and Erickson (1990). However, Isaacs and Opp (1991) noted that their surveys were by no means exhaustive.

In the fall of 1989, a raptor migration study was conducted in the HCNRA (Hoffman and Berkelman 1989). Observations were made at three locations. Golden eagles, red-tailed hawks, American kestrels, and sharp-shinned hawks were the most frequently observed migrating species. Numbers of migrating raptors were generally low, fewer than one bird per hectare (2.5 acres), and were not concentrated in any one area by the surrounding topography (Hoffman and Berkelman 1989).

Bechard *et al.* (1986) summarized the historical and current distribution of Swainson's and ferruginous hawks in southern Idaho. Both Swainson's and ferruginous hawk nests were reported for Adams and Payette Counties.

Peregrine falcons and bald eagles historically nested along the Snake River corridor. Their historic and present status will be discussed in Section 5.4.3.10. Although bald eagles no longer nest along the Snake River in Hells Canyon, the species commonly winters at the three Hells Canyon Project reservoirs (Isaacs *et al.* 1989). Peregrine falcons were found nesting successfully in Hells Canyon during 1996 (Akenson 1996). Unsuccessful nesting attempts were made in 1994 and 1995 (IPC, *unpubl. data*). *Threatened* and *endangered* species and *species of special concern* will be discussed in Section 5.4.3.10.

5.4.3.5. Small and Medium-Sized Mammals

In the Blue Mountains Province in Oregon, 29 small mammal species, 7 medium-sized mammal species, and 13 bat species were reported (Table 5-6; Marshall 1986). Asherin and Claar (1976) censused small and medium-sized mammals in Hells Canyon. Species occurrence was documented primarily by trapping with snap-, pit-, and live traps at 41 sample sites. Indices of abundance were calculated by habitat and season. Observations of tracks, scats, and other signs were recorded to supplement trapping efforts. Ten species of small mammals were trapped. These were the vagrant shrew (*Sorex vagrans*), montane vole (*Microtus montanus*), house mouse (*Mus musculus*), Great Basin pocket mouse (*Perognathus parvus*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), Ord's kangaroo rat (*Dipodimys ordii*), golden-mantled ground squirrel (*Spermophilus lateralis*), Townsend's ground squirrel (*Spermophilus townsendii*), and northern pocket gopher (*Thomomys talpoides*). Brownlee Reservoir was most diverse with nine species, followed by Oxbow and Hells Canyon Reservoirs with five species each. Six species were recorded below Hells Canyon Dam. The Ord's kangaroo rat, golden-mantled ground squirrel, and Townsend's ground squirrel were found only at Brownlee Reservoir. Deer mice comprised the majority of small mammals caught (86 percent), followed by house mice (4 percent), and montane voles (3 percent). Other species, namely the western harvest mouse, Great Basin pocket mouse, Ord's kangaroo rat, vagrant shrew, golden mantled ground squirrel, and bushy-tailed woodrat (*Neotoma cinerea*), each comprised less than 1 percent of the total number. Species diversity was much higher in riparian areas than in upland plant communities.

As for medium-sized mammals, yellow-bellied marmots (*Marmota flaviventris*) were found along the entire river corridor. The species was nearly always found in close proximity to rocky outcroppings. Yellow-bellied marmots were abundant along Oxbow and Hells Canyon Reservoirs and other places rock rip-rap was present along roads. Porcupines (*Erethizon dorsatum*) also were noted in Hells Canyon, but in low numbers. Mountain cottontail (*Sylvilagus nuttallii*) was abundant throughout the shrub-steppe and riparian plant communities found in Hells Canyon. Pygmy rabbits (*Brachylagus idahoensis*) were not noted, although the species was suspected to occur in the shrub-steppe at the upper end of Brownlee Reservoir. Likewise, black-tailed jackrabbits (*Lepus californicus*) could be expected in the general area, but were not observed.

Asherin and Claar (1976) collected bats in Hells Canyon by shooting, mist-netting, and diurnal roost searches. Seven species of bats were collected. These were, ranked in frequency of collection, the big brown bat (*Eptesicus fuscus*) (30 percent), yuma myotis (*Myotis yumanensis*) (27 percent), western pipistrel (*Pipistrellus hesperus*) (18 percent), little brown myotis (*Myotis licifugus*) (13 percent), small-footed myotis (*Myotis leibii*) (7 percent), silver-haired bat (*Lasionycteris noctivagans*) (4 percent), and pallid bat (*Antrozous pallidus*) (1 percent). In general, bats are not dependent on riparian vegetation, as most species roost in caves. However, most bat species feed over water, deriving food from insects produced in riparian communities. The number of bat species that occur in the Snake River corridor is open to question. Based on the number of species that occur in the Blue Mountains Province, additional species can be expected. Larrison and Johnson (1981) report ten likely and two possible species for this part of Idaho, while Groves and Marks (1985) listed thirteen species. Larrison (1967) reported 12 species for extreme southeast Washington, northeast Oregon, and western Idaho bordering the Snake River.

5.4.3.6. Furbearers and Mammalian Carnivores

Mammalian carnivores (Order Carnivora) comprise important components of the biological diversity in most terrestrial ecosystems. This is because species within this diverse group [including specialists such as the river otter (*Lutra canadensis*) and generalists like the coyote (*Canis latrans*)] are capable of occupying almost every habitat in North America (Spowart and Samson 1986). The variety of ways in which carnivores can affect the dynamics of wildlife communities is another characteristic of this group's diverse functioning in ecosystem processes. For example, high trophic-level predators such as mountain lions (*Felis concolor*) and wolves (*Canis lupus*) are potentially capable of strongly influencing community dynamics through limiting prey populations (Dixon 1982, Miller 1982, Paradiso and Nowak 1982). Other carnivores that have diets more accurately described as omnivorous (e.g., striped skunk (*Mephitis mephitis*)), are less likely to drastically affect their environment (Godin 1982). Despite specific functions and their capacity for affecting community processes, carnivores hold ecological value as both individual species and as a taxonomic group by contributing to the overall biological diversity of ecosystems (Risser 1995, Walker 1995).

In addition to biological and ecological value, carnivores also have anthropomorphic value both aesthetically and economically. Historically, carnivores were seen mostly as threats to humans and livestock to be systematically eliminated. However, the legal and public perceptions of carnivores have changed dramatically in the last 50 years in response to changing human values (ODFW 1993*a*, 1993*b*). Current views of predators range from that of livestock threat to trapping/hunting resource to symbol of America's diminishing wildlands. Also, recreation associated with hunting and viewing (especially the large predators such as black bears (*Ursus americanus*) and mountain lions) affect how people perceive and value carnivores. In addition to being important economic resources, predators are valued aesthetically, since many people simply find satisfaction in the knowledge that these species are important parts of the native fauna functioning in biological systems. This results in the belief that carnivores/furbearers should be protected because they are an integral part of the natural environment (Harris 1991; Beecham and Zager 1992; ODFW 1993*a*, 1993*b*).

Fifteen species of the Order Carnivora are believed to occur in the Hells Canyon area (Larrison 1967, Chapman and Feldhamer 1982). Additionally, lynx (*Felis lynx*) and wolverine (*Gulo gulo*) have been reported in the Wallowa Mountains to the east (USDA 1992, 1993, 1994). The kit fox (*Vulpes macrotis*) may also be an extremely rare transient in the southernmost portions of Hells Canyon (Larrison 1967, Samuel and Nelson 1982). Historically, wolf (*Canis lupus*) and grizzly bear (*Ursus arctos*) occupied the area, but are currently considered to be extinct in Hells Canyon (Craighead and Mitchell 1982, Paradiso and Nowak 1982). Other furbearers of the Order Rodentia that are often considered with this group are beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), and nutria (*Myocastor coypus*).

Species of this group are often legally classified in groups other than taxonomically. In Idaho, marten (*Martes americana*), fisher (*Martes pennanti*), mink (*Mustela vison*), river otter, beaver, muskrat, bobcat (*Felis rufus*), lynx, red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and badger (*Taxidea taxus*) are considered furbearing animals. However, there is no harvest season for fisher or otter. Western spotted skunk (*Spilogale gracilis*), striped skunk, long-tailed weasel (*Mustela frenata*), short-tailed weasel (*Mustela erminea*), and coyote are classified as predatory wildlife. The wolverine and kit fox are protected nongame species and may not be harvested. Grizzly bear and wolf are currently classified as *threatened* and *endangered* (CDC 1994). In both Idaho and Oregon, black bears and mountain lions are classified as big game animals (Harris 1991; Beecham and Zager 1992; ODFW 1993*a*, 1993*b*).

Asherin and Claar (1976) surveyed Hells Canyon for both aquatic and terrestrial furbearers in 1974 and 1975. Aquatic furbearers were identified by shoreline searches for tracks, scat, trails, lodges or dens, other signs, or trapping. Occurrence of terrestrial furbearers was documented by direct observation of animals, their signs, or both; and scent station sampling. Asherin and Claar (1976) observed four species of aquatic furbearers, namely beaver, river otter, mink, and muskrat. These four species occurred in all three Hells Canyon reservoirs. Only the river otter was recorded in the free-flowing reach below Hells Canyon Dam. Five species of terrestrial furbearers were reported for the three Hells Canyon reservoirs. These were coyote, red fox, striped skunk, raccoon, and badger. In the free-flowing reach below Hells Canyon Dam, bobcat, coyote, striped skunk, raccoon, and long-tailed weasel were observed.

Beaver, muskrat, mink, and river otter are generally associated with the aquatic and riparian areas along the Snake River, tributaries, and wetlands (Wolfe and Mortan 1975; Wolfe *et al.* 1976, 1977). The coyote is the most widespread medium-sized carnivore in Hells Canyon and occupies a broad ecological niche (Cahalane *et al.* 1979, MacCracken and Hansen 1987). This species can be expected wherever suitable denning sites and an adequate prey base are available. Badgers are found in desert habitats where soils are suitable for digging. They prey extensively on fossorial rodents (Messick and Hornocker 1981). Bobcats inhabit rimrock areas along river canyons and are generally nocturnal. River canyons and reservoirs provide habitat for raccoon, long-tailed weasel, and striped skunk, which are most active at night.

Currently, the only monitoring of carnivores and furbearers in Hells Canyon is through harvest. This includes big game harvest of black bears and lions, and trapping of furbearers. The harvest of all black bears, mountain lions, bobcats, and lynx is recorded in a mandatory check and report (IDFG 1994, IDFG 1995, ODFW 1995). In Idaho, trappers are also required to maintain records and file a report of species harvested each year (IDFG 1994). Although legal harvest is monitored relatively closely, this information is not always reflective of true population parameters or dynamics (Harris 1991, Beecham and Zager 1992). Therefore, directly surveying populations in conjunction with harvest data would provide better population information about these species. Population and behavioral characteristics (e.g., low densities, non-random distributions, large home ranges, and high mobility), however, often create problems for sampling and monitoring. As a result, no single or best technique has been developed for surveying all carnivore populations (Spowart and Samson 1986).

5.4.3.7.
Big Game Species

Big game species are relatively diverse in Hells Canyon, with nine species occurring within the canyon for at least part of the year or as transients (Asherin and Claar 1976). The most common and widely distributed is mule deer (*Odocoileus hemionus*) (McKern 1976). However, Rocky Mountain elk (*Cervus elaphus*) is probably the most important big game species economically and recreationally for hunting (Connelly and Brown 1990). Other important big game species are white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americana*), mountain lion (*Felis concolor*), Rocky Mountain bighorn sheep (*Ovis canadensis*), and mountain goat (*Oreamnos americanus*). Occasionally, pronghorn antelope (*Antilocapra americana*) and Shiras moose (*Alces alces shirasi*) may also enter portions of Hells Canyon

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Currently, hunting seasons in Hells Canyon (Idaho, Oregon, or both) for mule and white-tailed deer, Rocky Mountain elk, black bears, and mountain lions occur as either general seasons and/or controlled hunts. Bighorn sheep and mountain goats, which are generally restricted to small areas in the unimpounded river reach, occur at low population levels (USDE 1985). Hunts for these two species are therefore entirely controlled and limited (Hanna 1990, Hayden 1990, ODFW 1992*a*).

Mule Deer

Prior to settlement of Idaho and Oregon by people of European ancestry, mule deer were probably not very abundant because habitat conditions were less suitable for browsing ungulates. However, in the late 1800s and early 1900s, habitat conditions were altered by livestock grazing and fire suppression. Ranges formerly dominated by perennial grass communities were converted to shrub communities that were more conducive to the diet of mule deer. Changes in range conditions coupled with reductions in livestock grazing, increased predator control, and regulated hunting are believed to have contributed to the large population increases observed in Idaho and Oregon during the 1950s and 1960s. After these large population increases, habitat conditions again changed due to depletion of winter ranges by the deer themselves. Range depletion and harsh winter weather then caused drastic population declines during the 1970s. Currently, most populations have recovered but will probably never reach the record levels previously observed (ODFW 1990, Scott 1991).

Winter range has long been recognized as a very important component of the annual habitat requirements of mule deer. Nevertheless, availability of forage alone does not describe the suitability of winter habitat. Structural features such as thermal cover, aspect, and elevation are also crucial components of winter habitat. Probably the most serious threat to winter habitat is its loss through human development. Conserving mule deer winter range is a substantial challenge facing state game agencies (ODFW 1990, Scott 1991).

Aside from habitat considerations, the major task of game managers is balancing deer harvest (which contributed $23 million and $50 million dollars to Idaho's and Oregon's economies, respectively, in 1988) with deer population productivity. The most difficult problem is a lack of reliable and complete information. The aerial survey techniques that are employed to gather mule deer population parameters, such as size, density, buck:doe ratios, and doe:fawn ratios, generally are biased. Developing methods to assess the extent of these biases and correct them are priorities for game managers (ODFW 1990, Scott 1991).

In Hells Canyon, a variety of habitats are suitable for mule deer. These include the canyons and uplands bordering the Snake River. Productivity in the area is moderate to high (Kuck 1994). The largest concentrations of mule deer generally occur during winter along Brownlee and Oxbow Reservoirs. Periodically, heavy snow accumulation and long periods of cold weather cause winter deer mortality. For example, severe conditions during the winters of 1983/1984 and 1984/1985 killed almost all the fawns and 50 percent or more of the adult deer in some areas in northeastern Oregon (ODFW 1990) and western Idaho (IDFG 1990*c*). Populations now appear to be recovering from these declines.

Rocky Mountain Elk

Near the beginning of the 1900s, elk were among the most widely distributed and abundant large mammals in western North America. However, by the end of the century, elk populations were at very low levels due to unregulated harvest and habitat destruction. Currently, elk populations have recovered and are generally increasing across their distributions because of regulated harvest and habitat alterations that favor elk production. Increased populations have contributed to elk becoming a premier big game species in the western United States economically and recreationally. Elk hunting activities have provided $30 million and $40 million annually to Idaho's and Oregon's economies, respectively, and 704,500 and 660,000 hunter days (Unsworth 1991, ODFW 1992*b*).

Elk management entails the two broad categories of habitat management and population management. Hunting affects management strategies in each category, with its strong impacts on population parameters often being mitigated through security cover. Security cover is an essential component of elk habitat; its absence leads to overharvest and/or elk abandonment of areas with high human access. The critical nature of security cover to elk population status and overall habitat use has caused state game agencies to prioritize the need to understand relationships between characteristics of security cover and elk mortality (Unsworth 1991, ODFW 1992*b*, Edwards 1994).

In Hells Canyon, elk habitat varies in quality, therefore, population sizes vary across the area. The northern portions of Hells Canyon are generally considered productive elk habitat and numbers have been increasing. To the south, habitat is more patchy and regarded as lower quality for elk, although numbers have been increasing (Kuck 1995). Also, elk have expanded their range into habitat formerly occupied only by mule deer (USDI 1986). Hells Canyon provides critical wintering areas for elk, with the largest concentration generally occurring along the Snake River between Weiser and Hells Canyon Dam. These areas can have high use during severe winter weather conditions and are considered crucial elk winter range (USDI 1987).

White-Tailed Deer

Historically, white-tailed deer were more widely distributed in the western United States with populations occurring in many of the major river corridors of southern Idaho. Land use changes and overhunting in the early 1900s probably contributed to the loss of white-tailed deer in these riparian habitats. Although eliminated from these areas, white-tailed deer populations increased dramatically from the low population levels of the early 1900s to peak levels in the early 1950s. Populations have since declined but remain large, making white-tailed deer the most abundant big game species in northern Idaho. Consequently, they are also one of the most important game species, contributing over $7.7 million dollars to the Idaho economy in 1989 (Rybarczyk 1991).

Winter weather and habitat conditions have been identified as an important limiting factor for white-tailed deer in Idaho. However, in areas with lower elevation brushfields available, populations will frequently move to these areas during severe winter conditions. Consequently, in the presence of the increased human development, these areas have been identified as critical habitat in need of conservation as winter white-tailed deer habitat (Rybarczyk 1991).

Although most abundant in northern Idaho, white-tailed deer apparently occur as isolated populations in Hells Canyon. Asherin and Claar (1976) observed scattered groups of whitetails north of Granite Creek to Pittsburgh landing. These whitetail observations were closely associated with forested and riparian habitats in Hells Canyon. Although population survey data are not specifically available, white-tailed deer appear to be moderately abundant in northern portions of Hells Canyon (USDE 1985, Rybarczyk 1991). It is generally believed that whitetail numbers and distribution are increasing southward in Hells Canyon. However, status cannot be accurately evaluated until reliable measures are developed to monitor populations.

Black Bear

As with most large predators occurring in the western United States, the general public attitude towards black bears has changed drastically in the last 20 years. Once black bears were thought of as threats to livestock and agricultural and nuisances to be hunted for bounty. This attitude is now less evident, and the black bear is now classified as a big game species with strictly regulated harvest. In addition to its value as an important big game resource, black bears are also valued aesthetically, since many people find satisfaction in the knowledge that black bears are still an important part of the native fauna and are functioning in biological systems (ODFW 1993*a*).

The distribution of black bears in the northwestern United States corresponds closely to the distribution of coniferous forests. These forests generally occur as mosaics of various habitats that are important for meeting the forage and security requirements of bear populations. Areas of low-canopy cover are important for forb and shrub production, whereas dense areas are important for hiding and escape cover (Beecham and Zager 1992, ODFW 1993*a*).

Black bear populations are difficult to estimate, but they usually occur at relatively low densities with 1.5 to 2.0 bears per square mile in optimal habitats. Low densities are attributed to social mechanisms as well as a low reproductive rate. Despite the generally low densities of black bears, it has gained significantly in popularity as a game animal in the last 15 to 20 years. In Idaho, it is ranked third in importance as a game species behind deer and elk, and contributed over $2.5 million dollars to Idaho's economy in 1982 (Beecham and Zager 1992).

Because of the black bear's low densities (although reported as relatively high in the Hells Canyon area) and secretive nature, gaining the information necessary to effectively manage harvest is very difficult. Accordingly, the IDFG and ODFW have made developing techniques for gaining the information and data necessary to manage black bear harvest a priority. These priorities include investigating relationships between hunting techniques and vulnerability, and validating the assumption that source populations can produce harvestable surpluses. Also, developing an efficient and reliable technique to estimate population size and monitor trends is essential (Beecham and Zager 1992, ODFW 1993*a*).

Black bear thrive in the forested regions of Oregon and Idaho and still occupy much of their original range (ODFW 1987*a*). Population densities of black bear are considered high in northeastern Oregon and west-central Idaho. Black bear habitat between eastern Oregon and west-central Idaho, especially in Hells Canyon, is generally comparable. Therefore, similar densities of black bears can be expected in both the Idaho and Oregon sides of Hells Canyon. However, population survey data are not available (Beecham 1994). Harvest rates have remained stable on the Idaho side, which may suggest that black bear populations are stable (Beecham 1994).

Mountain Lion

The public and legal perception of mountain lions has changed drastically since people of European ancestry began populating western North America. Initially, mountain lions, as well as most other predators, were seen as a threat to livestock and the livestock industry that dominated much of the west for the last 150 years. As a result, attempts were undertaken to systematically eliminate mountain lions through paid bounty programs. In Idaho and Oregon, it was not until the late 1960s and early 1970s that mountain lions were reclassified as a big game species. This legislation was prompted by game managers who observed an increased popularity of lion hunting for sport, and recognition by legislators of this species' value as a resource providing benefits to the public and economy. This reclassification has allowed game agencies to manage mountain lions as a consumptive as well as non-consumptive resource to be conserved (Harris 1991, ODFW 1993*a*).

The protection mountain lions receive as a game species has allowed many of the populations that had previously suffered from unregulated harvest to recover during the last two decades. Although the mountain lion is now a protected species and populations are generally at viable levels, it is still a focal point for much public and political debate. Since the time that lions were viewed only as threats to livestock, public perceptions about this species have diversified to the point that it is difficult for game managers to adequately address views and concerns of all user groups. Examples of the current and diverse views about mountain lions range from that of livestock threat to hunting resource to symbol of America's diminishing wildlands. Examples of public concerns include:

1) the increased hunting demands and pressures on lion populations as the human population expands,
2) vulnerability to harvest by hunters using hounds,
3) human encroachment into mountain lion habitat, and
4) the belief that because large predators are an integral part of the natural environment they should not be hunted (Harris 1991).

To address increasing demands for hunting and the public's growing attitude that mountain lions need more protection, game managers have identified the need for more intensive management strategies that can only result from better information on lion populations. Required information includes an understanding of lion populations, responses to various levels of exploitation, and the effects of different harvest strategies on population characteristics and viability. Also, because it is currently very difficult to economically estimate lion population parameters (e.g., size, age and sex structure, mortality, and reproduction), managers also recognize that alternative methods need to be developed to gather this information (Harris 1991). Accordingly, state game agencies have prioritized the need to develop effective mountain lion management strategies, focusing on effects of harvest, as well as reliable means to gather useful population data (Harris 1991, ODFW 1993*a*).

The mountain lion was considered abundant or common throughout most of the forested parts of Oregon in the 1800s and early 1900s (ODFW 1987*b*). Probably a similar situation generally existed in Idaho and Hells Canyon. However, settlement in the late 1800s brought large numbers of livestock to the West, occupying range formerly inhabited by wild ungulates. As a result, mountain lions were perceived as significant threats to livestock and human interests, and were systematically destroyed (Harris 1991). Mountain lion numbers declined through this period until the species received legal protection as game animal. Mountain lion distribution and populations, as measured by harvest data, increased in response to increasing deer and elk populations and legal protection. Northeastern Oregon is believed to have the highest populations for that state (ODFW 1987*b*). Population numbers and status are not available for Idaho (Harris 1991). Mountain lion harvest data, in combination with other population parameters, may provide some indication for long-term population trends. As a result, mountain lion populations are currently considered to be increasing in Hells Canyon (Harris 1991).

Rocky Mountain Bighorn Sheep

According to historical reports, bighorn sheep were one of the most abundant large mammals in Idaho, occupying most of the large river drainages, including the Snake River and Hells Canyon. However, between 1880 and 1930, bighorn populations decreased dramatically, and some in Idaho completely disappeared. By the mid-1940s, bighorn sheep were extinct in Oregon. Contributing factors for these declines included unregulated hunting, competition with livestock, and introduced diseases associated with domestic sheep. Due to management efforts (e.g., translocation, habitat management, and livestock management), some bighorn populations in Idaho are currently recovering and isolated populations have been reestablished in Oregon. However, much suitable habitat is still devoid of bighorns (Hanna 1990, ODFW 1992*a*).

Game agencies have identified a large public interest in increasing bighorn populations for hunting and even more importantly for recreational viewing. It was estimated that bighorns could produce over $100 million dollars from non-consumptive uses alone (Hanna 1990). Game managers have also learned that the potential for increasing the distribution of bighorns through translocation is greater than for any other big game species in Idaho and Oregon. As a result, game managers from Idaho and Oregon have set goals to increase current bighorn populations and establish new ones, with an ultimate goal to stock all available and suitable habitat with viable populations. To accomplish this, specific management and information needs have been identified. These needs include:

1) conservation of bighorn habitat slated for human development,
2) reduction of bighorn/livestock interactions to minimize disease transmission (a specific concern in Hells Canyon),
3) cooperation among Idaho, Oregon, and Washington to maintain the integrity of the Rocky Mountain bighorn subspecies in subsequent translocation efforts, and
4) identification of potential release sites for future translocations (Hanna 1990, ODFW 1992*a*).

Mountain Goat

Mountain goats have adapted strategies to persist in the relatively harsh, unproductive habitats they occupy. One such strategy focuses on diverting energy resources more towards survival than to reproduction. Thus, the reproductive potential for mountain goat populations is relatively low compared to other North American ungulates. This results in slow population responses to increases in mortality such as that caused by hunting (Hayden 1990). Therefore, mountain goat harvests are generally designed to be very conservative.

The lack of quality winter forage has often been hypothesized as the primary source of mountain goat mortality. However, it has also been suggested that goats rely on conserving energy expenditures as opposed to maximizing forage intake while on winter ranges. Regardless, it is important to minimize disturbance of mountain goats on winter ranges. It is interesting to note that accidents, such as falling from cliffs and snowslides, are also an important source of mountain goat mortality (Hayden 1990).

Supporting claims that energy conservation is an important winter survival strategy, research has indicated that physical, rather than vegetative, characteristics best describe winter goat habitat. Consequently, strategies for providing winter habitat include protecting inaccessible areas with cliffs and alpine ridges. Vegetative manipulation is believed to be of little importance for managing mountain goat habitat. However, relationships between habitat management and responses by goat populations are actually poorly understood (Hayden 1990).

Because of poor understanding about factors affecting population density and strategies for winter survival, the IDFG has identified these as research priorities. Because population data is essential for managing mountain goat populations with respect to hunting and translocation efforts, the IDFG also recognizes the need to develop survey methods that provide accurate population estimates (Hayden 1990).

Mountain goats are native to Hells Canyon in Idaho (Rideout 1978). However, their historic status across the Snake River in Oregon is not clear (Bailey 1936). Historically, they occupied the Seven Devils Mountains on the Idaho side, but were apparently absent from this area by 1936 (Bailey 1936). They were restored to the Seven Devils with reintroductions in 1962 and 1964 (Oldenburg 1994). According to recent surveys, this population appears to be increasing and attempts have been made to use it as a source for translocations into other areas (Hayden 1990, Oldenburg 1994). This population’s movements appear to be confined mostly to the Seven Devils area. However, mountain goats have been observed near the Snake River and Hells Canyon Reservoir during winter and spring. No mountain goats are currently known to occupy the Oregon side of Hells Canyon.

Pronghorn Antelope

In Idaho and Oregon, pronghorn antelope occur in two major physiographic areas, broad mountain valleys and lowlands dominated by sagebrush communities. In Idaho, these habitats occur in the southern, southwestern, west-central, and central portions of the state.

In Oregon, similar habitats supporting pronghorns occur in the central, southcentral, southeastern, and eastern portions of the state. Pronghorns feed primarily on native shrubs and forbs when available and are dependent on sagebrush for year-round food and cover. Density and productivity of pronghorn antelope herds vary considerably in Idaho. In general, both parameters increase as precipitation increases. Most herds in Idaho have densities that vary from low to moderate. Low annual precipitation, poor range conditions, and private landholdings are some factors depressing both density and productivity of herds. In some areas, however, pronghorn herds have increased and reached optimum levels for their habitats.

Pronghorn occur only in the most southern portions of the Hells Canyon area. The population in the BLM Cascade Resource Area is predicted to increase over the next 20 years. Currently, however, this population is probably relatively small (USDI 1987). In the Baker and northern Malheur Resource Areas, pronghorn antelope also occur occasionally. An increase of pronghorn antelope numbers is also expected in these resource areas (USDI 1986). Most pronghorn habitat in and adjacent to Hells Canyon is fair to marginal, because of overutilization by livestock and wildfires (USDI 1986, USDI 1987).

5.4.3.8.
Amphibians and Reptiles

The distribution and status of amphibians and reptiles in Hells Canyon are poorly documented (Marshall 1986, Groves and Peterson 1992). Nussbaum *et al.* (1983) provided the best summary of information on the distribution of Idaho’s herptiles. On the Oregon side of Hells Canyon, seven amphibian, four lizard, and five snake species were reported (Marshall 1986). On the Idaho side, ten amphibian, six lizard, and six snake species have been recorded (Table 5-7). If these counts are combined, ten amphibian, six lizard, and six snake species potentially occur in Hells Canyon. In addition, one amphibian, one lizard, and six snake species may occur, but have not been observed to date (Table 5-7).

Population density estimates are not available for most species, except in general terms (Table 5-7). The long-toed salamander (*Ambystoma macrodactylum*), western toad (*Bufo boreas*), and Pacific tree frog (*Hyla regilla*) were considered to be widespread, while the Great Basin spadefoot (*Scaphiopus intermontanus*), Woodhouse's toad (*Bufo wooodhousei*), bullfrog (*Rana catesbeiana*), and tailed frog (*Ascaphus truei*) appeared to have discontinuous or local populations. The highest species diversity of amphibians was found in Brownlee Reservoir, with a gradual decrease in diversity downriver. All lizard species appear to have discontinuous or local populations with the exception of the western skink (*Eumeces skiltonianus*), which appears to be widespread (Table 5-7). Again, the highest species diversity was found in the upper parts of Brownlee Reservoir with a sharp decrease to the mountainous downstream reaches of Hells Canyon (Asherin and Claar 1976).

Three snake species appear to be widespread, namely racer (*Coluber constrictor*), gopher snake (*Pituophis melanoleucus*), and western rattlesnake (*Crotalus viridus*) (IPC, unpubl. data). The rubber boa (*Charina bottae*), western terrestrial garter snake (*Thamnophis elegans*) and common garter snake (*Thamnophis sirtalis*) appeared to have discontinuous distributions. The night snake (*Hypsiglena torquata*) was found only once, but may be distributed more widely than is currently known. This species is nocturnal and is difficult to survey. That may also be the reason that the western ground snake (*Sonora semiannulata*), ringneck snake (*Diadophis punctatus*), and longnose snake (*Rhinocheilus lecontii*) were not encountered in surveys by Asherin and Claar (1976). These three species either burrow in the soil or are active at night and difficult to survey. Western ground snakes are likely to be fairly common in the area (IPC, unpubl. data).

5.4.3.9. Insects and Related Arthropods

Insects and related arthropods are widely distributed in the sagebrush steppe community type. Their role in the food chain is that of vegetation consumer, becoming so abundant at times that they can completely defoliate shrubs, as does the sagebrush moth (*Aroga websteri*) and the migratory grasshopper (*Melanoplus sanguinipes*). The following description of insect and arthropod ecology is based on research conducted at the Arid Lands Ecological Reserve, located on the Hanford Site in southcentral Washington (Rogers *et al.* 1988). The great number of species of insects and related arthropods at the Idaho National Engineering Laboratory are probably representative of Hells Canyon upland areas (Stafford *et al.* 1986).

Insect-arthropod populations are considered to play important roles in invertebrate and plant community dynamics. Herbivores and omnivores dominate this invertebrate community. During population eruptions, large insect numbers can consume huge quantities of plant materials. Their foraging activities accelerate breakdown of dead plant materials, releasing essential nutrients for plant growth. They are also important food sources for birds (particularly the horned lark, western meadowlark, and sage sparrow), which all feed insects to their young.

Coleoptera, Diptera, Lepidoptera, Hymenoptera, and Araneida comprise 90 percent of the insect-arthropod biomass. Insect-arthropod biomass peaks at the Arid Lands Ecological Reserve in June. Sagebrush steppe communities have been modified by human activities to a greater or lesser extent over the past 150 years. Population fluctuations of insect-arthropod communities may respond to some externally imposed human disturbance regime, but such relationships are currently unclear (West 1983).

Interactions among insect populations, vegetation, and human disturbances are complex and outside the scope of this document. Invertebrate federal *candidate* species and state *species of special concern* are discussed in section 5.4.3.10.

5.4.3.10.
Threatened and Endangered Species and Sensitive Species

Federal *endangered*, *threatened* or *candidate* species, as well as state *sensitive* species that occur, or may occur, in Hells Canyon and vicinity, are listed in Table 5-8. Under the Endangered Species Act, an *endangered* species is one in danger of extinction throughout all, or a significant portion, of its range. A *threatened* species is one likely to become *endangered* within the foreseeable future throughout all or a significant portion of its range. Species designated as *threatened* and *endangered*, or *candidate* species for *threatened* or *endangered* are managed by the USFWS (CDC 1994, ONHP 1995).

Definitions of *sensitive* species vary among resource agencies. ODFW defines *sensitive* species as those constituting naturally-reproducing native animals which are likely to become *threatened* or *endangered* throughout all or a significant portion of their range in Oregon (Marshall *et al.* 1996). *Sensitive* species are broken into four categories (Marshall *et al.* 1996). *Critical* species are those for which listing as *threatened* or *endangered* is pending, or those for which listing as *threatened* or *endangered* may be appropriate if immediate conservation actions are not taken. *Vulnerable* species are those for which listing as *threatened* or *endangered* is not believed to be imminent and can be avoided through continued and expanded use of adequate protective measures and monitoring. *Peripheral* species are those whose Oregon populations are on the edge of their range. Included are those species which had low population numbers historically in Oregon because of naturally limiting factors. Also considered *critical* are some *peripheral* species which are at risk throughout their range, and some disjunct populations. Species have an undetermined status when their status is unclear (ONHP 1995).

The IDFG uses similar terminology for Idaho *species of special concern* (CDC 1994). *Sensitive* species are defined as native species which are either low in numbers, limited in distribution, or have suffered significant habitat losses. Three categories of species are identified. *Priority* species meet one or more of the criteria set forth under Endangered Species Act, and the state presently contains, or formerly constituted, a significant portion of the species range. *Peripheral* species are those which meet one or more of the criteria above, but whose populations in Idaho are on the edge of their breeding range. Finally, *undetermined* status species are those that may be rare in the state, but for which there is little information on their population status, distribution, and/or habitat requirements. The IDFG defines a *threatened* species as one which is likely to be classified *endangered* in the foreseeable future throughout all or a significant portion of its Idaho range. *Endangered* species are any species in danger of extinction throughout all or a significant portion of its Idaho range.

In addition, the BLM and USFS have definitions for *sensitive* species occurring or potentially occurring on federal lands under their respective jurisdictions. (CDC 1994, ONHP 1995). The BLM considers those species *sensitive* that are:

1) under status review by the USFWS,
2) typified by numbers that are declining so rapidly that federal listing may become necessary,
3) typically small and widely dispersed, and
4) inhabiting ecological refuges or other specialized or unique habitats.

The USFS considers those species for which population viability is questionable to be *sensitive*. Questions of viability can be evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Threatened and Endangered Species

The peregrine falcon and bald eagle are the only federally designated *threatened* species known to occur in Hells Canyon. The wolf (*Canis lupus*), listed as *endangered*, may occur as a transient. Peregrine falcons were historically known to nest at two locations along the Snake River in Hells Canyon (Bechard *et al.* 1987). One historical site was in Oregon near Hells Canyon Dam. The other site was near the confluence of the Grand Ronde and Snake Rivers. At least until 1967, peregrines at this second site produced wild young. Peregrines were reintroduced at this site in 1987 (Bechard *et al.* 1987). Since 1987, the Wallowa-Whitman National Forest has cooperated with the ODFW and the Peregrine Fund in annually releasing peregrines at P.O. Saddle in Hells Canyon. In 1990, peregrine falcons were also released from High Dive, located in the Payette National Forest, 8 miles east of Hells Canyon (Levine and Erickson 1990). In 1990, a peregrine survey of the HCNRA was conducted, but peregrines were not observed (Levine and Erickson 1990). Peregrine falcons occupied a nesting territory above Hells Canyon Dam in 1995 and 1996 (IPC, unpubl data). In 1996, a successful nesting attempt was reported below Hells Canyon Dam (Akenson 1996).

Historic and present distribution of the bald eagle are essentially the same. However, numbers of eagles in the continental United States have decreased dramatically in the last 200 years. In response to this decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous states and *threatened* in the remaining states, including Oregon. Bald eagles historically nested along the Snake River in Hells Canyon. One pair reportedly nested at the mouth of Two Creeks in the early 1900s (Taylor 1989). At least five other historic nest sites have been reported (Isaacs *et al.* 1989). Currently, seven existing and suspected bald eagle nest sites occur in the vicinity of Hells Canyon (Isaacs *et al.* 1989). Existing nests occur at Unity Reservoir, Phillips Reservoir, and Wallowa Lake. Nests suspected to be built by bald eagles were reported at the Grande Ronde, Wallowa, and Lostine Rivers, and at Eagle Island Creek. The Unity Reservoir bald eagle pair has produced young for several years prior to 1989 (Isaacs *et al.* 1989).

Substantial numbers of bald eagles winter in Wallowa, Union, and Baker Counties. As a result, midwinter bald eagle counts in Hells Canyon, which were organized by the USFWS, began in 1979. Numbers of wintering bald eagles along the Snake River Canyon doubled over the period 1988 to1992 (□ = 59.2 bald eagles) compared to the period 1979 to 1983 (□ = 26.2 bald eagles) (Isaacs 1992). In 1990, 53 occupied bald eagle territories were estimated to occur in Idaho, and 175 in Oregon (Bald Eagle Working Team 1990, Kjos 1992).

Concern about the potential impacts of habitat alteration and other human activities on the species, and the need to identify important winter areas, resulted in a study on wintering bald eagles in northeastern Oregon from 1988 to 1991 (Isaacs *et al.* 1989, 1990). Similar trends in numbers of wintering eagles were found in the winters of 1988/1989 and 1989/1990. Numbers increased from November through December, peaked in January and February and declined rapidly through April (Isaacs *et al.* 1990). Average weekly counts in 1989/1990 were 67 in November, 168 in December, 231 in January, 263 in February, 141 in March and 34 in April. The highest count was in the middle of February, with 282 bald eagles. Forty-nine percent of all bald eagles were observed at the Hells Canyon Project reservoirs in 1988/1989 and 56 percent in 1989/1990. Twenty-seven night roosts were located and an additional 27 were suspected. Exceptional roost counts were at two bald eagle roosts along Hells Canyon Project reservoirs: 55 eagles were recorded at Eagle Island Creek and 100 at Soda Creek.

The wolf was, in historical time, widely distributed throughout the western United States. Settlement of the west resulted in an almost systematic extermination of the wolf when livestock was introduced. In 1915, the federal government passed a law to exterminate wolves on federal lands. When government wolf control programs were terminated in the early 1960s, wolves slowly began to recover in a few remote regions of the west. The wolf was recognized as a federally listed *endangered* species in 1973. Idaho gave the species a similar classification and protection in 1977. Likewise, the wolf is listed as *endangered* by the ODFW. The current wolf distribution in Idaho includes the northern border adjacent to Canada and Montana, and the central Idaho wilderness and adjacent national forests (Spahr *et al.* 1991). A male gray wolf was killed near Huntington in 1974. That appears to be the closest sighting of a wolf to Hells Canyon reported in recent times.

Federal Candidate Species and Species of Special Concern

The USFWS is currently revising the list of taxa that are *candidate*s for listing as *endangered* or *threatened* species (Federal Register, Vol. 61(40), February 1996). Presently, the terms *species at risk* or *species of concern* are being used informally by the USFWS when referring to species formerly classified as *Category 2* species. These terms are considered “terms of art” that describe the entire realm of taxa where conservation may be of concern, but neither term has official status. Two species are listed as *candidate* species that may occur in the Hells Canyon—the Great Basin population of spotted frog (*Rana pretiosa*), and the northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) (Federal Register, Vol. 61(40), February 1996). Specific information on status and distribution is not available for most federal *candidate* species and state *sensitive* species in Hells Canyon. Data available from the literature are summarized in the following text.

Amphibians and Reptiles

Eleven species of amphibians and reptiles formerly classified as *candidate* species or state *species of special concern/sensitive* species may occur in Hells Canyon. These include one USFWS *Category One* species [i.e., the Great Basin Population-Oregon side of the Snake River of spotted frog], and three former USFWS *Category Two* species [i.e., the Main Population-Idaho side of the Snake River of spotted frogs, the tailed frog (*Ascaphus truei*), and the sagebrush lizard (*Isceloporus graciosus*)]. The following s*ensitive* species or s*pecies of special concern* may also occur: tiger salamander (*Ambystoma tigrimum*), western toad (*Bufo boreas*), leopard frog (*Rana pipiens*), Mojave black-collared lizard (*Crotaphytus bicinctores*), ringneck snake (*Diadophis punctatus*), longnose snake (*Rhinocheilus lecontei*), and ground snake (*Sonora semiannulata*). See Table 5-8 for more details.

The spotted frog ranges from extreme southeastern Alaska through western Alberta, western Montana and northwestern Wyoming to northern Utah and central Nevada, and west to the Pacific coast in Oregon and Washington. The spotted frog prefers marshy ponds and lake edges. In the southern part of its range, the spotted frog occurs primarily as isolated populations, which may occur up to an elevation of 3300 m. Populations of spotted frogs have greatly decreased from interspecific competition with northern leopard frogs and introduced bullfrogs, and loss of riparian habitat (Spahr *et al.* 1991, Marshall *et* *al.* 1996). The species formerly occurred at scattered localities throughout Oregon, but is now extirpated from western Oregon. The yellow variety still occurs at scattered locales in eastern Oregon (Marshall *et al.* 1996). The spotted frog appears secure in northeastern Oregon (Marshall 1986).

The tailed frog ranges in the Rocky Mountains from southeast British Columbia to northern Idaho, and southeast Washington to northeast Oregon. The species is found in cold fast-flowing perennial streams in forested areas. In Oregon, the species occurs on the west slopes of the Cascade Range, Coast Range and Wallowa Mountains. In Idaho, tailed frogs have been found in tributaries to the Snake River in the Hells Canyon reach (IPC, unpubl. data). The status of the species is unknown, but there is evidence of population declines and range contractions (Marshall *et al.* 1996).

In North America, the northern leopard frog ranges from northcentral Oregon to Arizona and New Mexico. The species occurs in northcentral Oregon along the Columbia River and in the Snake River drainage of northern Malheur and southern Baker counties. The species prefers marshes and meadows from which it may range into hay fields and grassy woodlands. The current status of the species in unknown in Oregon (Marshall *et al.* 1996). Likewise, little information is available on the species in Idaho or the Hells Canyon vicinity.

The western toad ranges from southeast Alaska south to northern California and western Montana. The species prefers forested and brushy areas from sea level to high mountains.

The species is widely distributed in Oregon, but absent in the valleys of the Great Basin (Marshall *et al.* 1996). The status of the species in Idaho and Oregon is unknown, but populations are declining.

The woodhouse's toad ranges from the eastern seaboard of the United States west as far as Montana, and southeast to the corner of northeastern California. The species prefers riparian habitats, sagebrush flats, and fields. Disjunct populations occur along the Snake River in Idaho and Oregon. The status of the species is unknown other than presence as isolated populations within limited areas (Marshall *et al.* 1996).

Diurnal Birds of Prey

Ferruginous hawks have historically inhabited much of western North America. The species breeds in semi-arid and grassland regions; its breeding range is the most restricted of all North American buteos. Ferruginous hawks prey on a variety of small mammals, birds, and insects. The species is reported to have declined throughout much of its range. This decline has been attributed to the conversion of grasslands for agricultural, loss of resting sites, control of natural fires, declines in prey populations, and human disturbances (Harlow and Bloom 1987, Marshall *et al.* 1996). The ferruginous hawk appears to currently be restricted to northcentral and southeastern portions of Oregon (Bechard *et al.* 1986, Harlow and Bloom 1987). In Idaho, ferruginous hawks were always limited to the southern portion of the state (Bechard *et al.* 1986). Ferruginous hawks nest in the Wallowa-Whitman National Forest, but no specific information is available (USDA 1990*a*).

The Swainson's hawk has a distribution similar to the ferruginous hawk. In the early 1900s, the species was one of the most common nesting raptor species across eastern and central portions of Oregon (Bechard *et al.* 1986). Swainson's hawks were formerly considered quite common in arid and semi-arid habitats, but have recently declined dramatically (Harlow and Bloom 1987). The population in Oregon is estimated at 400 to 800 pairs (James 1987, Harlow and Bloom 1987). Historically, Swainson's hawks were common nesters in northern Idaho counties. The population appears to have declined, but its current status is actually unknown (Bechard *et al.* 1986).

The northern goshawk is holarctic in distribution. The species occurs throughout the western United States. Northern goshawks are residents in northeastern Oregon and north and northcentral Idaho (Reynolds 1987). Preferred habitat during the breeding season is deciduous, coniferous, and mixed mature to old-growth forests (Hayward and Escano 1989). Northern goshawks nest at elevations from 580 to 1860 meters in Oregon. Nest trees are frequently the largest trees in a stand and are often adjacent to small breaks in the canopy. Densities of goshawk nests range from 11.0 pairs per 100 km^2 in Arizona to 2.4 pairs per 100 km^2 in Alaska. Densities for Hells Canyon and vicinity are not available, but are likely to fall somewhere in the middle of these ranges. Levine and Erickson (1990) recorded three occupied northern goshawk territories in a raptor survey of the Snake River corridor in the HCNRA. The northern goshawk is also an indicator species for mature and old-growth forests on the Wallowa-Whitman National Forest. In high mountain areas, some wintering individuals descend to lower elevations and can be found in more open shrubland and woodlands.

Owls

The great gray owl resides in forested areas across North America. In Idaho, resident great gray owls are found in north, north-central, and southeastern Idaho (Munts and Powers 1991). The species nests in central and northeastern Oregon, but is considered an uncommon local resident (Marshall *et al.* 1996). Quantitative data on population trends is not available (Forsman and Bull 1987).

The burrowing owl (*Athene cunicularia*) occurs throughout the western United States. The species breeds and forages in open grasslands, deserts, agricultural lands, and urban areas (Marti and Marks 1987). Burrowing owls are highly dependent upon burrowing rodents in most parts of the west for nesting. Very little population data is available for the western United States. The Idaho population appears to be stable (Marti and Marks 1987), but the status in Oregon is unclear (Marshall *et al.* 1996). Burrowing owls appear to do well in disturbed habitats and may be one of the raptors least affected by man-made environmental changes. However, large-scale conversion of sagebrush-steppe habitat creates highly unfavorable conditions for the species.

The regional status of the four small forest owls, the boreal owl, northern saw-whet owl, flammulated owl, and northern pygmy owl, is poorly known because of their small sizes, low population densities, and, with the exception of the northern pygmy owl, nocturnal habits (Reynolds *et al.* 1987). The boreal owl is circumpolar in distribution. It is found in higher-elevation coniferous forests dominated primarily by spruce (*Picea* spp.) and fir (*Abies* spp.). However, it is also found in lodgepole pine and Douglas fir habitats immediately adjacent to the spruce-fir zone. In the 48 contiguous states, it nests in the mountains of Washington, Idaho, Montana, Wyoming, and Colorado (Reynolds *et al.* 1987). In Idaho, boreal owls nest in north and northcentral parts of the state. Studies in the northern Rocky Mountains suggest that the number of breeding pairs varies widely from year to year (Reynolds *et al.* 1987). The species exists in small, isolated populations, posing threat of local extirpation. In Oregon, the species occurs as geographically isolated meta-populations because of spotty habitat (Hayward 1994). Data for North American populations are very limited and are not available for the Hells Canyon area.

The flammulated owl occurs in montane forests in western North America from Central America to British Columbia. In Idaho, flammulated owls nest in northern and west-central portions of the state. In Oregon, the species is restricted to the Cascade Mountains and the northeastern section of the state (Reynolds *et al.* 1987, Marshall *et al.* 1996). It is the only forest owl species classified as a neotropical migrant. Flammulated owl nesting habitat consists of mature to old forest stands, with open, multiple canopy layers and low tree densities (Moore and Frederick 1991). Roosting areas, however, have higher tree densities and canopy cover than nesting sites. In a study in west-central Idaho, singing male densities varied from 0.09 to 0.84 males per 40 km (25-mile) line transect (Moore and Frederick 1991). In eastern Oregon, densities of 0.72 males per 40 km (25-mile) line transect were reported (Goggans 1986). The species was once thought to be rare, but is now known to occur at least uncommonly and even commonly in prime habitat (Marshall *et al.* 1996).

The northern pygmy owl resides in woodlands and forests in foothills to high mountains from southeastern Alaska, south through British Columbia and most of the western mountains to Mexico and Guatemala. The species nests throughout Idaho, except in the deserts in the southern and southwestern portions of the state. In Oregon, the northern pygmy owl nests in the western and northeastern parts of the state (Reynolds *et al.* 1987). Little is known about population status and nesting habitat because few nests have been found. This owl is active during the day and feeds on small birds, mammals, reptiles, and insects. Nests have been found in Douglas fir, grand fir, and quaken aspen forests. Almost nothing is known of the territories and ranging behavior of this owl. Territories apparently are large, separating pairs by more than 1.6 km (1 mile) (Reynolds *et al.* 1987).

Gallinaceous Birds

The sage grouse (*Centrocercus urophasianus*), which is dependent upon sagebrush-dominated rangelands, was historically widespread in southern Idaho and southeastern Oregon. Currently, its status is of concern to wildlife managers because of general population declines across its range. In response to declines, the western sage grouse subspecies, which occurs in Oregon, was listed as a *candidate* for *threatened* or *endangered* listing (*C2*) in 1985 by the USFWS (Drut 1994). Because sage grouse were historically abundant in the shrub-steppe habitats of the western U.S., efforts have recently been undertaken to understand causes for population declines (Willis *et al.* 1993, Marshall *et al.* 1996). Declines are associated with habitat loss due to cultivation, sagebrush control, wildfire, and livestock grazing (USDI 1987, Marshall *et al.* 1996). Populations have been documented in areas adjacent to the southern reaches of Hells Canyon in both Oregon and Idaho (USDI 1987, Smith 1990, Willis *et al.* 1993). However, few formalized surveys for sage grouse have been conducted in Hells Canyon. Marshall *et al.* (1996) has stated that improved inventory procedures, lek counts, and basic inventories in summer and winter areas are needed. Thus, little information is available on the current status of sage grouse abundance and distribution within Hells Canyon.

Similarly, Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) were classified as a federal *C2* species (CDC 1994), because of distribution-wide declines. Columbian sharp-tailed grouse historically occupied much of the Pacific Northwest, including Hells Canyon (Marks and Marks 1987, USDI 1987). Currently, sharptails are considered to be extinct in Oregon, and in west-central Idaho are known to exist only as isolated populations (Miller and Graul 1980, USDI 1987, Hemker 1994). The decline of this species is associated with habitat loss due to overgrazing and conversion of rangelands to agriculture (USDI 1987, Spahr 1991). The status of sharp-tailed grouse specifically in Hells Canyon is unknown. Only one sharptail dancing ground is known to exist in Hells Canyon (USDI 1987). However, few organized surveys for sharptails have been conducted in Hells Canyon, and distributional information is restricted to anecdotal sightings.

Mountain quail are distributed from Vancouver Island, British Columbia south along the mountains of the Pacific coast to the northern Baja Peninsula (AOU 1983, Spahr *et al.*

1991). The status of mountain quail (*Oreortyx pictus*) populations have become the focus of concern throughout the intermountain region. Because of population declines in this region, the mountain quail was classified as a *species of special concern* by the IDFG and as a *sensitive* species by the BLM and Regions 1 and 4 of the USFS. In 1991, the USFWS listed mountain quail as a *Category 2 (C2) candidate* species, since detailed data on distribution, abundance, life history, habitat use patterns, and population ecology is limited. Little research has been conducted because of the bird's secretive behavior, low population densities, and use of dense vegetation in difficult terrain (Heekin and Reese 1995).

Specifically in Hells Canyon, however, Ormiston (1966) investigated mountain quail food habits, habitat use, and movement. More recently, Vogel (1994) assessed habitat suitability in selected tributaries of Brownlee Reservoir. Although mountain quail are now absent from this area, habitat appeared suitable for reintroduction efforts (Vogel 1994). Reese and Smasne (1996) also searched for mountain quail in areas studied by Ormiston (1966) in the HCNRA, but reported locating no quail. Although Reese and Smasne found no mountain quail, isolated populations are believed to exist elsewhere in the HCNRA (Stephens and Sturts 1991).

The distribution of the spruce grouse is generally congruent with that of the boreal coniferous forest. Spruce grouse in Oregon, which are categorized as a sensitive species, are mostly restricted to the Wallowa Mountains (Marshall *et al.* 1996). However, individuals in Oregon may move through Hells Canyon to link with populations in Idaho.

The species reaches the southernmost extent of its range in Idaho. Spruce grouse are sparsely distributed throughout their ranges in Idaho and Oregon. Information on population sizes is not available for either state (Hemker 1994). Spruce grouse are considered *sensitive* in Oregon because of limited numbers and distribution, possibly because of wildfire and logging (Marshall *et al.* 1996).

Waterfowl

Harlequin ducks (*Histrionicus histrionicus*) breed in western North America from western Alaska south to Vancouver Island, eastern Oregon and western Wyoming. In Idaho, they have been found along swiftly flowing mountain streams (Cassirer *et al.* 1991). Population densities on streams used by harlequin ducks averaged 0.15 pairs per km (0.6 mile) of suitable stream (Cassirer *et al.* 1991). Harlequin ducks were observed at elevations from 600 to 1200 meters (1968 to 3937 feet). They nest along streams, mainly on the west slopes of the Cascade Range. In the Wallowa-Whitman National Forest of eastern Oregon, harlequin duck habitat exists and individuals have been sighted (USDA 1990*a*). Also, a breeding record is available for the Wallowa Mountains from the 1930s (Gabrielson and Jewett 1940). In Oregon, harlequins winter at selected sites on the Pacific Coast, especially along rocky shores. Surveys have not been conducted in Oregon (Cassirer and Groves 1991).

Shorebirds

The long-billed curlew (*Numenius americanus*) historically was abundant over much of the prairie regions of North America. Extensive market hunting and loss of habitat exterminated the species from eastern North America in the latter part of the 18th century. In the western U.S., numbers continued to decline through the early part of the 20th century until the 1930s (Bent 1929). Then numbers stabilized, apparently as a result of reduced hunting and grazing pressure. Also, long-billed curlew started to exploit newly created habitat, such as annual grasslands and irrigated crop lands (Cochran and Anderson 1987). The population of long-billed curlews in the Columbia and northern Great Basin was estimated at 8,000 to 13,000 nesting pairs in 1980 (Pampush 1980). An estimated 2,500 to 3,500 nesting pairs are found in the central Snake River Basin, with most nesting in Idaho (Pampush 1980). An important breeding area is southeast of Hells Canyon in the Cascade Resource Area of the BLM Boise District. This area supports an estimated 1,200 nesting pairs (USDI 1987). Habitat also exists in the Wallowa-Whitman National Forest, where scattered sightings have been reported (USDA 1990*a*). The long-billed curlew is considered an uncommon breeding bird in the Blue Mountains Province in Oregon (Marshall 1986).

The upland sandpiper (*Bartramia longicauda*) breeds locally from north-central Alaska, to central Maine, south to northeastern Oregon, central Colorado and across the plains to northcentral Texas. The species was abundant in historical times but was greatly reduced in the past due to market hunting and agricultural practices. Stephens and Sturts (1991) reported the species as nesting near Hells Canyon. The upland sandpiper is also a rare breeding bird in the Blue Mountains Province in Oregon. The largest population of upland sandpipers in the Rocky Mountains was found in the Blue Mountains as small, disjunct populations (Marshall 1986). Extensive surveys in 1984 and subsequent observations accounted for fewer than 100 upland sandpiper sightings in Oregon (Herman *et al.* 1985). Populations in Idaho are even smaller. Habitat is available in Wallowa-Whitman National Forest, where the species has been reported (USDA 1990*a*).

Perching Birds

Loggerhead shrikes (*Lanius ludivicianus*) are widely distributed in North America. They range from southern Canada to Mexico and from the west to the east coast. Southern populations are largely residents while northern populations are at least partially migratory (Miller 1931, Bent 1965). Concern was expressed during the 1980s that loggerhead shrike populations were declining, with mild to precipitous declines observed in most of the U.S. (Davis and Morrison 1987). The Pacific Coast and the southwest, however, seem to have stable to slightly declining populations (Davis and Morrison 1987). In shrub-steppe habitats of southeast Oregon, no decline was evident over the last 15 years (Keister and Ivey 1994). The species is mainly found in sagebrush and juniper steppe in eastern Oregon (Marshall *et al.* 1996). The species is considered an uncommon breeder in the Blue Mountains of Oregon (Marshall 1986). Stephens and Sturts (1991) recorded loggerhead shrikes as transient in east-central Idaho. There are no long-term data available on population trends of loggerhead shrikes in west-central Idaho.

The rosy finch (*Leucosticte arctoa*) breeds above the timberline from Alaska to southwestern Alberta and south through the Cascades, Sierra Nevada, and the Rocky Mountains to east-central California and north-central New Mexico. A subspecies of the rosy finch, the Wallowa rosy finch (*L. arcotoa wallowa*) occurs during summer around snow fields in the Eagle Cap Wilderness Area of the Wallowa-Whitman National Forest (Marshall 1986). The status of rosy finches in the Wallowa Mountains is unclear, particularly because of their confusing taxonomic status (Marshall *et al.* 1996). Populations of the black rosy finch (*L. arctoa atrita*), another subspecies of the rosy finch, have not yet been identified (USDA 1990*a*).

The bank swallow (*Riparia riparia*) ranges from western and central Alaska to southern California and southern Texas. In Oregon, the species occurs as a summer resident mainly east of the Cascade Mountain Range (Marshall *et al.* 1996). The bank swallow breeds throughout Idaho, except at high elevations (Stephens and Sturts 1991). A joint Idaho/Oregon wildlife survey in 1991 found three colonies totaling 650 burrows along the Snake River east of Nyssa, in Malheur County, Oregon. The status of the bank swallow in Oregon and Idaho is unclear (Marshall *et al.* 1996, Stephens and Sturts 1991).

The yellow-billed cuckoo (*Coccyrus americanus*) breeds over much of the United States and northern Mexico. However, the species has declined in the western United States since the 1930s. The species was formerly an abundant to common breeder along the Columbia River west of the Cascades. The species prefers large riparian forests, especially those with cottonwood overstories and willow understories. The yellow-bellied cuckoo historically nested in southern Idaho (Stephens and Sturts 1991). No current nest sites are known in Oregon (Marshall *et al.* 1991) and information is not available for Idaho.

The black-throated sparrow (*Amphispiza bilineata*) can be found in the Great Basin, Mojave, and Colorado deserts. In Oregon, the species is found in the southeast corner of the state (Marshall *et al.* 1996). Black-throated sparrows nest throughout the southern part of Idaho (Stephens and Sturts 1991). The species typically occurs in a narrow zone between valley or playa floors and steep rocky areas, mountain ranges, or escarpments (Bent 1968). Black-throated sparrows were historically very rare in Oregon. Currently, however, they are a rare to uncommon summer resident and vagrant (Marshall *et al.* 1996). Information on the status of the species is not available for Idaho.

The grasshopper sparrow (*Ammodramus savannarum*) has a spotty breeding range from British Columbia to the southeast U.S. The range of the species in Oregon is disjunct and changes periodically. Several locations are clustered in northeastern Oregon (Marshall *et al.* 1996). Grasshopper sparrows nest throughout southern Idaho (Stephens and Sturts 1991). Specific information on population status, however, is not available.

Woodpeckers

The pileated woodpecker (*Dryocopus pileatus*) is a widely dispersed breeding bird in North America. The species is generally limited to mature coniferous, deciduous, and mixed forests, with large, dead trees. The pileated woodpecker is uncommon in coniferous forests of northeastern Oregon (Bull 1987). The species is an important primary excavator of nest cavities that are used by many secondary cavity nesters. The density of pileated woodpeckers in the Wallowa-Whitman National Forest was estimated at one pair per 220 hectares (89 acres) (Bull 1987). The species is reported to breed in the vicinity of Hells

Canyon in Idaho (Stephens and Sturts 1991). Specific information on the status of this species in Hells Canyon is not available.

The white-headed woodpecker (*Picoides albolarvatus*) ranges from southern British Columbia south through Washington and Idaho to southern California and western Nevada (AOU 1983). The species uses open-canopied stands of mature and older ponderosa pine, and less frequently, mixed ponderosa pine and Douglas fir (Frederick and Moore 1991). White-headed woodpeckers were reported in a survey in the HCNRA, and were found to use a wider range of habitats during the breeding season than had previously been thought (Frederick and Moore 1991). However, information collected in this survey was insufficient to provide density estimates for the species. The species is considered an uncommon breeder in the Blue Mountains Province in Oregon (Marshall 1986). The bird is considered rare to uncommon, having a patchy distribution even within ponderosa pine zones in Oregon (Marshall *et al.* 1996).

Three-toed woodpeckers (*Picoides tridactylus*) range across North America from the tree line south to southern Oregon and through Idaho and Utah to New Mexico and Arizona. The species is found in northern coniferous and mixed forest types to elevations of 3000 meters (9842 feet). Forests containing spruce, grand fir, ponderosa pine, tamarack (*Larix laricina*), and lodgepole pine are used (Spahr *et al.* 1991). Nests may be found in spruce, tamarack, pine, western red cedar (*Thuja plicata*), and aspen. It forages on a wide variety of tree species, depending on location. In the northeastern United States, densities were estimated at approximately five pairs per 100 hectares (40 acres) (Spahr *et al.* 1991).

Densities may increase during beetle outbreaks. Individuals maintain territories year round, although insect outbreaks may cause irregular movements. Specific information on the status of this species is not available for Hells Canyon.

The black-headed woodpecker (*Picoides arcticus*) ranges from coniferous forests of Alaska and Canada into the high-elevation forests of the Cascade Range and the Blue Mountains of Oregon. In Idaho, the species can be found in coniferous forests throughout the state (Stephens and Sturts 1991). The species is found in spruce (*Picea* spp.), jack and lodgepole pine (*Pinus banksiana* and *P. contorta*), but also is associated in Oregon with ponderosa pine, or mixed forests (Marshall *et al.* 1996). The species is locally common in Oregon with a spotty distribution. The black-headed woodpecker breeds throughout Idaho in suitable habitat (Stephens and Sturts 1991). However, specific information on population size is not available.

The Lewis' woodpecker (*Melanerpes lewis*) ranges from British Columbia to southern New Mexico and eastern Colorado. The species is found in open country with scattered trees rather than dense forest. Open or park-like ponderosa pine forests are probably the major breeding habitat. They are also found along edges of pine and juniper stands and in deciduous forests, especially riparian cottonwoods (DeGraaf *et al.* 1991). The species was originally a summer resident in every part of Oregon (Gabrielson and Jewett 1940), but their numbers and distribution have declined since the late 1940s. This decline is apparently continuing in Oregon. Now, the species is only found breeding in the oak-ponderosa pine forests and river valleys of northeast Oregon. In Idaho, the species breeds throughout the state. Specific information on population status, however, is not available (Stephens and Sturts 1991).

Bats

The range of the spotted bat (*Euderma maculatum*) is restricted to western North America and northern Mexico (Hall 1981). The species ranges as far north as British Columbia. Little is known about the status of the spotted bat. The species appears to be widespread, but rarely abundant (Fenton *et al.* 1987). It seems to prefer arid areas with canyons and cliffs where it can roost (Poché and Bailie 1974, Poché and Ruffner 1975, Woodsworth *et al.* 1981, Leonard and Fenton 1983). The critical factor appears to be the presence of cracks and crevices ranging from 2.0-5.5 cm (0.8 to 2.1 inches) in width at the opening (Poché 1981). In Utah, Poché (1981) found numerous spotted bats in cracks and small crevices. They were not found in caves or trees. Poché (1981) suggested that the spotted bat may select a narrow range of roosting parameters. Parameters include the absence of forests or trees, availability of cliffs, little annual rainfall, and mild winters with a few nights where temperatures drop below 0 degrees C. Spotted bats appear to feed mainly on moths (Poché 1981, Woodsworth *et al.* 1981, Fullard *et al.* 1983, Leonard and Fenton 1984, Wai-Ping and Fenton 1989). No records are available for spotted bats in Oregon, with only a single record for southwestern Idaho (Hall 1981).

The western big-eared bat (*Plecotus townsendii*) occurs throughout western North America from British Columbia to southern Mexico, and east to South Dakota and western Texas and Oklahoma. The species is widely distributed throughout the intermountain region. Western big-eared bats use juniper/pine forests, shrub-steppe habitats, deciduous forests, and mixed coniferous forests from sea level to elevations of 3300 meters (10,825 feet). The species does not migrate, but remains at hibernacula from October through February. Low reproductive rates, limited roost sites, and sensitivity to human disturbance makes the species vulnerable (Spahr *et al.* 1991). Perkins (1990) estimated a population of 2,800 individuals in the state of Oregon, of which 1,600 occur east of the Cascades. Population numbers are not available for Idaho.

The long-eared myotis (*Myotis evatis*) ranges from central British Columbia south to new Mexico and Arizona. In Oregon, the species is found statewide in forested and riparian habitats. Likewise, the species occurs throughout Idaho (Groves and Marks 1985). However, information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The long-legged myotis (*Myotis volans*) ranges from southeast Alaska to central Mexico. The species inhabits coniferous forests, but is also found in riparian and desert habitats (Warner and Czaplewski 1984). The bat is likely to occur throughout Oregon and Idaho. Information on the status of the species in Oregon or Idaho is not currently available (Marshall *et al.* 1996).

The pallid bat (*Anrtozous pallidus*) ranges from southern British Columbia south through Arizona and New Mexico. This bat inhabits arid regions, especially those with rocky areas near water. In Oregon, they are usually associated with canyons. Rocky crevices and human structures are used for day roosts. Night roosts are located in shallow caves, cliff overhangs and human structures (Hermanson and O'Shea 1983). The species is uncommon is Oregon and populations are local. Specific information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The silver-haired bat (*Lasionycteris noctivagans*) occurs throughout much of North America from southeastern Alaska to northern Mexico. The species is most abundant in forested areas and prefers old-growth Douglas fir/western hemlock habitats (*Tsuga heterophylla*) (Marshall *et al.* 1996). The bat species occurs throughout Oregon and Idaho (Groves and Marks 1985, Marshall *et al.* 1996). However, information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The western small-footed myotis (*Myotis cilolabrum*) ranges from extreme southern British Columbia to the northern edge of Mexico. In Oregon, the species is found in valleys and ponderosa pine forests east of the Cascade Range. Population numbers are unknown. The bat is confined to habitat that is not modified on a large scale. Its status as a sensitive species in Oregon needs to be re-evaluated (Marshall *et al.* 1996).

The Yuma myotis (*Myotis yumanensis*) ranges from southwest British Columbia to southern Colorado, Arizona, and northwestern New Mexico. The species is likely to occur throughout Oregon. In Idaho, the species appears to be restricted to arid areas with caves and human structures (Groves and Marks 1985). Information on the status of the species in both Oregon and Idaho is not available (Marshall *et al.* 1996).

Lagomorphs

Pygmy rabbits are found in seven western states. In both Oregon and Idaho, the species appears to occur only in isolated pockets (Weiss and Verts 1984). The geographic range of the species includes most of the Great Basin and some adjacent intermountain areas of the western United States (Green and Flinders 1980*a*). Pygmy rabbits are closely associated with dense or clumped stands of big sagebrush, growing in deep, loose soils (Green and Flinders 1980*a*,*b*; Weiss and Verts 1984). Pygmy rabbits are unique because they dig shallow burrows. Greasewood (*Sarcobates vermiculata*) stands are also occupied (Davis 1939). The pygmy rabbit is dependent on big sagebrush for cover and, to a large extent, for food (Wilde 1978; Green and Flinders 1980*a*,*b*; White *et al.* 1982*a*,*b*). This dependency may pose a threat to the species. Fragmentation of sagebrush communities will ultimately affect existing populations. Pygmy rabbit populations do not seem to be cyclic as other leporids, their reproductive patterns do not seem capable of responding quickly to favorable environmental conditions (Wilde 1978, Green and Flinders 1980*a*). Populations of pygmy rabbits appear to be susceptible to rapid declines and local extirpation (Weiss and Verts 1984). Population densities apparently vary in several orders of magnitude from less than 1 to 45 rabbits per hectare (2.5 acres) (Green and Flinders 1980*a*). Asherin and Claar (1976) did not record pygmy rabbits in Hells Canyon during their surveys, although the species was suspected to occur in the shrub-steppe habitat at the upper end of Brownlee Reservoir.

Insectivores

The distribution of the Preble's shrew (*Sorex preblei*) is unclear. Records suggest that the species may occur throughout the Columbia Plateau and Snake River Plain, and extend throughout the northern Rocky Mountains (Hoffman and Fisher 1978). All established records of this shrew, however, are at elevations ranging from 1400 m (4593 feet) to 2700 m (8858 feet) (Hoffmann *et al.* 1969, Hoffmann and Fisher 1978, Tomasi and Hoffmann 1984, Williams 1984). Habitat descriptions where Preble's shrews have been caught were generally described as (montane) sagebrush communities (Williams 1984), arid to semi-arid shrub-grass associations, or openings in montane coniferous forests dominated by sagebrush (Tomasi and Hoffmann 1981). Preble's shrews apparently have been collected in the Wallowa-Whitman National Forest (USDA 1990*a*). Specific information on population status is not available.

Rodents

The Idaho ground squirrel (*Spermophilus brunneus*) is limited to a few isolated colonies in five counties in western Idaho (Adams, Valley, Gem, Payette and Washington Counties) (Yensen 1991). The northern population is restricted to Adams and Valley Counties with the main concentration between the Seven Devils Mountains and the Cuddy Mountains in Adams County. The southern population occurs in Gem, Payette, and Washington counties north of the Payette River. The northern populations occur in meadows surrounded by ponderosa pine and Douglas fir forests between 1150 m (3773 feet msl) and 1550 m (5085 feet msl) in elevation. Vegetation in these drier meadows is often dominated by stiff sage (*Artemisia rigida*) or mountain big sage (*Artemisia tridentata vaseyana*) (Yensen

1991). Populations are small (fewer than 200 individuals). Seventeen populations have been identified. Southern populations occur at elevations between 670 m (2198 feet) and 975 m (3199 feet) in the low rolling hills and valleys north of the Payette River. The distributional range is bounded to the south by the Payette River, to the west by the Snake River, and on the northeast by unsuitable habitat (Yensen 1991). The species has been collected from 24 sites in the southern range. The limited ranges and small breeding populations makes the species vulnerable to a variety of threats.

Carnivores

The marten (*Martes americana*) inhabits boreal forests of North America. In the western United States, marten ranges include Oregon, Idaho, Washington, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, and California (Strickland *et al.* 1982). In northeastern Oregon, marten are relatively common (Marshall *et al.* 1996). In the Blue and Wallowa Mountains of northeastern Oregon, marten are classified as Sensitive-State Vulnerable (ONHP 1995), but are a harvested furbearer in Idaho (Will 1995). Sensitive status was assigned in Oregon because of declining habitat quantity and quality due to harvest of mature and old-growth timber.

Martens generally inhabit mature and old-growth mesic forests that contain large quantities of standing and downed, coarse woody debris (including in Idaho) (Koehler *et al.* 1975, Koehler and Hornocker 1977, Marshall *et al.* 1996). Hence, habitat fragmentation due to logging may be isolating populations and affecting long-term viability. National forests in Oregon often use marten as an indicator species for old-growth forests, although provisions in the national forest planning process may be inadequate (Marshall *et al.* 1996). Martens have been documented to occur at upper elevations adjacent to Hells Canyon in Oregon (USDA 1992, 1993, 1994). It is anticipated that the marten also occurs adjacent to Hells Canyon in the Seven Devils Mountains of Idaho. Adequate information is not currently available to assess population status nor distribution in and adjacent to Hells Canyon.

The wolverine (*Gulo gulo*) has a circumboreal distribution. In North America, the species occurs in Alaska and across the boreal forests of Canada south into the northwestern United States. Wolverine numbers declined steadily in the contiguous U.S. after the late 1800s. Today, they are uncommon. In the continental U.S., the presence of wolverines has been confirmed in Wyoming, Washington, Oregon, Idaho, and Montana. Only Idaho and Montana are known to support reproducing populations of wolverines (Hornocker and Hash 1981, Copeland 1996). The species' status is unknown in these other states. Wolverines are a naturally low-density species throughout their range. Densities are low, even in the best habitats, and closely tied to the diversity and availability of food. The distribution and status and of wolverines in and adjacent to Hells Canyon is currently unknown. Marshall *et al.* (1996) reported that research is needed to better define wolverine habitat needs and status.

The present-day distribution of the wolverine in Idaho is probably in the mountainous portions of the state from the South Fork of the Boise River north to the Canadian border (Groves 1988). In Oregon, wolverine occurs statewide in mountainous regions (Marshall *et al.* 1996). The species inhabits tundra and coniferous forest zones, generally at higher altitudes during summer and mid to lower elevations during winter. Low-elevation riparian areas may be important winter habitat. They lead a solitary life except during the breeding season and while females rear young (Spahr *et al.* 1991).

Information about wolverine populations is usually limited because of the species' secretive habits and generally low densities. Most information available has been collected incidentally to fur harvest. However, within the continental U.S., wolverine are legally harvested only in Montana. Therefore, basic information about wolverine distribution and relative abundance in most areas potentially occupied south of the Canadian/United States border is limited. In the absence of harvest data, distributional surveys may be the only means of establishing the extent of the wolverine's range. Establishing this species' presence in an area is the first piece of information necessary for understanding habitat requirements, movement patterns, and demography. Hence, this baseline information is essential for understanding the effects of human disturbance and natural resource development in areas occupied by wolverines (Zielinski and Kucrea 1995, Marshall *et al.* 1996).

The fisher (*Martes pennant*i) occurs in North America from British Columbia to Nova Scotia, south to the northeastern United States. They also occur in Montana, central Idaho, northwestern Wyoming, Oregon, and California. Fishers may occur adjacent to Hells Canyon in the Wallowa Mountains of Oregon and Seven Devils Mountains of Idaho (Spahr *et al.* 1991, Marshall *et al.* 1996). Fisher movements and habitat use are generally determined by the availability of food, dens, and weather conditions. Food is probably the most important factor (Strickland *et al.* 1982). No studies of fisher habitat have been conducted in Oregon (Marshall *et al.* 1996). However, research elsewhere found that fishers prefer forests dominated by conifers with extensive and continuous canopies (e.g., 70 to 80 percent cover). Dense lowland forests and mature to old-growth forests with high canopy closure often satisfy habitat requirements of the fisher (Spahr *et al.* 1991).

The fisher is classified as a *species of concern* by the USFWS and of *critical status* by the ODFW (ONHP 1995). The IDFG also classifies the fisher as a *species of special concern*, and the BLM and USFS classify the fisher as *sensitive* (CDC 1994). Fisher are *sensitive* in Oregon and Idaho because of their general rarity and their questionable status as a viable species. Over-trapping and habitat destruction, mainly due to logging, wildfire, and settlement, have constricted the fisher's range. Forest fragmentation, which reduces and isolates suitable habitat, is the current threat to fisher populations. Accordingly, timber harvest has been associated with fisher declines (Spahr *et al.* 1991, Marshall *et al.* 1996). Because fishers are a secretive, low-density species, most population information is available only from trapping records. Because they are no longer trapped in Idaho or Oregon, little is known about fisher populations in these states (Spahr *et al.* 1991). Currently, no information on the status and distribution of fishers specifically in Hells Canyon is available.

Lynx (*Lynx canadensis*) is holarctic in distribution, ranging across the boreal region of Canada and Alaska, down to the northern tier of the U.S. (McCord and Cardoza 1982). In the western U.S., they are found as isolated populations in spruce, fir, and lodgepole pine forests of Washington, Idaho, Montana, Wyoming, Colorado, and Utah. A peripheral record also exists for the Wallowa Mountains of northeastern Oregon (Coggins 1969). Lynx are at the southern extremity of their range in Idaho and Oregon, and probably occur at low densities in these states (McCord and Cardoza 1982, Leptich 1990).

The species is generally abundant and widespread in northern portions of its range. However, lynx have declined in much of their former range, excluding Alaska (McCord and Cardoza 1982). Declines have been attributed to hunting, trapping, predator control, and loss of wilderness forests (Spahr *et al.* 1991). Forest fragmentation due to timber harvest, roads, and development is of primary concern for loss of habitat and travel corridors (Spahr *et al.* 1991). Because of range contraction and population declines in Oregon and Idaho, lynx is currently classified as a *species of concern* (formerly *Category-2 candidate* species) by the USFWS (Spahr *et al.* 1991, CDC 1994, ONHP 1993).

The most recent surveys for lynx in the Hells Canyon area occurred in the Wallowa Mountains of Oregon and adjacent to Hells Canyon. The USFS conducted winter track surveys from 1991 to 1994. Only two incidental sightings of lynx were reported in the Wallowa Valley, Eagle Cap, and Hells Canyon National Recreation areas combined (USDA 1992, 1993, 1994). Specific information on lynx densities in Hells Canyon and the surrounding vicinity is currently not available.

The kit fox (*Vulpes velox*) is a narrowly specialized fox that is adapted to desert and semi-arid habitats of western North America (Egoscue 1962, Samuel and Nelson 1982). Currently, five subspecies of kit fox are identified. The Nevada kit fox (*V. velox nevadensis*) occurs farther north than other subspecies and is largely identified with the Great Basin and adjacent cold desert habitats (O'Neal *et al.* 1987). The range of this subspecies is reported to extend into extreme southeastern Oregon and southwestern Idaho (Samuel and Nelson 1982, Marshall *et al.* 1996). The kit fox is classified as a *species of special concern* by the IDFG, *threatened* by the ODFG, and *sensitive* by the BLM (CDC 1994, ONHP 1995). Kit fox was originally listed as *threatened* in Oregon due to a scarcity of records combined with susceptibility to habitat alteration, predator control programs, trapping, and incidental shootings. Mining, residential development, and other human-caused habitat alterations are currently considered as potentially detrimental to the kit fox in Oregon (Marshall *et al.* 1996). It is doubtful that kit foxes occur in abundance in Hells Canyon or the immediate vicinity, based on the currently known distribution of the species (Samuel and Nelson 1982).

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5.5. Botanical Resources

5.5.1. Historic Botanical Resources

Historical records describing the shrub steppe region vary widely in the amount of information concerning native vegetation. They do confirm that the geographic areas presently dominated by sagebrush vegetation or its successional derivatives are essentially the same as those prior to European settlement. At least nine species and subspecies of original sagebrush vegetation have been identified (Tisdale *et al.* 1969). Intermixing of these species was apparently rare, due to each species' specific adaptation to its respective environment. Disturbance factors such as grazing, fire, and drought have dramatically altered the composition and productivity of these communities (Tisdale *et al.* 1969, Tisdale and Hironaka 1981). The same is true of the area's grasslands steppe. Tisdale *et al.* (1969) quote from a 1902 account that describes bunchgrasses growing "abundantly" and "in a state of nature." Before the late 1800s, herbivory disturbance to the grassland steppe was limited to foraging by wildlife. By 1870, however, Euro-American settlement in the Hells Canyon area had become widespread, and large herds of cattle and sheep were introduced (Evans 1967 in Tisdale 1979). In the mid-1700s, the Nez Perce Tribe began using the canyons to pasture and shelter their horse herds. Grazing severely affected grasslands that were easily accessible to homesteads. Competition from introduced annuals, e.g., cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum asperum*), created another threat (Tisdale *et al.* 1969, Tisdale and Hironaka 1981, Miller *et al.* 1986).

5.5.2. Current Botanical Resources

The types of vegetation occurring along the canyon slopes of the Middle Snake River are the result of three primary ecological factors: topography, soils, and climate. Of these three considerations, climate exerts the strongest influence on the development of plant life. The region is semi-arid, falling in the rain shadow of the Cascade Range to the west. Most precipitation occurs in the spring and winter (Tisdale *et al.* 1969, Tisdale 1986, Johnson and Simon 1987). Little or no precipitation falls during the hottest months of summer. As a general rule, winters in the canyons are mild, while summers on the canyon floor may be extremely warm. Mean temperatures above 2000 m (6562 feet msl) elevation range from -9 degrees C in January to 13 degrees C in July. By contrast, mean temperatures below 1000 m (3281 feet msl) elevation range from 0 degrees C in January to between 28 degrees C and 33 degrees C in July (Johnson and Simon 1987). The relatively mild winters below the canyon rim have allowed the development of disjunct species such as hackberry (*Celtis reticulata*), which is most often found in the southwestern states, but commonly occurs in the Middle Snake River area (Tisdale 1979).

Within the context of regional climate, topography is a major influence on the development and distribution of vegetation (Tisdale *et al.* 1969, Tisdale 1979, Tisdale 1986). Indeed, one study (Tisdale 1979) noted that variations in aspect, elevation, and slope gradient often cause dramatic differences in microclimate, thereby affecting the character of both soils and vegetation. As a result, the topographical complexity of Hells Canyon has produced a mosaic of vegetation types (Tisdale 1979, BPA 1984, BLM 1986). Grassland, shrubland, riparian, and coniferous forest communities exist in close proximity. Interfingering of grassland and forest, for example, occurs at a number of sites throughout the canyons due to variations in aspect (Tisdale 1979).

5.5.2.1. Wetland and Riparian Communities

Detailed knowledge of the character of wetland and riparian communities in Hells Canyon is unknown. Descriptions are based on work that focused on particular plant communities (Miller 1976, Miller and Johnson 1976, Debolt 1992) or is based on limited sampling efforts (Huschle 1975, Asherin and Claar 1976). Emergent wetland communities in the study area are composed mostly of common cattail (*Typha latifolia*), narrowleaf cattail (*Typha angustifolia*), American bulrush (*Scirpus americanus*), and common spikerush (*Eleocharis palustris*). A common cattail/American bulrush community type occupies shallow shorelines, shallow bays, and ponds. The plants grow to a height of approximately 2 meters (6.5 feet) and their distribution varies in density. Willows are sparsely represented, and various forbs grow on the shoreline side of the stands (Asherin and Claar 1976). A common cattail/common spikerush community type occurs on some tributary deltas. Narrowleaf cattail is present, though sparsely distributed. Willows are slightly more abundant than in the common cattail/American bulrush type (Asherin and Claar 1976).

A narrow band of diverse riparian communities follows the course of the Snake River and its many tributaries. Although it is limited in geographic area, this riparian zone is vital because of the biological diversity it provides (BLM 1986). Predominant tree species in riparian areas include white alder (*Alnus rhombifolia*), water birch (*Betula occidentalis*), and black cottonwood (*Populus trichocarpa*). Predominant shrub species in riparian areas include syringa *(Philadelphus lewisii*), netleaf hackberry (*Celtis reticulata*), chokecherry (*Prunus virginiana*), black hawthorn (*Crataegus douglasii*), and poison ivy (*Toxicodendron radicans*).

Grassland communities are also common along the Snake River and its tributaries. Riparian vegetation is not present along many shoreline sections. Upland vegetation on steep canyon slopes simply meet a rocky shoreline. Where this situation occurs, as on the canyon slopes, the dominant species are bluebunch wheatgrass (*Pseudoroegnaria spicata*), cheatgrass, and Idaho fescue (*Festuca idahoensis*) (Asherin and Claar 1976).

Although coniferous forest communities are generally restricted to the higher elevations of steep canyon slopes, they do reach down as far as the river at certain locations. This is the case at sites around the main bodies of Oxbow and Hells Canyon Reservoirs, where a ponderosa pine/bluebunch wheatgrass type extends to the river on north-facing slopes (Asherin and Claar 1976, BPA 1984). A ponderosa pine (*Pinus ponderosa*)/hackberry type may also extend down to the river in this area.

5.5.2.2.
Herbaceous-Dominated Vegetation Types

The dry climate and typically stony, shallow soils of the canyon have favored the development of grassland steppe communities at the lower and middle elevations (Tisdale 1979, Tisdale 1986). The steppe classification was made by Daubenmire (1970), based on the presence of an appreciable cover of perennial grasses on zonal soils. Franklin and Dyrness (1973) made a further distinction, classifying as shrub steppe those sites on which sagebrush (*Artemisia* spp.) and perennial grasses codominate. Commonly occurring grass species in the study area include bunchgrasses such as bluebunch wheatgrass, Sandberg bluegrass (*Poa secunda*), and Idaho fescue (Franklin and Dyrness 1973, Garrison *et al.* 1977, BPA 1984, Tisdale 1986). Sand dropseed

(*Sporobolus cryptandrus*) and red threeawn (*Aristida longiseta*) are also common and at times dominant (BPA 1984, Tisdale 1986). As might be expected, significant correlations exist between soil types and the distribution of plant communities. For example, Johnson and Simon (1987) found that habitats dominated by bluebunch wheatgrass tend to occur on soils with little or no loess influence, while habitats dominated by Idaho fescue occur most often on soils which are highly influenced by loess content.

Habitat types in which bluebunch wheatgrass is dominant occur throughout the area of study and occupy over half of its grassland area (Tisdale 1986). Bluebunch wheatgrass shows extensive genetic variation and a remarkable ability to adapt to ecological factors (Miller *et al.* 1986). The species is prized as a palatable forage for both domestic livestock and wildlife. It produces more herbage than all other associated species combined (Miller *et al.* 1986). Bluebunch wheatgrass flourishes on deep, loamy soils, but adapts to coarser and more shallow soils as well. Generally, it is associated with Idaho fescue on deeper soils, and with Sandberg bluegrass on shallower soils.

A bluebunch wheatgrass/plains prickly pear (*Opuntia polyacantha*) habitat type is present on southerly slopes and exposed ridge tops between 260 m (853 feet) and 1100 m (3609 feet) elevations. A bluebunch wheatgrass/Sandberg bluegrass/arrowleaf balsamroot *(Balsamorhiza sagittata*) habitat type is evident throughout the main river canyon at lower and middle elevations between 320 m (1050 feet) and 1,500 m (4921 feet). Cheatgrass is an annual invader throughout the area, replacing bluebunch wheatgrass as the dominant species on sites where grazing is or has been heavy. Habitats dominated by Idaho fescue are limited primarily to the reach between Brownlee Dam and the confluence of the Snake and Salmon Rivers (Asherin and Claar 1976). For example, an Idaho fescue/bluebunch wheatgrass habitat type covers large areas of the lower and middle valley slopes between 430 m (1411 feet) and 1600 m (5249 feet) elevations (Tisdale 1986). A sand dropseed/Sandberg bluegrass habitat type occupies some gentler slopes of the Snake River canyon between elevations of 260 m (853 feet) and 575 m (1886 feet), while a red threeawn/Sandberg bluegrass habitat type is present on colluvial fans and low ridge tops between 300 m (984 feet) and 600 m (1969 feet). On a site-to-site basis, other grass species are present in abundance and may be dominant. These species include creeping wildrye (*Elymus triticoides*), which is dominant on the islands at the upper end of Brownlee Reservoir, and medusahead which may show dominance on specific soil types in the area around Oxbow Reservoir (BPA 1984).

In addition to plains prickly pear and arrowleaf balsamroot, a great number of other perennial and annual forbs are also present in the study area, often as important components of specific vegetation types. Other commonly occurring forb species include yarrow (*Achillea millefolium*), starry cerastium (*Cerastium arvense*), tumblemustard (*Sisymbrium altissimum*), storksbill (*Erodium cicutarium*), various lupines (*Lupinus* spp.), and white sweetclover (*Melilotus alba*), the latter showing dominance on the extensive roadfill and talus slopes in the reach between Oxbow Dam and Hells Canyon Dam (BPA 1984).

5.5.2.3. Shrub-Dominated Vegetation Types

Shrub species comprise a large segment of the canyon’s overall vegetation composition. Shrub steppe vegetation types occur in the Hells Canyon study area at mid-elevations especially in the upper region of the study area. For example, big sagebrush (*Artemisia tridentata*) is a dominant species in the southern sector of the study area, particularly in the area around Brownlee Reservoir (BPA 1984). Commonly occurring shrubs include big antelope sagebrush, bitterbrush (*Purshia tridentata*), hackberry, serviceberry (*Amelanchier alnifolia*) and bitter cherry (*Prunus emarginata*) (BPA 1984, Tisdale 1986). Other varieties of sagebrush are also present, including low sagebrush (*Artemisia arbuscula*), stiff sagebrush (*Artemisia rigida*), and silver sagebrush (*Artemisia cana*) (Franklin and Dyrness 1973, Tisdale and Hironaka 1981). Sagebrush stands are limited for the most part to the area around Brownlee Reservoir. The herbaceous layer in these stands, where present, is dominated by Sandberg bluegrass, with a variety of forbs also occurring.

Stands of hackberry may be found throughout the study area, either on lower slopes with rocky, residual/colluvial soil, or on alluvial terraces with sandy soil (Tisdale 1986). In these stands, hackberry is often mixed with a number of other shrub and tree species, including antelope bitterbrush, blue elderberry (*Sambucus cerulea*), and ponderosa pine (BPA 1984). The herbaceous layer is most often dominated by bluebunch wheatgrass, with cheatgrass and sand dropseed dominant in those areas which have been heavily disturbed by the grazing and trampling of cattle.

5.5.2.4.
Tree-Dominated Vegetation Types

The predominant forest community in the area of study is a ponderosa pine/bluebunch wheatgrass plant association. This association typically occurs as a savanna of ponderosa pine trees distributed over a grassland steppe dominated by bluebunch wheatgrass. Shrubs are almost completely absent, except for sparsely-distributed drought-resistant species such as antelope bitterbrush and serviceberry (Garrison *et al.* 1977, Johnson and Simon 1987). The only commonly occurring forbs are yarrow and lupines. Distribution of the ponderosa pine/bluebunch wheatgrass association are found at elevations ranging from 1060 m (3478 feet) to 1560 m (5118 feet) on sandy loam soils. A ponderosa pine/hackberry type is limited primarily to the upper end of Hells Canyon and to Hells Canyon and Oxbow Reservoirs. The tree layer in this type varies from scattered individuals to sparse woodland. Hackberry dominates the shrub layer in moderate density. Poison ivy is also abundant (Asherin and Claar 1976).

As stated earlier, interruption of vegetation development and species distributions along the Middle Snake River has been due primarily to the grazing and trampling of domestic herds and wild ungulates. Although the dry and rugged landscape of the canyons prevented all but the most accessible sites from being heavily disturbed, grazing on those sites had a severe impact (Tisdale *et al.* 1969, Tisdale and Hironaka 1981, Tisdale 1986). Heavy grazing in the late spring and early summer, during the vulnerable growth stages of bluebunch wheatgrass and Idaho fescue, added to the problem. The abundance of herbaceous species declined while the competing species of woody shrubs flourished in their absence. Today, better range management has improved the situation on some sites. On others, the steep and stony canyons still constitute their own best protection.

Fire poses a threat to the area’s vegetation. The dry, hot summers of the region insure a ready supply of fuel for the season’s frequent lightning-sparked fires. Most species of sagebrush are easily killed by fire. The immediate effect of fire on sagebrush/grass communities is the significant depletion of sagebrush and a corresponding increase in understory grasses (Tisdale and Hironaka 1981). Bluebunch wheatgrass and other coarse grasses seem able to withstand burning relatively well, while Idaho fescue may show a reduction in yield for up to 15 years afterwards (Tisdale and

Hironaka 1981, Miller *et al.* 1986). When the fire occurs in early summer, native perennials are more easily killed and the dominance of cheatgrass is typically enhanced (Miller *et al.* 1986).

5.5.3. Species of Special Concern and Rare Plant Communities

5.5.3.1. Species of Special Concern

One hundred and sixty-seven rare plant species may occur in the Hells Canyon study area including the federally listed species, *Mirabilis macfarlanei* (P. Brooks, USFS-WWNF, *pers. comm*.; R. Rosentreter, Idaho-BLM, *pers. comm.*; C. Button, Oregon-BLM, *pers. comm.*; Idaho CDC, *pers*. *comm*.; ONHP, *pers*. *comm*.) (Table 5-9). For several years the Idaho Conservation Data (CDC) has performed surveys for (then) federal *candidate* and *threatened* species on the Idaho side of the Hells Canyon area. The most recent inventories (Moseley and Mancuso 1991, 1992) summarize findings for six species including puzzling halimolobos (*Halimolobos perplexa* var. *perplexa*), Hazel's prickly phlox (*Leptodactylon pungens ssp. hazeliae*), gold-back fern (*Pentagramma triangularis*), Wolf's currant (*Ribes wolfii*), bartonberry (*Rubus bartonianus*), and American wood sage (*Teucrium canadense* var. *occidentale*). One federally listed plant species occurs in the study area: Macfarlane's four-o-clock (*Mirabilis macfarlanei*). It is endemic to the Snake, Salmon, and Imnaha river drainages. Nine populations of *Mirabilis macfarlanei* are known to occur on the Idaho side of the HCNRA. Most of them were only recently discovered (Mancuso and Moseley 1991). Only two populations are reported from Oregon in the Hells Canyon area (USFS-WWNF GIS database).

The remaining species are identified as USFS or BLM *sensitive* species or are listed as *rare* species by the Idaho CDC, the Oregon Natural Heritage Program (ONHP) or the Oregon Department of Agriculture (Table 5-9). Many of these are identified as *watch* or *review* species; that is, species for which additional information is needed to determine rarity. Often, *watch* or *review* species are found to be more common than expected and are then dropped from the list of rare species.

Many of the species occupy the higher elevations of the Hells Canyon Study Area. These species are not likely to occur along the reservoirs or downstream reach; however, they may occur in the vicinity of transmission lines that are associated with the Hells Canyon Project license. They are therefore included as part of this description of the Hells Canyon environment.

5.5.3.2.
Rare Plant Communities

Johnson and Simon (1987) and Tisdale (1986) have provided thorough descriptions of the many grassland, shrub and forest communities and plant associations of the Hells Canyon area. Some communities and associations have been identified by both Johnson and Simon (1987) and Tisdale (1986). Terminology used by both Johnson and Simon (1987) and Tisdale (1986) differs somewhat, so a brief discussion of habitat types, plant associations and plant communities is warranted. Habitat type refers to the distribution or potential distribution of a *climax* (stable) plant community with predictable species composition, structural qualities, and habitat characteristics (Daubenmire 1978). Plant association refers also to the climax community defined with the same constraints as habitat type. The critical difference is the broader landscape perspective inherent in the term "habitat type," while association refers to local conditions. For the purposes of discussion here, habitat type and plant association will be used interchangeably. The definition of community type among the authors is similarly related. Johnson and Simon (1987) define community type as seral stages (species assemblages that are at some stage intermediate to and tending toward climax communities) that appear so frequently on the landscape that they can be described. Also included in their definition are assemblages that cannot be placed in a plant association classification due to paucity of information concerning synecological relationships. Tisdale (1986) defines community type as collections of species "which are distinctive, but whose climax status is uncertain."

Several communities and associations have been identified as *rare* in Idaho (INHP 1988) and Oregon (ONHP 1992) (Table 5-10). Associations have been ranked by their abundance based on information from the literature and expert advice. All ranks include information about global and local status.

Most of the vegetation of Hells Canyon has been affected by a long history of grazing and over-utilization by non-native ungulates. In some cases fire disturbance may play an active role in maintaining communities. The rare forest communities and associations described below occur at high elevations in the canyon and are not likely to be directly affected by hydropower operations. However, they may be of value to wildlife that utilize the lower slopes of the canyon and are therefore included herein.

Grassland Communities

The sand dropseed/Sandberg's bluegrass community type (Tisdale 1986) and sand dropseed plant association (Johnson and Simon 1987) occur along the sandy, gravelly islands and terraces adjacent to the Snake River in the driest and hottest sections in Hells Canyon (Johnson and Simon 1987, Tisdale 1986). Sand dropseed is the dominant species, but exotic forbs and annual grasses are abundant. Nearly 47 percent of the species encountered by Tisdale (1986) were exotic. While the dominant species that make up this community are not especially palatable, livestock tend to congregate under the occasional hackberry shrubs that may occur in the area, thereby affecting community vigor (Johnson and Simon 1987). The sand dropseed association is locally abundant in the study area, but possibly *rare* outside of Hells Canyon in Idaho (INHP 1988). It is ranked as *possibly globally rare* and *locally rare* (*G2?S1?*)[*] by the CDC and as *globally common* and *locally common* (*G4S3*) by ONHP (Table 5-10).

The bluebunch wheatgrass/Wyeth's buckwheat (*Erogonum wyethii*) plant association (Johnson and Simon 1987) occurs on steep, rocky, southeast to southwest-facing slopes. Distribution in the canyon is very limited. In fact, Johnson and Simon (1987) suggest the association may be endemic to the North Pine Creek, Oregon area, although a similar community was found on the North Fork of the Clearwater River in Idaho. Grazing disturbance, in particular by sheep, has impacted most occurrences of the association and may be responsible for the low diversity of perennial forbs that characterizes it. The Idaho

[*] A question mark associated with rare plant rankings indicates more information is needed to confirm the rank per Natural Heritage Programs.

CDC ranks this association as *locally rare* and *possibly globally rare* (*G2?S1*) while the ONHP ranks it as *globally common* and of unknown distribution in Oregon (*G4SU*).

Shrubland Communities

The antelope bitterbrush/bluebunch wheatgrass plant association (Johnson and Simon 1987) generally occurs on shallow, rocky soils subtended by colluvium on east-southeast-facing slopes. In the Hells Canyon area, it appears to be confined to the vicinity of Pine Creek Canyon at lower elevations than the bluebunch wheatgrass/Wyeth's buckwheat plant association. A scattering of bitterbrush among bluebunch wheatgrass, sandberg bluegrass and bulbous bluegrass (*Poa bulbosa*) gives this association a savanna-like appearance. This association provides abundant forage for wildlife. The association is fairly widespread in the West but is considered unique in Oregon (*G3S1*) and Idaho (*G3?S1?*) (Table 5-10).

The western juniper (*Juniperus occidentalis*)/Idaho fescue-bluebunch wheatgrass plant association (Johnson and Simon 1987) is confined to tributaries of the Grande Ronde River, Oregon at upper canyon slope positions, principally along basalt rimrock outcrops. Generally this association occurs adjacent to rich fescue grasslands. It tends to be heavily utilized by wildlife and cattle because the adjacent fescue grasslands provide important foraging areas while the western juniper component of this association provides valuable shade areas. The association occurs more commonly west and south of Hells Canyon. The CDC and ONHP list western juniper communities with either Idaho fescue or bluebunch wheatgrass, but not both. Using the global and state ranks for both communities as reported for each state, the rank appears to be *locally uncommon*, but *globally common* (*G3S2*) (Table 5-10).

The buckwheat/Oregon bladderpod plant association (Johnson and Simon 1987) is limited to hydrothermally altered basaltic outcroppings. These outcroppings occur infrequently in the lower Imnaha and Snake River canyons. Total cover value of the buckwheat (*Eriogonum* spp.)/bladderpod (*Physaria oregana*) association is low primarily due to the harsh environmental conditions encountered: high solar input, high temperatures, dark rock and very shallow soils. The sparsity of vegetation and lack of cover limits the attractiveness of this association to wildlife and cattle. This plant association is ranked as *possibly globally* and *locally uncommon* (*G2?S2?*) by the CDC and as common by the ONHP (Table 5-10).

The sparsely vegetated stiff sagebrush (*Artemisia rigida*)/Sandberg bluegrass community is found on very shallow, basalt-derived soils in Adams and Washington counties (Hironaka *et al.* 1983). The substrate is extremely rocky and overlies basalt bedrock. The community, as described by Tisdale (1986) occurs at moderately high elevations (approximately 1300 m (4265 feet)). A slightly different community, described by Hironaka *et al.* (1983) occurs in the vicinity of Brownlee Reservoir (Tisdale 1986) at lower elevations (490 m (1608 feet) to 650 m (2133 feet)). During winter and spring the thin soil layer quickly becomes saturated and surface runoff occurs. Soils frequently remain saturated long enough to exclude establishment of other species of sagebrush from the surrounding area (Hironaka *et al.* 1983). The low relative cover of vegetation (bare ground and rock account for almost 40 percent of cover) does not provide much grazing and browsing opportunity. When adjacent communities do provide forage, trampling of these communities while the soil is moist can have significant negative impacts on community composition and health. The CDC and ONHP rank this community as *globally widespread* (*G4*), *common* in Oregon (*S3*) and *uncommon* in Idaho (*S2?*) (Table 5-9).

The netleaf hackberry/bluebunch wheatgrass habitat type (Tisdale 1986) or plant association (Johnson and Simon 1987) tends to occur on lower elevation, rocky sites. Soils tend to be developed from residual and colluvial materials. Many of the sites have been severely disturbed and show a predominance of exotic herbs. Grazing and browsing animals and recreationists have been identified as historic and current sources of disturbance to this habitat type. Where the associations have not been disturbed, bluebunch wheatgrass is a dominant component of the understory and the association is identified as a habitat type. The Idaho CDC (1988) ranks the hackberry/bluebunch wheatgrass association as *globally* and *locally uncommon* (*G3S2*). The association is thought to be more *common* in Oregon (G3S3).

A second type of hackberry association tends to occur on the alluvial terraces found along the Snake River (Johnson and Simon 1987). There soils are deep, coarsely textured sands. Sand dropseed becomes the dominant herbaceous component. Neither the ONHP nor the CDC have included this association in their lists of plant communities occurring in their respective states.

Forest Communities

The grand fir *(Abies grandis)*/Pacific yew (*Taxus breuifolia*)/queen's *cup (Clintonia uniflora*) plant association (Johnson and Simon 1987) is limited within the canyon and is found primarily on northeast and northwest exposures where soils are relatively deep (100 cm (39 inches) to 200 cm (78 inches)) and fire frequency is extremely low. The presence of yew in the understory of grand fir is indicative of cool temperatures and moist or saturated soils associated with seepages and springs. Yew is highly susceptible to burning, as is grand fir, when fires are hot enough to burn the duff layer and damage roots. The grand fir/pacific yew/queen's cup association is found in Idaho and Oregon between 1300 m (4265 feet) and 1750 m (5741 feet) elevations. The association is *uncommon globally* and *locally* in Oregon (*G2S2*) and Idaho (*G2?S2?*) (Table 5-10).

The grand fir/goldthread (*Coptis occidentalis*) plant association (Johnson and Simon 1987) is co-dominated by grand fir and Englemann spruce (*Picea englemannii*). Sites are cool, moist, steep, north-facing slopes with shallow soils. Common understory species, such as big huckleberry (*Vaccinium membranaceum*), Utah honeysuckle (*Lonicera utahensis*), prince's pine (*Chimaphila umbellata*), thimbleberry (*Rubus parviflora*), and sweet cicely (*Ozmorhiza chilensis*), underscore the moist conditions apparent under the canopy. Johnson and Simon (1987) consider this to be an uncommon association in Hells Canyon although it does occur more commonly in the nearby Seven Devils Mountains and the northern Rocky Mountains. The ONHP identifies this association as *globally and locally rare* (*G2S1*) (Table 5-10). Idaho CDC does not rank this association although it occurs within the state.

The grand fir/mountain maple (*Acer glabrum*)-ninebark (*Physocarpus malvaceus*) community type (Johnson and Simon 1987) occurs on deep, moderately productive soils on relatively steep, unstable slopes. Grand fir is dominant or co-dominant with douglas-fir (*Pseudotsuga menziesii*). This community is considered to be transitional between douglas-fir/ninebark communities and the grand fir types growing at higher elevations. Typical understory species include Rocky Mountain maple, Utah honeysuckle, ninebark, false Solomon's-seal (*Smilacina racemosa*), bigleaf sandwort (*Arenaria macrophylla*) and sweet cicely. Fire played a role in maintaining this community, however fire suppression has allowed grand fir to become established in the understory. Big game, especially elk, deer, bear, mountain lion and ruffed grouse, utilize the grand fir/mountain maple-ninebark community for bedding, hiding and thermal cover. This community is ranked as *globally common* and *locally uncommon* in Idaho (*G3S2*). The ONHP does not list the association, but the associations with mountain maple or ninebark in the understory of grand fir are both ranked *G3S3* indicating the associations are *locally* and *globally common* (Table 5-10).

The ponderosa pine/Idaho fescue plant association (Johnson and Simon 1987) is found on soils less than 45 cm (17.5 inches) in depth, although rooting occurs much deeper through fractures in the underlying bedrock. Surface soils are commonly silt loam with a small percentage of rock material. Underlying soils shift to clay loams and silty clay loams. The association is typically found growing on mid- to low-elevation ridges and can occur on east, west or south-facing slopes. The latter habitats may be included among the most severe of all sites in the Wallowa-Snake Province. Ponderosa pines are scattered in small groups within what otherwise would be called Idaho fescue grassland. The appearance is of a tree savanna, with occasional cover by shrubs such as common snowberry and rose. The ponderosa pine/Idaho fescue association is thought to be *common globally*, but of limited distribution in Idaho and Oregon (*G3S2* and *G4S2*, respectively) (Table 5-10).

Little information is available about the ponderosa pine/antelope bitterbrush/bluebunch wheatgrass plant association (Johnson and Simon 1987), except that it is considered to be transitional between the bitterbrush, big sagebrush steppe and more mesic forested communities. The sites appear to be heavily utilized by deer, elk, and cattle. The association is apparently more common in central Oregon (Hall 1973). Similar to the ponderosa pine/Idaho fescue type, to which Hall (1973) claims this is related, the general distribution is wide, but local distribution in Idaho is limited (*G3?S2*). In Oregon this association is *locally common* (*G3S3*).

Few of the plant associations are classified as rare for both states. Most are ranked as less common in Idaho than Oregon.

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5.6.
Cultural Resources

5.6.1.
Introduction

Cultural resources consist of prehistoric, ethnographic, and historic sites and remains which may provide knowledge about the past condition and use of the Hells Canyon area. The cultural resources study area extends from Farewell Bend downstream to the confluence between the Snake and Salmon Rivers and 0.1 mile inland from maximum pool level in each of the reservoirs and from the Idaho and Oregon shorelines in the free-flowing reaches.

5.6.2.
Prehistoric Native American Resources

5.6.2.1.
Early research

The prehistory and paleoenvironments of the study area are described in a comprehensive overview of the lower Snake River Basin by Reid (1991*a*). Early research in the study area was conducted by conducted by Alice Fletcher, Harvard Peabody Museum, in the 1890s (Sappington and Carley 1995). Fletcher's Nez Perce informant drew a map of 78 early 19th-century village locations, including several in the study area (Reid 1991*a*). Spinden (1908), also supported by Harvard Peabody Museum, wrote an ethnography of the Nez Perce which is still used by study area scholars (Reid 1991*a*). Early research continued in the late 1940s under the auspices of the Smithsonian Institution/National Park Service River Basin Surveys (Reid 1991*a*) which included projects by Shiner (1951) and Caldwell and Mallory (1967). These projects were so underfunded and done so quickly that the archaeological resources were seriously underestimated (Sprague 1984, quoted in Reid 1991*a*). For example, Shiner's survey did not locate the Nez Perce villages in the Oxbow area, including a village site at Indian Creek (10-AM-72), which had been mapped by Fletcher's informant 50 years earlier. Nevertheless, early researchers established Native American village locations and developed the regional cultural chronologies upon which contemporary research is based.

5.6.2.2. Cultural and Geochronology

Both earlier and contemporary researchers have been concerned with the development of cultural chronologies (Figure 5-6). With some minor modifications, the Leonhardy and Rice (1970) chronology for the lower Snake region still serves as a temporal framework for current research (Reid 1991*a*). The sequence begins with the Windust Phase (ca. 10000 to 8000 BP), characterized by short-bladed stemmed projectile points, probably propelled by spear throwers (atlatls); antler tools indicating the use of tailored skin clothing; the exploitation of deer, elk, pronghorn, rabbits, and mussels; and some use of rock shelters. The following Cascade Phase (8000 to 5000 BP) is characterized by large, lanceolate projectile points below Mazama ashfalls (i.e. prior to 6700 BP) and by large side-notched Cold Spring points above Mazama ash; atlatl weights; keeled and tabular scrapers; grinding stones, manos and other seed processing tools; a subsistence base which included river mussels, salmon, steelhead, serviceberry, camas, lomatium, and grass seeds in addition to the fauna exploited during the Windust Phase; the appearance of such specialized sites as the Stockhoff biface workshop (Womack 1977), outside of Hells Canyon; regular use of rock shelters such as the Bernard Creek Rock Shelter, in Hells Canyon (Randolph and Dahlstrom

1977); in general the subsistence-settlement pattern was similar to that of the ethnographic Nez Perce according to Bense (1972, quoted in Reid 1991*a*). The succeeding Tucannon Phase (5000 to 2500 BP) is characterized by contracting stemmed or corner-removed triangular blade dart points; net sinkers and shuttles indicating net-making; hopper mortars and pestles suggesting root-crop processing. Bighorn sheep were now exploited in addition to the fauna of the preceding Cascade Phase, and anadromous fish are the predominant fish species harvested (Reid 1991*a*). The following Harder Phase (2500 to 700 BP, or 500 BC to AD 1300) may have witnessed the establishment of the first large pithouse villages on the lower Snake (Leonhardy and Rice 1970, quoted in Reid 1991*a*). The late prehistoric Piqunin Phase (after ca. 700 to before 200 BP, or after AD 1300 to before AD 1700) are characterized by small corner and basal notched projectile points, twined basketry, bone awls, matting needles, and harpoon elements (Reid 1991*a*). The final Numipu phase (AD 1700 to AD 1858 to 1863) corresponds to the ethnographically known Nez Perce and Palus (Reid 1991*a*). Reid (1991*b*) subdivides the Numipu phase into a protohistoric subphase (AD 1700 to 1805) and an historic/ethnographic Nez Perce phase after AD 1805. The Numipu Phase probably saw the arrival of northern Great Basin Numic speakers in Hells Canyon. Ethnographic data indicates that incessant warfare existed between the Penutian-speaking Nez Perce, Cayuse, and Sahaptins who lived in the region and the Numic-speaking Shoshone, Bannock, and Northern Paiutes from the northern Great Basin (Fletcher *n.d.*, Reid 1988, quoted in Reid 1991*b*).

Geochronology has also been a critical concern for contemporary Hells Canyon researchers. For example, recent research has estimated that there have been 40 or more floods in the lower Snake between 15,300 and 12,700 BP backed up from glacial Lake Missoula (Waitt 1985, quoted in Reid

1991*a*). Two paleosols at Pittsburg Landing have been dated to more than 7340 ± 90 BP and 5620 ± 90 (Reid 1991*a*). Two later paleosols at Pittsburg Landing have been dated to 3750 ± 90 BP and 3110 ± 80 BP (Reid 1991*a*). Two regional ashfalls attributed to the Mount Mazama eruption have been dated to 7015 ± 45 BP and 6845 ± 50 BP (Bacon 1983, quoted in Reid 1991*a*). Landslides have also been identified in the study area. For example, slides occurred at Rush Creek between 15,000 to 14,000 BP and 6700 BP, possibly blocking the Snake at Rush Creek and creating a lake 60 km (37 miles) to 70 km (43 miles) long (Gibson *et al.* 1990, quoted in Reid 1991*a*).

Other contemporary research concerns listed by Reid (1991*a*) include lithic technology (Muto 1976), archaeofaunas (Schroedl 1973, Lyman 1976), archaeo-stratigraphy (Hammatt 1977), the development of a new approach after 1975 which postulated the predominance of "broad-spectrum foragers" during the early and mid Holocene, "semisedentary foragers", and protohistoric "equestrian foragers" (Schalk 1983) following Binford's (1982) lead.

5.6.2.3. Archaeological sites

Several archaeological sites have been investigated in the study area. For example, in the Brownlee Reservoir area, Caldwell and Mallory (1967) excavated the Robinette Village (35-BA-5), an open site dated from ca. AD 500 to AD 1750 to 1800, and Robinette Cave (35-BA-3), a rock shelter. In Oxbow Reservoir, the Ray Site (35-BA-23) contained several stone-lined pits of uncertain function (Caldwell and Mallory 1967). In Hells Canyon Reservoir, the McGraw Creek site has three houses dating to the period ca. 500 BC to AD 1500 (Warren *et al.* 1968); the Big Bar Site (10-AM-1) was excavated, recovering four housepits and is dated between ca. AD 500 and ca. AD 1750 to 1806

(Caldwell and Mallory 1967, Pavesic *et al.* 1964). Excavation of the Allison Creek Rock Shelter (10-AM-201) yielded cache pits, hearths, and food processing artifacts, and is not securely dated.

5.6.2.3.1. *Hells Canyon Archaeological District*

The area between the present site of Hells Canyon dam and the Salmon River confluence has the richest archaeological remains of the study area. According to Idaho State Historic Preservation Office (SHPO) records, there are 12 recorded sites between Hells Canyon Dam and Oxbow Dam while there are 438 recorded sites between Hells Canyon Dam and the Salmon River. One hundred fifty-four historic and 384 prehistoric sites located in the first 68 miles below Hells Canyon Dam have been incorporated into the Hells Canyon Archaeological District (Torgeson 1972). This district extends about 13 miles below the Salmon River confluence.

The 154 historic sites in the district include 63 placer and 25 hardrock mines, 27 of which have walls, foundations, or cabin remains; most of the other historic sites are homesteads associated with farming and sheep ranching (Torgeson 1972). Fifteen of the homesteads have structures including dwellings, bars, sheds, or root cellars, many or which are intact; there are 19 sites with irrigation canals; 34 non-mining sites have rock alignments, walls, or corrals; and 45 sites have historic artifacts, mainly farm implements. Other historic sites consist of cemeteries, roads, and trails; an historic petroglyph; and a test shaft for a proposed dam (Torgeson 1972).

The 384 prehistoric sites in the National Register District include 151 rockshelters, 212 open sites, and 21 sites with rockshelters and housepits or other open-site features (Torgeson 1972). Rockshelter sites are highly variegated: some have deep deposits; some occur in multi-shelter sites; 37 have stone tools including grinding implements and 78 sites have lithic debris; 100 have pictographs, the most prevalent characteristic of rockshelter sites, with red pigment; shell and/or bone has been found in 41 sites; and 37 rockshelters have rock walls, rock alignments, and depressions. The most prevalent feature at open sites are housepits (Torgeson 1972). A total of 550 generally saucer-shaped housepits occur at 158 sites in the District; 34 sites have small cache pits, often associated with housepits; rock cairns occur at 15 sites; 98 open sites have stone debris and 42 sites have stone tools; 27 sites have faunal remains; and rock art also occurs at open sites.

5.6.2.3.2. Major archaeological excavations

There have been several major excavations at sites below Hells Canyon Dam. For example, at Hells Canyon Creek Village (35-WA-78), Pavesic (1986) excavated five house depressions and discovered massive rock walls in three of the structures. Excavation of Hells Canyon Creek Rock Shelter recovered evidence of nine occupations dating to 7000 BP (Reid 1991). The Bernard Creek Rock Shelter also has a 7000-year time depth as well as a record of changing subsistence practices (Reid 1991, Randolph and Dahlstrom 1977).

Major excavations at Pittsburg directed by Reid (1991*b*) yielded information on prehistory and paleoenvironments. His work recovered evidence of the Bonneville flood and landslides (Reid 1991*b*); distinguished between various Harder and Piqunin Phase site types including residential bases, field camps, and locations (Reid 1991*b*); and determined that Pittsburg Landing housepits are generally smaller than those associated with matrilocal residence patterns (Reid 1991*b*).

In the Camp Creek/Tryon Creek area, the late Frank Leonhardy conducted excavations at 35-WA-286, a small site with occupations dating to ca. 1500 to 500 BP, and 35-WA-288, a house dating to ca. 1200 BP (Leonhardy and Thompson 1991).

At Kurry Creek, Reid and Gallison (1994) have identified two sealed mid-Holocene living floors which provide insights into subsistence strategies in Hells Canyon between 6000 and 5000 B.P. Apparently, local subsistence diversification rather than storage, exchange, or other economic mechanisms was the central subsistence strategy at that site.

5.6.2.3.3.
Rock art

Rock art studies below Hells Canyon dam have recorded 177 sites in 71 river miles below the dam (Reid 1991*a*). Five major styles have been identified by Leen (1988, quoted in Reid 1991*a*), including shield-bearing figures similar to Fremont designs.

5.6.2.4. Knowledge gaps

In spite of the large number of sites investigated, there are critical gaps in the knowledge of the prehistory of the study area. These include missing and sometimes inaccurate reports of excavations already done; incomplete maps of archaeological sites, reservoir boundaries, and drawdown zones; incomplete paleo-environmental records, incomplete correlations of patterns of cultural change with paleo-environmental change; gaps in the cultural sequence, especially during the Clovis period (11,500 BP - 11,000 BP); inadequate projectile point typologies and seriational studies; and only limited studies of the processes of culture change.

5.6.3. Ethnographic Information on the Nez Perce

Ethnographic information about the study area has been gathered since Lewis and Clark's expedition. Spinden (1908) was the first anthropologist to describe the Nez Perce. The Nez Perce refer to themselves as Numipu. However, outsiders generally use the French translation of "Pierced Noses", a term sometimes used by Lewis and Clark to refer to the group. The term is derived from their practice of piercing their noses to hold a dentalium shell ornament (Spinden 1908). According to Spinden (1908), there were several Nez Perce bands on the Snake River, the southern limit of their occupation being the Imnaha/Snake confluence, at the northern end of the study area. South of this boundary, a buffer zone separated the Nez Perce from their Shoshone enemies (Spinden 1908).

5.6.3.1. Nez Perce material culture

The Nez Perce built mat-covered communal long houses, at least one being 150 feet long with 24 fires for more than 40 families; mat- or skin-covered circular tipis usually sunk 2 feet into the ground, especially for winter; grass- and earth-covered, subterranean circular menstrual lodges 20 feet in diameter, sunken 5 or 6 feet deep into the ground; smaller subterranean men's and boys' lodges, 10 to 12 feet in diameter, sunken 3 feet into the ground; small sweat-houses; and small temporary shelters used on hunting trips (Spinden 1908).

Nez Perce material culture was influenced strongly by Plains culture since the mid-1800s (Spinden 1908). For example, clothing was of general Plains type (Spinden 1908). Artifacts included stone knives, projectile points, pipes, mortars, and pestles; elk antler wedges, horn bows, bone awls, and bone gaming pieces; trade goods consisted of copper, probably from the Plains or Northwest Coast, Mexican silver dollars, and iron used for arrowheads and knives; basketry packs, cooking baskets, and cups and bowls; woven women's hats, mats, and wallets; wooden bowls and horn spoons; fire-hardened wood digging sticks; and fire-drills (Spinden 1908).

Nez Perce musical instruments consisted of rattles, drums, flutes, and whistles (Spinden 1908). Art included pictographs painted with red and yellow ocher, petroglyphs, and combinations of the two techniques (Spinden 1908). Textiles were decorated with many motifs (Spinden 1908).

5.6.3.2. Nez Perce subsistence and settlement

The Nez Perce were hunter-gatherers and ate camas, kouse (e.g. *Lomatium kaus* Wats), bitterroot (*Lewisia rediviva* Pursh), and other roots; various berries, including blackberries (*Rubus macropetalus* Dougl.), chokecherries (*Prunus dimissa* Nutt.), huckleberries (*Vaccinium membranaceum*) and most importantly serviceberries (*Amelanchier* sp.); sunflower (*Helianthus* sp.), *Chenopodium* sp. and grass seeds; lichen and inner tree bark as famine foods; ponderosa pine (*Pinus ponderosa* Dougl.); nuts; several species of fish including blue-backed salmon (*Oncorhynchus nerka* Walb.), Chinook salmon (*O. tschawytscha* Walb.), steelhead salmon (*Salmo gairdneri* Richardson), cutthroat trout (*S. mykiss gibbsii* Suckley), suckers (e.g. *Pantosteus jordani* Evermann, *Catostomus macrocheilus* Girard), and sturgeon *(Acipenser transmontanus Richardson)*; elk (*Cervus canadensis* Erxleben), deer (*Odontocoelus americanus macrourus* Raf. and *O. hemionus* Raf.), mountain sheep (*Ovis cervina* Desmarest) and bison (*Bison americanus* Griff). Outside of the study area, otter, beaver, bear, and ducks were consumed (Spinden 1908).

Hunting and fishing was done with arrows, spears, gorge hooks, traps, fish weirs, decoys, and nets (Spinden 1908). According to Spinden (1908), the Nez Perce acquired horses in 1770. Prior to that time, transportation was by canoe and snowshoe (Spinden 1908).

More recently, Schwede (1966) described the Nez Perce subsistence-settlement system for the pre-contact period (AD 1750 - 1805). Schwede (1966) found that most villages are located at lower elevations than camps, probably because the canyons offered protection from winter weather, most villages are located at the mouths of intermediate streams, and most camps are located near small streams "in mountainous regions at the heads of larger tributaries" (Schwede 1966).

Baenen (1965) describes the contemporary conflict between Nez Perce hunting and fishing rights and the surrounding non-Indian population. He states that the importance placed upon hunting and fishing in traditional Nez Perce culture and the consequent pride that the Nez Perce feel in participating in hunting and fishing is an important element in the conflict (Baenen 1965).

5.6.3.3. Politics and social organization

Warfare with the Shoshone was a frequent event among the ethnographically known Nez Perce (Spinden 1908). There was also some conflict with the Blackfoot and Crow to the east on the Plains and the Spokane and Coeur d'Alenes to the north. Spinden (1908) was not able to ascertain the extent of Nez Perce pre-horse warfare. Arrows poisoned with rattlesnake venom, clubs, hide shields, and armor were used in warfare (Spinden 1908).

Nez Perce social divisions were based on village locations: each village elected war and peace chiefs, and had its own fishing place and its own zone along the river (Spinden 1908). Village groups cooperated for warfare but this relationship did not continue during peacetime (Spinden 1908). There were tribal and intertribal councils composed of chiefs and elders which discussed village administration, war, and peace, and ratified treaties in which decisions were based on unanimous agreement (Spinden 1908).

Oratory was an important part of Nez Perce culture (Spinden 1908). Chief Joseph's surrender speech, one of the most moving orations in American history, is a striking example:

> "*I am tired of fighting. Our chiefs are killed. Looking Glass is dead. Toohulhulsote is dead. The old men are all dead. It is the young men who say yes or no. He who led the young men is dead. It is cold and we have no blankets. The little children are freezing to death. I want to have time to look for my children and see how many of them I can find. Maybe I shall find them among the dead. Hear me my chiefs, I am tired. My heart is sick and sad. From where the sun now stands I will fight no more forever.*"

Individual property consisted of a person's tools, weapons, slaves, and horses while the long-house and fishing places were communal property (Spinden 1908). With the exception of meat gathered in large hunts, all fresh meat was owned by the hunter; and it was the chief's responsibility to see that all of his subordinate families provided for themselves lest they become a communal responsibility (Spinden 1908).

5.6.3.4. Religion and Ceremonialism

The dead were usually buried "within sight of the village," poles and then stones were piled on graves with grave ornaments consisting of personal property and sometimes sacrificed horses (Spinden 1908). Houses were moved after the death of one of the occupants (Spinden 1908). This has obvious implications for estimations of prehistoric population from housepit numbers.

Shamen had significant influence in Nez Perce culture. The shaman's power was obtained at a sacred vigil (Spinden 1908). A shaman's duties included exorcising ghosts, curing the sick, bringing warm weather, inflicting disease or misfortune, and taking a leading part in ceremonies (Spinden 1908).

In addition to the shaman's assistance, sweat baths were important in curing diseases; medicinal herbs were also used (Spinden 1908).

According to Spinden (1908), Nez Perce religion was animistic: they believed that both good and evil spirits dwelled in trees, hills, and rivers, among other natural objects. The sun was believed to be the source of wisdom and a benefactor of shamans and chiefs; Coyote was a super-hero to the Nez Perce (Spinden 1908).

5.6.3.5. Relations with other groups and cultures

Because of the presence of equal numbers of Plains and Pacific Coast culture elements, Spinden (1908) felt that Nez Perce culture was transitional between Plains and Pacific Coast culture. There were intertribal dances and public ceremonies among the Nez Perce, Yakima, Wallawalla, and Umatilla at both irregular and regular intervals, sometimes accompanied by gaming and horse-racing (Spinden 1908).

5.6.4. Historic cultural resources

Despite its isolation, Hells Canyon was occupied during historic times by explorers, fur trappers, miners, riverboat operators, townspeople, homesteaders, the USFS, and eventually the hydropower industry.

5.6.4.1. Exploration

Early Anglo-European exploration of Hells Canyon began in 1806 when Lewis and Clark entered lower Hells Canyon on their return from the Pacific. Three members of the party, John Ordway, Robert Frazier, and Peter Wiser, who gave his name to the town and river of Weiser, may have visited the confluence of the Snake and Salmon Rivers at this time (Carrey *et al.* 1979).

5.6.4.2. Trapping

Fur trappers with the Wilson Price Hunt party of John Jacob Astor's Pacific Fur Company entered Hells Canyon on December 3, 1811 at the confluence of Wolf Creek and the Snake, about 25 miles upriver of the present location of Brownlee Dam (Carrey *et al.* 1979), eventually camping at the Oxbow (Beal and Wells 1959, Vol. I). The party had a terrible trip downstream on the Snake from Henry's Fork, and their fortunes did not improve: men had drowned upstream and in the Canyon, weather was very cold and snows were deep, the party was starving, horses fell to their death, some horses were eaten, river currents were violent, and canoes and gear were lost.

Donald McKenzie, a veteran of the Hunt Party expedition, returned to Hells Canyon in 1819 (Carrey *et al.* 1979, Beal and Wells 1959). McKenzie and six French-Canadian *voyageurs* began an upstream trek of the Snake from its confluence with the Columbia in search of a fur trading corridor to the Upper Snake River territory. After this experience it was decided that overland trade routes would be more practical, an opinion shared by Peter Skene Ogden of the Hudson's Bay Company (Carrey *et al.* 1979).

Captain Benjamin Louis Bonneville penetrated Hells Canyon as far downstream as Thirtytwo Point Creek, about 4 miles downstream from Big Bar, in 1833. The apparent purpose of his four-person expedition was to reconnoiter Hudson's Bay Company fur trapping territory (Carrey *et al.* 1979).

5.6.4.3. Mining

There were several historic mines in the study area (Carrey *et al.* 1979; Lindgren 1901, Livingston and Laney 1920, Parks and Swartley 1961, Swartley 1914). For example, the Seven Devils mining district, located at the top of Kleinschmidt Grade, contains a series of copper deposits (Carrey *et al.* 1979). Levi Allen of the Stubadore Company discovered the Peacock copper lode in 1862 during an expedition up the Snake from Lewiston (Carrey *et al.* 1979).

Placer mining was going on in the canyon proper during the 1880s (Carrey *et al.* 1979).

Work at the Iron Dyke copper mine near Homestead, Oregon was begun in 1896 (Carrey *et al.* 1979). By 1917, Iron Dyke had the largest copper concentrator in the state. At the peak of production, about 150 men worked at the mine. Between 1910 and 1934, the Iron Dyke produced 34,000 ounces of gold, 256,000 ounces of silver and 14,000,000 pounds of copper (Carrey *et al.* 1979). The mine closed at the beginning of World War II.

The Blue Jacket Mine, located on Indian Creek, was a contemporary of the Iron Dyke Mine (Carrey *et al.* 1979). In 1885, Blue Jacket was owned by Albert Kleinschmidt as were the Queen and Alaska claims, also on Indian Creek (Carrey *et al.* 1979). Ironically, Blue Jacket ore was smelted at Anaconda, Montana rather than across the river at Iron Dyke where Blue Jacket's own smelter had been relocated successfully after failing at its original location.

Other mines in Hells Canyon include the River Queen mine, located on the Idaho side below Ballard Creek, operated between 1912 and 1940 (Carrey *et al.* 1979). Claims at the Red Ledge copper mine at Eagle Bar were first staked in 1894 (Carrey *et al.* 1979). In the 1920s, miners built a schoolhouse in Schoolmam Gulch, below Squaw Creek to serve approximately ten students (Carrey *et al.* 1979). Mining was suspended with the outbreak of World War I but resumed thereafter. As of 1979, although no ore had yet been produced, the 1,500 acre Red Ledge mine consisted of several patented and unpatented claims and millsite claims; 2,400 feet of tunnels; and 16,000 feet of drilling (Carrey *et al.* 1979). This work resulted in a preliminary definition of the ore body as a large, low-grade copper and zinc lode.

5.6.4.4. Transportation

Mining activity resulted in the construction of the Kleinschmidt Grade, built by Albert Kleinschmidt between 1889 and 1891 (Carrey *et al.* 1979). The road connected the Peacock Mine to the Snake so that ore could be shipped by steamboat up river to the Huntington or Olds Ferry railheads.

Mining also served as the main impulse for several attempts to navigate the canyon by steamboat. Navigation of the Snake between Lewiston and Fort Boise, the confluence between the Boise and Snake Rivers, became an important issue in 1862 with the discovery of gold in the Boise Basin

(Carrey *et al.* 1979). A scouting party sent from *Lewiston* on September 20, 1862 reported that shallow draft steamer navigation from *Lewiston* to Fort Boise was feasible. The aim of this endeavor was to develop a faster route from *Lewiston* to the Boise Basin than the overland route through the Blue Mountains. It was hoped that this new route would divert the Boise Basin trade from Salt Lake City to *Lewiston*. The scouting reports were optimistic in the extreme.

In 1865, competition for mining-related trade routes between Idaho and California led to attempts by the Oregon Steam and Navigation Company (O.S.N.) to establish steamboat service from *Lewiston* upstream to Owyhee Ferry (Carrey *et al.* 1979). The 110-foot long steamer *Colonel Wright* attempted the voyage in June of 1865 but was turned around and nearly wrecked in a bad eddy about 25 miles upstream from the Salmon River confluence.

Another attempt to navigate Hells Canyon took place in 1869 to 1870. In June of 1869, the steamboat *Shoshone* departed from Owyhee Ferry to descend the Snake to Lewiston and beyond (Carrey *et al.* 1979). The ship used hawsers to negotiate rapids below Brownlee Ferry and then wintered in the Canyon near Steamboat Creek while awaiting supplies, fuel, and possibly higher water. The journey was resumed in April 1870, but nearly ended in disaster at Copper Ledge Falls, near the present location of Hells Canyon Dam. At this point, an error in navigation resulted in a collision with the rocks which caused serious damage to the vessel. The damage was repaired and the voyage was resumed the next day. Several other bad rapids were negotiated, the ship was stopped many times for repairs and to cut wood for fuel. During one of these fueling stops, Captain Sebastian Miller was nearly killed by a rolling tree. Despite these harrowing experiences, the *Shoshone* arrived in Lewiston on April 27th. The *Shoshone* did not return to Hells Canyon.

In 1891, further attempts were made to navigate Hells Canyon by steamboat (Carrey *et al.* 1979). Albert Kleinschmidt built the grade which bears his name from the Seven Devils down to the Snake River in order to ship copper ore to the Union Pacific (Oregon Short Line) railhead at Huntington, Oregon. The 165-foot-long, 300-ton capacity steamship *Norma*, named after Kleinschmidt's daughter, was built near Huntington. The *Norma* made only two trips. Kleinschmidt's mining fortunes declined, the price of copper dropped, and the panic of 1893 temporarily halted additional attempts to develop navigation. Also, steamer passage was impeded by the Oregon Short Line's railroad bridge upstream from Huntington.

In 1903, the steamboat *Imnaha* was built at Lewiston to support copper mines at the mouth of the Imnaha River (Carrey *et al.* 1979). Lining rings implanted at various rapids to assist in navigation were used until dangerous rocks could be dynamited. The *Imnaha* navigated the Canyon 14 times until it was wrecked in Mountain Sheep Rapid on November 9, 1903.

Regular transportation service on the Snake began in February, 1910 with Ed McFarlane's steel-hulled, gasoline engine *Flyer* (Carrey *et al.* 1979). Early trips were made between Lewiston and the mouth of the Grande Ronde. Within one year, the *Flyer* was reaching Defiance Eddy, 4 miles upstream of Pittsburgh Landing. A second boat, the *Prospector*, was added in 1912. In 1914, river navigation was improved with the blasting of several rocks in the river channel. The first regular mail run in the Canyon was begun in 1919 (Carrey *et al.* 1979).

There were several ferry crossings in Hells Canyon. For example, there was a cable ferry that crossed the river from Robinette (Carrey *et al.* 1979). The Brownlee Ferry transported cattle from the Idaho side to Oregon so that they could winter near Halfway (Carrey *et al.* 1979). Brownlee Ferry operated after the 1860s. There was a ferry at Ballard Creek, across from Kleinschmidt Grade from about 1893 until 1926 when a bridge was constructed (Carrey *et al.* 1979).

Railroad connections to the Hells Canyon area from Wyoming were surveyed in 1864 by the Northwestern Railroad Company, a subsidiary of the Union Pacific. The section from Grange, Wyoming to Blake’s Junction, east of Huntington, was called the Oregon Short Line (Carrey *et al.* 1979). The original intent of the survey was to map a railroad route through the Canyon to *Lewiston*. In 1905, an extension of the route was surveyed through Robinette and Copperfield to Homestead. Construction began in 1907.

The development of railroads in Hells Canyon proper began in 1911 (Carrey *et al.* 1979). On October 3, 1911, the Northwestern Railroad Company sent six boats containing a survey party from Homestead. Hells Canyon took its usual toll: one man died of pneumonia, boats were swamped several times and gear was lost. Part of the voyage was made on the *Flyer*, mentioned above. The party finally arrived in *Lewiston* on the river January 13, 1912. There were no immediate results of this trip: it was determined that railroad development would have been cost-effective at that time.

5.6.4.5.
Urban development

Urban development was interconnected with the growth of mining, railroads, and early hydropower development in Hells Canyon. The development of Copperfield, one of the wildest towns in the region, began shortly before the turn of the century (Carrey *et al.* 1979). In 1897, the 160-acre Copperfield Ranch was established. The land was sold in 1906 to commercial interests who learned of railroad and Idaho-Oregon Light and Power Company's hydropower plans for the nearby Oxbow area. The Copperfield townsite was platted by 1908.

Copper mining, railroad construction, and hydropower development created a boom town shortly thereafter. By 1907 there were saloons, brothels, a post office, boarding houses, a jail, and other buildings. A school and railroad depot were in operation by 1909. Church and hospital services were performed in less permanent structures. A suspension bridge across the river was built in 1911 but was destroyed by a flood in the early 1920s.

At the peak of the Copperfield boom there were about 700 men employed, many with permanent jobs. Another 400 people lived in the area and supported the town with farming, ranching, and other activities. After-hours pursuits of drinking, gambling, whoring, and brawling flourished with such vigor that the town was described as "no place for a Presbyterian" (Carrey *et al.* 1979) and "Gomorrah on the Snake" (Carrey *et al.* 1979).

Oregon Governor Oswald West sent his secretary, attorney Fern Hobbs, along with an armed escort, to Copperfield in 1914 to reform the town. Reform efforts succeeded: the town's questionable emporia were closed by the governor's orders. Ms. Hobbs returned to Salem, leaving the armed guard. Legal challenges to these reform efforts failed. Also, the town's population declined precipitously: by 1914 there were only 32 voters registered (Carrey *et al.* 1979). The Copperfield post office ceased operation in 1927. The schoolhouse was dismantled in 1945.

The community of Homestead was established in 1888 to serve the Iron Dyke Mine, just downstream from Copperfield (Carrey *et al.* 1979). A second schoolhouse was built in 1918 where two teachers taught 30 to 40 students that year. At its peak, Homestead had two stores, a post office, a gas station and a meat market. The town declined when the railroad tracks were removed with the start of dam construction at Oxbow. School and postal services were transferred to Oxbow.

The town of Robinette was platted in 1910 in the hopes that the railroad would be extended from Huntington (Carrey *et al.* 1979). The town's economy was dependent upon mining, timber, the railroad, and ranching. The town was flooded in 1958 by Brownlee Reservoir.

5.6.4.6. Homesteads

There are several early homestead and cabin sites in Hells Canyon (Carrey *et al.* 1979). These include Oxbow Village, settled in the 1870s; Pine Creek where there was a cabin in 1888; Wildhorse Creek, homesteaded in 1910; and the mouth of Black Canyon Creek, settled in 1911.

Other sites listed by Carrey *et al.* (1979) included Spring Creek, which was farmed in 1926; Big Bar, where agricultural terraces are still visible on the Idaho side, was farmed for fruit and vegetables to serve the Seven Devils, Landore, and Cuprum mining camps in the 1890s; Steamboat Creek, just above Hells Canyon Dam, was the site of a cabin, garden, and peach orchard in the 1890s; Stud Creek, just below the Hells Canyon Dam site, where there was a cabin in 1910-11; Lamont Creek, where there was a tent-cabin in 1905-06; Chimney Bar, where there was a dugout cabin with a stone fireplace and chimney in the 1890s or before; and Battle Creek, which was homesteaded between 1910 and 1938.

On Granite Creek, there was a cabin prior to 1909, a log house in its place in 1909, and eventually a blacksmith shop and root cellar. There is also a black powder magazine constructed of rock and earth against a bluff at the Granite Creek campsite. A homestead entry was filed for Granite Creek in 1911 and patented 10 years later. There was a ranch at Granite Creek until 1976 when it was incorporated into the HCNRA (Carrey *et al.* 1979).

Other homestead and cabin sites mentioned by Carrey *et al.* (1979) include Three Creeks, settled in 1899, where a 14-foot by 20-foot log house, a frame house, a barn and irrigation ditches were constructed but no structures remain; Saddle Creek, and its tributary, Rough Creek, settled in 1895; Bernard Creek, settled in 1901 and patented in 1906, where a bunkhouse and two cabins were built; Bills Creek, homesteaded, with cabins constructed, between 1905 and ca. 1911 and again from ca. 1912 to 1927; Sluice Creek, where a dugout cabin was built in the early 1880s as part of a cow camp, twin cabins were built in 1909, and school was taught in a walled tent in 1922; Rush Creek, where a cabin was occupied between 1920 and 1924; Pony Bar was homesteaded in 1913; Johnson Bar, filed in 1911 and again in 1914 after which a stone house, stone fences, and a rock corral were constructed; Sheep Creek, settled in 1884 and filed in 1913, where a stone cabin was constructed in ca. 1884 and where there was a substantial house in 1925; Hutton Creek has a root cellar and collapsed cabin that predates the late 1930s; Caribou Creek and Little Bar, the site of a sheep operation beginning in 1921, had a shearing shed, a bunkhouse, and a cellar until the late 1940s; and Myers Creek and Big Bar had a rock cabin in the early 1900s and is related to the Brownlee Shooting, an incident written about by Mark Twain.

Carrey *et al.* (1979) list several other homesteads in the remainder of the study area, including the Jordan Homestead at Kirkwood Bar, home of Idaho Governor and later U. S. Senator Len B. Jordan (Jordan 1954).

5.6.4.7.
Forest management

The USFS has had an active role in Hells Canyon. For example, many of the homesteads listed above reverted to USFS ownership, trails were built through the Canyon (Carrey *et al.* 1979), and the HCNRA was created on December 31, 1975.

5.6.4.8.
Hydropower development

Commercial hydropower development began in 1908 with the initiation of construction at the Idaho-Oregon Light and Power Company's plant at the Oxbow (Carrey *et al.* 1979, Stacy 1991). Construction of diversion tunnel was completed in 1909. Financial problems reduced the power output from the originally planned 24,000 kW to 600 kW (Carrey *et al.* 1979). The present Oxbow Dam, which incorporates the original diversion tunnel, was completed in 1961 as part of the three-dam Hells Canyon Complex. The entire complex, consisting of the Hells Canyon, Oxbow, and Brownlee Dams, was dedicated in 1968 (Stacy 1991).

5.6.4.9. Recreation

A early "recreational" use of Hells Canyon was Amos Burg and John Mullins' canoe descent in 1925 (Carrey *et al.* 1979). Burg repeated the trip by canoe in 1929 and by rubber raft in 1946.

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5.7. Recreational Resources

5.7.1. Study Area and Recreation Use

5.7.1.1. Introduction to the Study Area and Recreation Use Associated with the Three Hells Canyon Complex Reservoirs

Generally, the recreation study area for the Hells Canyon Complex begins approximately 8 miles downstream and west of the town of Weiser, Idaho and continues downstream along the Snake River corridor to the northern boundary of the HCNRA for a total of 167 miles (Figure 2-1). The scope of the study area was determined by the Recreation and Aesthetic Resources Work Group, which is made up of representatives from IPC and various federal, state and local agencies and interest groups in a collaborative process of decision making. The river corridor is the primary area of focus for recreation studies; however, the study area differs among the various recreation studies with some study areas extending to the canyon rim or beyond. The Hells Canyon Complex lies within multiple recreation regions in Idaho and Oregon including the northcentral and southwestern regions in Idaho (Idaho Outdoor Recreation Plan 1990), and the northeast and southeast regions in Oregon (Oregon State Comprehensive Outdoor Recreation Plan 1991).

Hells Canyon is considered the deepest gorge in North America and attracts a wide variety of tourists and recreational visitors. The four-season climate in the study area offers a multitude of outdoor recreation opportunities. Some of the more popular activities include: fishing, whitewater and reservoir power boating, float boating, camping, sightseeing (natural and historical), picnicking, water skiing, hiking, hunting, and plant and animal viewing. Idaho State Highway 71 from Cambridge provides access to the lower end of Brownlee Reservoir and also to Oxbow and Hells Canyon Reservoirs. Interstate 84 is adjacent to the upper end of Brownlee Reservoir for several miles along eastern Oregon with several exits allowing access to the reservoir. Multiple primary and secondary roads also provide access to the upper end of Brownlee from the towns of Weiser, Farewell Bend, Huntington, and Richland. There are several developed camping facilities within the study area that provide electrical hookups, water, bathrooms, and shower facilities for a fee. Other camping facilities provide a more primitive experience, having only vault toilets and/or a public water source. A wide array of dispersed camping opportunities also exists within the study area.

The three reservoirs within the Hells Canyon Complex provide some of the most diverse fisheries in the Northwest. Brownlee Reservoir is one of the most popular fishing destinations in Idaho and Oregon. The upper end of the reservoir provides abundant catfishing opportunities with the lower end yielding thousands of crappie fillets. This area also provides ample bass fishing and hosts bass fishing tournaments on a regular basis throughout the spring and summer months. Crappie, bluegill, flathead catfish, channel catfish, smallmouth bass, largemouth bass and yellow perch are available to anglers from March through November, while rainbow trout are usually biting from September to June. Oxbow and Hells Canyon Reservoirs provide excellent angling opportunities as well. Below Hells Canyon Dam, ocean-going steelhead trout can be caught from fall through spring. It is not uncommon for these fish to reach seven to ten pounds. This lower section of the Snake River also provides angling opportunities for the largest of all American freshwater fish, the white sturgeon. These fish can attain lengths of more than 10 feet.

In 1991, IPC submitted FERC Form 80 Recreation Use Reports to the FERC, detailing estimated recreation use figures for Project No. 1971. During 1990, IPC reported an estimated annual total of 890,500 visits to the Hells Canyon Complex. Of that total, 474,800 visits were to Brownlee Reservoir, 155,000 visits to Oxbow Reservoir and 260,700 visits to Hells Canyon Reservoir.

The BLM, Vale District, Baker RA, Oregon and Boise District, Cascade RA, Idaho have proposed recreation area management plans and environmental assessments pertaining to Brownlee, Oxbow and Hells Canyon Reservoirs. The purpose of the plans is to develop management strategies for recreation use with coordinated interagency efforts. Each BLM plan includes a description of proposed facility developments and priorities. Both plans focus primarily on water-based recreation facilities with trails and overlooks adjacent to the reservoirs. At this time, neither plan has been finalized.

IPC signed a Memorandum of Understanding (MOU) with the BLM Lower Snake River District, Idaho and the Vale District, Oregon in 1996. The MOU states that "The purpose of this MOU is to provide for the continuing public use and enjoyment of the Brownlee, Oxbow, and Hells Canyon Reservoirs and adjacent public and IPC lands, and to promote protection of recreational resource values while considering environmental, aesthetic and cultural resource values."

The IDFG conducted a creel survey between February and November of 1970 and determined there were 64,068 hours of angler use on the Brownlee Reservoir (Goodnight 1971). In cooperation with the ODFW, IDFG completed another creel survey in 1989 and indicated that use increased to 792,600 angler hours for the same time of year (Mabbott and Holubetz 1990).

The Oregon State Marine Board reported that boat use in Oregon increased by 67 percent from 1982 to 1992, while the state's population increased by 12 percent during the same period (Oregon State Marine Board 1993). In 1992, there were an estimated 89,841 boat use days in Baker County, compared to 63,214 in 1989 (an increase of 30 percent).

5.7.1.2. Introduction to the Study Area and Recreation Use Associated with the HCNRA

On December 31, 1975, Congress established the HCNRA in west-central Idaho and northeastern Oregon. Its 652,488 acres straddle Hells Canyon of the Snake River, from the peaks of Idaho's Seven Devils Mountains on the east, to Oregon's rimrock and mountain slopes on the west (Figure 2-1). The recreation area was created to preserve the free-flowing character of the Snake River in Hells Canyon for future generations and to protect archaeological, historical and ecological values. It was also established to enhance recreation opportunities and public enjoyment of the area. The area is generally undeveloped and remote with only a few campgrounds and maintained roads.

To assure the protection and continuation of free-flowing waterways, Congress created the National Wild and Scenic Rivers System. A 67.5-mile reach of the Snake River within the HCNRA is divided into two distinct classifications: *wild*, the 31.5 miles from Hells Canyon Dam to Pittsburg Landing; and *scenic*, the 36.0 miles from Pittsburg Landing to the northern boundary of the Wallowa-Whitman National Forest. The balance of the river within the HCNRA, to Asotin, Washington is in “study” status.

The Wild and Scenic Snake River Corridor extends approximately one-quarter mile beyond the high water mark on each shore. Although in places the river corridor neighbors the Hells Canyon Wilderness, the corridor itself is not wilderness and wilderness regulations do not apply. Developed campsites, man-made structures and some motorized equipment may be found in the river corridor. The Hells Canyon Wilderness was designated by Congress to protect the wild character of the area. To help safeguard the naturalness of the wilderness, some activities, such as the use of motorized equipment, mechanized transportation and building of structures, are not allowed. Exceptions allow quick response to emergencies and administration of the area. Permits are required for all boating on the Wild and Scenic Snake River during the high-use season (Memorial Day week through September 10). Permits are not required for non-commercial boating during the remainder of the year (USDA Forest Service, 1994*b*).

In April of 1992, the Hells Canyon Scenic Byway, a series of interconnected travel routes to and through the HCNRA on the Wallowa-Whitman National Forest, was added to the National Forest Scenic Byway System. This is a cooperative venture between the USFS and Oregon Department of Transportation. The series of routes include State Highway 82 from Baker City over the Wallowa Mountains to Enterprise and La Grande, the road to the Hells Canyon Overlook, the Hat Point Road and the Imnaha River Road. The Snake River Road, from Oxbow to Hells Canyon Dam, is being considered for possible inclusion. National recognition has been given to this series of routes because of its outstanding scenery and its recreational, historical, educational and cultural significance.

Recreation visitation has experienced a dramatic increase during the past decade in the HCNRA, rising by more than 147 percent during the primary season from 1979 through 1991 (USDA 1994*b*). The process of developing a comprehensive plan for river recreation began in earnest in 1988 when the USFS decided to evaluate and revise the current recreation management plan for the Wild and Scenic Snake River. It is USFS policy to examine use trends periodically and make adjustments to the management plan if necessary. The USFS determined that the increase in use was affecting the recreation experience being provided. Concern for maintaining the Hells Canyon resource and reducing visitor conflicts spurred a new planning effort resulting in a draft recommendation in 1992 (The Hells Canyon Limits of Acceptable Change Planning Task Force 1991).

A visitor study was conducted by the University of Idaho, Department of Wildland Management, to describe the people who use the Snake River for recreation in the HCNRA, how they use the river, and to identify their management preferences and perceptions of the river. The emphasis was on float and power boat users, but participants in land-based river activities were also included (Dept. of Wildland Rec. Manag., University of Idaho 1989).

In 1994 the Final Environmental Impact Statement (FEIS) for the HCNRA was completed by the USFS. Based on the analysis contained in the FEIS, the Forest Supervisor was to decide whether or not to implement the proposed action, which was developed through a Limits of Acceptable

Change (LAC) planning process, or to implement one of six alternative actions (USDA 1994*b*). The proposed and alternative actions involved varying levels of restrictions on the use of the HCNRA for overnight and day use and the use of private and commercial powerboats, floatcraft, personal watercraft and aircraft. A decision to implement Alternative C (different than that proposed by the LAC Task Force), with modifications, was made on September 11, 1996 by the Forest Supervisor. The decision was scheduled for implementation beginning in the 1997 primary season. A 45-day appeal period followed this decision.

In 1995, IPC developed a MOU with the Wallowa-Whitman National Forest. The MOU states that "This agreement will establish a framework upon which local Forest Service officials and Idaho Power officials may cooperatively exchange biological survey information, and recreational/visitor use data that now exists and will be collected in the upcoming years."

5.7.2. Existing Recreational Facilities

Ten camping facilities offering a variety of amenities are located within the project area. Of these, four are owned by IPC, two by the BLM, one by the State of Oregon, one by Baker County, and the remaining two by private entities.

5.7.2.1. Description and Location Of IPC's Recreation Facilities Associated with the Three Hells Canyon Complex Reservoirs

All IPC parks have full-time maintenance personnel, and fees are assessed for overnight camping. Park rules and regulations are posted in all parks. Public telephones are available at all facilities.

Informational, historical, and interpretive signs are present at various locations throughout the parks and the Hell Canyon Complex. All park facilities are open from April through September, with only portions of facilities open for the remainder of the year.

Hells Canyon Park

Hells Canyon Park is located on the Idaho side of Hells Canyon Reservoir and is a day/night use recreation facility. It is landscaped with 15 acres of turf, shade trees and a paved road through the park. Included are restroom facilities with showers, 24 electrical hookups for recreational vehicles (RVs), four electric pedestals for recharging boat batteries, water hookups, picnic tables, barbecue stands, numerous tent spaces, a sanitary dump station for RVs, a concrete boat ramp and boat docks.

Copperfield Park

Renovated in 1989, Copperfield Park is located on the Oregon side of Hells Canyon Reservoir near the community of Oxbow, and is a day/night use recreation facility. There are six acres of turf, paved roads, terraced landscaping and numerous trees throughout the park. There are 62 RV sites with electricity, water, fire pits and picnic tables. The park also has ten tent camping sites with picnic tables and barbecues. There are restroom facilities with showers. A sanitary dump station and additional vehicle parking are available.

Copperfield Boat Ramp Facility

The Copperfield boat ramp facility, constructed in 1994, is located approximately one mile downstream of Copperfield Park, on the Oregon side of Hells Canyon Reservoir. Facilities include a two-lane concrete boat ramp, boat docks, parking, garbage receptacles, and portable toilets (available seasonally).

Oxbow Boat Launch

The Oxbow boat launch is a day-use-only site and is located on the Oregon side of Oxbow Reservoir on a narrow strip of land adjacent to Highway 71. Facilities include a gravel boat ramp, docks, composting toilet, garbage pickup, and parking.

Carter's Landing

Located on the Oregon side of Oxbow Reservoir, Carter's Landing encompasses approximately 1.7 acres. Facilities are limited to several impromptu camp sites, a composting toilet, picnic tables, garbage pickup, and an unimproved boat launch.

McCormick Park

McCormick Park is located on the Idaho side of Oxbow Reservoir approximately one mile downstream of Brownlee Dam and is a day/night use recreation facility with 12.3 acres of turf, shade trees, restroom facilities with showers, 34 RV sites with electrical and water hookups, picnic tables, numerous tent spaces, barbecues, and a sanitary dump station for RVs. A concrete boat ramp, boat ramp parking and docks are adjacent to the park.

Woodhead Park

Woodhead Park is located on the Idaho side of Brownlee Reservoir and is a day/night use recreation facility. A remodel and expansion of Woodhead Park was completed in the spring of 1995 to enhance camping, parking and boating facilities. A realignment of Highway 71 was necessary to increase park acreage. The park now encompasses 65 acres of turf, shade trees and naturally landscaped areas. There are 124 RV sites with electricity, water, picnic tables, and fire rings. There are also 15 walk-in tent sites with water, picnic tables, and fire rings. Two large picnic areas with shelters can accommodate group gatherings. Woodhead also has restrooms and comfort stations (including showers), a day use area, a waste water treatment lagoon, a fish cleaning station, a four-lane (78 feet wide) boat ramp and a single-lane boat ramp both with docking systems, a boat/trailer parking area, interpretive/information displays, a trail system and paved roads. The four-lane boat ramp was extended in the spring of 1996 to allow reservoir access down to an elevation of 2022 feet (reservoir "full pool" is at 2077 feet).

Impromptu Areas

In addition to the developed parks, IPC maintains a number of impromptu camping and access areas adjacent to project waters and within the project boundary. Available at some are portable toilets, garbage pickup and unimproved boat launching facilities.

5.7.2.2. Description and Location of Non-IPC Recreation Facilities Associated with the Three Hells Canyon Complex Reservoirs

Deep Creek Access Trail

The USFS, IDFG and IPC cooperatively participated in a project to construct and improve the trail from Hells Canyon Dam to Deep Creek in 1989. The trail provides access via a series of metal stairways, landings, railing, and natural surfaces to the Idaho side of the Snake River below Hells Canyon Dam for anglers and other outdoor enthusiasts. The USFS maintains the trail.

Big Bar

The USFS owns this terraced area on the Idaho side of Hells Canyon Reservoir. Limited facilities include vault toilets, interpretative signs, and a gravel boat ramp with docks. Impromptu camping occurs at various locations throughout this site. During 1996, IPC worked cooperatively with the USFS to enhance vault toilets, improve roads, and establish erosion control. The USFS (Payette Ranger District) is presently evaluating future recreational enhancements for Big Bar.

Hells Canyon Trail with Associated Campgrounds

A trail was inundated when Hells Canyon Dam construction was completed in 1967. IPC rebuilt the trail on the Oregon side of Hells Canyon Reservoir. It is now referred to as the Hells Canyon Trail and is presently maintained by the USFS. The area has since received Congressional designation as a Wilderness and developed camp sites located along the trail have been removed with the exception of the following facilities:

- Leep Creek - Near Big Bar, a vault toilet;
- Dove Creek - Downstream of Big Bar, a vault toilet;
- Vermilion Bar - Downstream of Dove Creek, a vault toilet; and
- Lynch Creek - Downstream of Vermilion Bar, a vault toilet.

The toilets are scheduled for removal by the USFS sometime in the future.

OX Ranch

OX Ranch is located adjacent to McCormick Park on the Idaho side of Oxbow Reservoir, just downstream of Brownlee Dam. Access to OX Ranch is via McCormick Park Road. In 1996, owners of the OX Ranch contracted with an outfitter to begin offering commercial horseback riding trips along Oxbow Reservoir during the summer months.

Hewitt/Holcomb Park

Hewitt/Holcomb Park is a day/night use recreation facility located on the Powder River arm of Brownlee Reservoir near Richland, Oregon. It is owned and operated by Baker County. Originally, the lands on which the park was constructed were donated by IPC to a local sporting club which later donated the land to Baker County for recreational development. The park is landscaped with turf and shade trees and also has a paved road and parking area. Included are restroom facilities, RV camp sites with electrical and water hookups, picnic tables, a playground, a fish cleaning station, boat ramps, and numerous docks. A fee is imposed for overnight camping.

Swede's Landing

Located several miles upstream of the Powder River arm on the Oregon side of Brownlee Reservoir, Swede's Landing is owned and maintained by the BLM. Swede's Landing covers approximately three acres and provides impromptu camp sites, a vault toilet, and an unimproved boat ramp. The BLM plans to install an additional vault toilet in 1997 and add gravel to the existing parking area and boat ramp as part of a cooperative effort with IPC.

Big Deacon Creek

Big Deacon Creek is privately owned and is approximately five acres in size. This site provides some graveled pads for RV parking, a primitive boat ramp, and a dock. This site is also used by Mountain Man Resort as an Oregon-side access point to their facility by boat.

Mountain Man Resort and Marina

Mountain Man Resort is a privately owned facility located on the Idaho side of Brownlee Reservoir, 32 miles northwest of Weiser. The resort is part of a 38,000-acre ranch and is accessible via Rock Creek Road, which is maintained by Washington County. The lodge accommodates up to 34 people for overnight stays and provides a meeting room and meals.

Primitive camping facilities and teepees are also available for overnight use for a fee. Guided hunting and fishing are offered on a private shooting preserve. A marina is adjacent to the lodge and provides boat mooring, boat rentals, fuel, bait, tackle, fishing licenses, and groceries.

Spring Recreation Site

Spring Recreation Site is a day/night use recreation facility located just downstream of the Burnt River on the Oregon side of Brownlee Reservoir near Huntington, Oregon. It is owned and operated by the BLM. Originally, land on which the park was constructed was donated by IPC to the BLM for recreational development. A BLM fire-fighting crew is stationed at this location. Minimal shade is provided. Access is via a paved road from Huntington and a gravel road from Richland. The facility has vault toilets, camp sites, drinking water, a fish cleaning station, a boat ramp, and boat/trailer parking.

Steck Park

Steck Park is a day/night use recreation facility located on Brownlee Reservoir downstream from Weiser, Idaho, directly across from the Burnt River inlet. It is owned by the IDFG, however, the BLM has a perpetual management easement for the operation of the site. The park is landscaped with turf, shade trees, and gravel road access. Included are vault toilets, drinking water, picnic tables, a covered picnic area, camping area, a fish cleaning station, a boat ramp, and docks.

With assistance from the IDFG, a local bass fishing club, and acquisition of adjacent lands, an additional boat ramp was constructed in 1990 contiguous to and downstream of the park.

The BLM is presently renovating Steck Park. Plans include restructuring camp sites to better designate individual site boundaries. In 1995 and1996, the BLM improved the structure of seven individual campsites and added fire rings, picnic tables and barbecue grills. Six new vault toilets were also added. Plans for 1996 and 1997 include the restructuring of eleven vehicle sites and five tent sites which will have fire rings, picnic tables, and barbecue grills. The boat ramp will also be extended during this time and an additional 180 feet of dock added. In 1997 and 1998, the BLM plans to add an additional 32 camp sites, with four of those sites being large enough to accommodate groups with up to eight vehicles per group. The BLM intends to initiate a fee for overnight use beginning in 1998.

Farewell Bend Recreation Area

Farewell Bend Recreation Area is a day/night use recreation facility owned and operated by the State of Oregon. It is located near the Farewell Bend turnoff on Interstate 84, adjacent to Brownlee Reservoir. Originally, the land on which the park was constructed was donated by IPC to the State of Oregon for recreational development. The park is 73 acres with extensive landscaping including turf, shrubs and shade trees. There are 93 RV sites with electrical and water hookups, 45 “primitive” sites providing paved areas, a common water source and no electrical hookups and four walk-in sites for tent camping.

Since 1995, Farewell Bend has also added covered wagons and teepees for unique camping experiences and an amphitheater for interpretive programs. There are restroom facilities with showers, washroom, electrical hookups, water hookups, picnic tables, barbecue pits, interpretive/information panels, a fishing access trail and pier, a fish cleaning station, a boat ramp with docks, and boat/trailer parking. A fee is assessed for day and overnight camping.

During fiscal year (FY) 1988-89, visitor day attendance at Farewell Bend State Park was reported at 264,568. This is compared to FY 1974-75, when visitor day attendance was 158,000. The 1988 Park Visitor Survey conducted by the Oregon State Parks and Recreation Division showed that 38 percent of overnight users arrived in motor homes and 28 percent traveled in automobiles. This compares to a 12 percent motor home rate and 58 percent automobile rate for day users at Farewell Bend State Park (BLM, Idaho 1992).

BLM Oasis Site

The BLM owns and maintains this site which is adjacent to and downstream of Oasis Campground on the Oregon side of Brownlee Reservoir. Impromptu camp sites are present, as are a boat ramp and portable toilet. In the fall of 1996, the BLM removed the concrete from the boat ramp and plans to have it replaced with gravel. A vault toilet and grading of the parking area are planned for 1997 as part of a joint effort between the BLM and IPC.

Oasis Campground

Oasis Campground is a privately owned facility located approximately 10 miles downstream of Weiser on the Oregon side of Brownlee Reservoir. It is downstream and immediately adjacent to Snake River RV Park. There are 23 RV sites with electrical, water and sewer hookups and a restroom with showers. Bait and tackle are sold on-site.

The Snake River RV Park

The Snake River RV Park is a privately owned, eight-acre campground on the Oregon side of Brownlee Reservoir, approximately 10 miles from Weiser. The campground was open for business in 1996 with some facilities yet under construction. Ten camp sites with electrical, water and sewer hookups, a restroom facility with showers and washroom, and a paved boat ramp were available by the end of 1996. The owner plans to add at least ten additional camp sites, a fish cleaning station, dog runs, and a day-use area beginning in 1997. This site is immediately adjacent to Oasis Campground.

Impromptu Areas

Many impromptu camping areas and sportsman access areas exist along Brownlee, Oxbow, and Hells Canyon Reservoirs on lands managed by various state and federal agencies.

5.7.2.3. Description of Major Recreation Facilities on the Snake River in the HCNRA

The USFS operates and maintains the following sites in the HCNRA (USDA 1994*a*).

Snake River National Recreation Trail

The Snake River National Recreation Trail is a 31-mile trail paralleling the Snake River in Idaho. It begins at Granite Creek (access by boat from Hells Canyon Dam) and ends at Pittsburg Landing. Sections of the trail may be flooded during high water.

Hells Canyon Creek Recreation Site and Stud Creek Trail

The major portion of the Hells Canyon Creek Recreation Site and Stud Creek Trail is located on the rock spoil site that resulted from the construction of Hells Canyon Dam. It is located in the HCNRA, outside the project boundary approximately one-half mile below Hells Canyon Dam on the Oregon side of the Snake River, and is managed by the USFS. The USFS staffs the site seven days per week from Memorial Day weekend through September 15. It is the major launch site for float trips on the Snake River through Hells Canyon and scenic jet boat trips down river are also offered from this location. During 1992, a 1,200-sq.-foot USFS visitor center and boat launching facilities were constructed. The Stud Creek Trail traverses the Oregon shore from this site for about 1 mile downstream.

Kirkwood Historic Ranch and Associated Campground

The Kirkwood Historic Ranch and associated campground is the site of an historic ranch, museum and interpretive site detailing early canyon life. Toilets are available but there is no drinking water. The site is open all year. Access is by river or by an off-road vehicle trail. The public has access to communications at this site and is advised to report fires and emergencies here. Three camping sites accommodating large groups are within easy walking distance of Kirkwood Historic Ranch and provide shade, composting toilets, and tables.

Pittsburg Administrative Site and Associated Campground

The Pittsburg Administrative Site is not available for camping; however, the adjacent Pittsburg Landing campground offers road access, a boat launch ramp and float apron, some shade, drinking water, a toilet, and picnic tables. There is a trail head for the Snake River National Recreation Trail. The public has access to communications at this site and is advised to report fires and emergencies here.

Cache Creek Ranch Administrative Site

A visitor contact/information point is located at the Cache Creek Ranch Administrative Site. This is a day-use-only site to acquire north entry permits, maps and other information. Amenities include shade, water, toilet, and tables.

5.7.2.4. Description of Primitive Camping Sites on the Snake River in the HCNRA

The following sites are maintained by the USFS and provide primitive camping along the Snake River Corridor from Hells Canyon Dam to the Washington/Oregon border (USDA Forest Service 1994*a*):

- Square Beach: Sandy beach, old mining claim; capacity small group**.**
- Brush Creek: Water in creek, sandy beach below creek; capacity medium group.

- Rocky Point: Shade, no water, good landing; capacity medium group.
- Chimney Bar: Shade, no water; capacity large group.
- Warm Springs: Shade, rocky beach; capacity large group.
- Barton Cabin: Historic site. Upriver from Battle Creek, approximately 200 yards from river.
- Battle Creek: Good landing. Tie up 100 yards down-river from creek. Shade; capacity large group. Another campsite located above creek; capacity large group.
- Sand Dunes: Good landing, sandy beach, no water; capacity small group.
- Birch Springs: rocky beach, water supply scant; capacity medium group.
- Wild Sheep: Water, campsite 75 yards from river below Wild Sheep Creek. Stopping point to view rapids; capacity large group.
- Rocky Bar: Rocky beach, shade, no water; capacity large group.
- Upper Granite Creek: Tie up in rocky cove; 75 yards up trail to grassy bench above creek. Shade, water; capacity large group.
- Hibbs Ranch: Historic site; up Granite Creek 1 mile. Site of an ambush and murder.
- Lower Granite Creek: Tie up 200 yards below creek; up trail to bench. Water, shade; capacity large group.
- Cache Creek Bar: Difficult boat landing. High grassy bar below Cache Creek, water off-site; capacity large group.
- Three Creeks: Good water, shade, steep climb to bench. Difficult access below creek; capacity large group.
- Oregon Hole: Shade, no water; capacity large group.
- Upper Dry Gulch: Good landing; no water, shade; capacity large group.

- Lower Dry Gulch: Good landing, shade. Spring just below rim of river bank; capacity large group.
- Hastings: Old placer mine, gravel beach in low water. Water; capacity medium group.
- Saddle Creek: Difficult landing at flows over 30,000 cfs; tie up downstream side of creek. Water, shade on upper bench to the north; capacity large group.
- Bernard Creek: Good landing for rafts downstream from creek on gravel beach; not a good powerboat site. Old cabin on north side of creek. Shade, water, hike up trail 100 yards; capacity large group.
- Rush Creek: Marginal landing located downstream from rapid; rocky beach. Water dries up in summer; capacity large group.
- Johnson Bar Landing: Beach, water available at Sheep Creek; capacity large group.
- Sheep Creek: Fair landing; pull in at creek. Camp is on upriver side of creek; cabin on bench north of creek is occupied under special use permit. Shade, water; capacity large group.
- Steep Creek: Low-water site. Beach, good landing below creek; capacity medium group.
- Yreka Bar: Poor powerboat landing. Shade, no water; capacity large group.
- Upper Sand Creek: Poor powerboat landing; no shade or water; capacity medium group.
- Sand Creek: Administrative cabin for Idaho and Oregon Fish and Wildlife Departments.
- Pine Bar: Beach, shade, water. Located below Willow Creek; capacity large group.
- Upper Quartz Creek: Rocky landing, poor powerboat site. No water, little shade. Located above Quartz Creek; capacity large group.
- Lower Quartz Creek: Good landing, no water, some shade. Located below Quartz Creek; capacity large group.

- Caribou Creek: Good floatboat landing, poor powerboat landing. Located below Caribou Creek. Shade; capacity large group.
- Dry Gulch: Shade, beach, no water; capacity large group.
- Big Bar: Fair powerboat landing; rocky. No shade, no water; capacity large group.
- Upper Salt Creek: Beach, shade. Water at Salt Creek; capacity large group.
- Lower Salt Creek: Beach, shade. Water at Salt Creek; capacity large group.
- Two Corral: Beach, shade, no water; capacity large group.
- Gracie Bar: Good floatboat landing, shade; capacity large group.
- Half Moon Bar: Easy landing, small site, no water; capacity medium group.
- Slaughter Gulch: Good landing; capacity large group.
- Yankee Bar: Beach, no water, little shade; capacity small group.
- Russell Bar: Fair landing for rafts, poor landing for powerboats. shade, no water; capacity large group.
- Cat Gulch: Easy landing, small beach. Shade; capacity medium group.
- Corral Creek: Cobble beach, shade, water upriver 200 yards; capacity large group.
- Fish Trap Bar: Sandy beach, good landing. No water; capacity large group.
- Upper Pittsburg: Road access, campground, parking area. Toilet, table, some shade, no water.
- Klopton Creek: road access. Good floatboat landing. Shade, no water; capacity small group.
- Silver Shed: Good landing, shade, no water; capacity large group.
- Pleasant Valley: Boat landing very difficult at some water levels. Shade, water 150 yards upstream from camp, off-road vehicle trail; capacity medium group.
- Davis Creek: Good landing, no water, little shade; capacity medium group.

- McCary Creek: Difficult landing, no water; capacity medium group.
- Big Canyon: Fair landing; water, shade, table; capacity large group.
- Somers Range: No water, small site; capacity small group.
- Lower Big Canyon: No water, sandy beach; capacity small group.
- Somers Creek: Rocky landing; water, table, shade, capacity large group.
- Camp Creek: Some shade, no water, tables; capacity large group.
- Tryon Creek: Good landing; shade, water at creek, table; capacity large group.
- Lookout Creek: Shallow landing; no water, some shade, table; capacity large group.
- Bob Creek: Sandy beach, no water, shade, table; capacity large group.
- Wolf Creek: No shade, no water, private property, private road; capacity small group.
- Bar Creek: Poor powerboat site. Water dries up. Shade; capacity large group.
- Deep Creek: Site of Chinese massacre in 1887. Poor landing; pull in near creek. Carry gear over boulders 20 yards to site. Shade, water; capacity medium group.
- Robinson Gulch: No water, shade, table; capacity large group.
- Dug Creek: Water, small site; capacity small group.
- Dug Bar Landing: Primitive launch area, road access. Toilet, no water; capacity medium group.
- Dug Bar: Rocky landing; road, access point. Toilet, no water; capacity medium group.
- Warm Springs: Warm spring, no drinking water; beach, shade. Private land; capacity large group.
- ZigZag: Beach, no water; capacity small group.
- Divide Creek: Low-water site above mouth of creek. Water, shade; capacity large group.
- China Bar: Beach; capacity large group.

- Imnaha: Poor powerboat landing. Pull in above Imnaha confluence. Shade, no water; capacity medium group.
- Eureka Bar: Swift water for raft landing. Poor powerboat landing. Table, no water; capacity large group.
- Knight Creek: Good landing, shade, water; capacity large group.
- Salmon Mouth: Beach, little shade, no water; capacity large group.
- Salmon Falls: Beach, no shade; capacity large group.
- Salmon Bar: Table, some beach area; capacity large group.
- Geneva Bar: Sand and rock beach, no water; capacity large group.
- Cook Creek: Sandy beach, water; capacity medium group.
- Lower Jim Creek: Sandy beach, shade, table; capacity large group.
- Meat Hole: Beach, no water, small low-water site; capacity small group.
- Cactus Bar: Good landing, beach, no water; capacity medium group.
- Upper Cottonwood Creek: Water, shade, beach, table; capacity large group.
- Lower Cottonwood Creek: Water, shade, beach; capacity large group.
- Upper Cougar Bar: Beach, no water or shade, low water site; capacity medium group.
- Coon Hollow: Interesting stop at old cabin with flotsam museum. Some shade, table; capacity large group.
- Cochran Island: Float camp only due to shallow river approach, secluded, shade, table, no water; capacity large group. Short hike to Coon Hollow.
- Garden Creek: Beach, shade, small low water site; capacity small group.
- Upper Cache Creek: Good landing, sandy beach, pack to bench from river, table, capacity large group.

- Lower Cache Creek: Beach, no water or shade, small low water site; capacity small group.

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5.8. Land Management

5.8.1. Historical and Current Land Use

5.8.1.1. Overview of Historic Basin Land Use

The first inhabitants did not enter the Hells Canyon area until approximately 12,000 years ago. These early peoples left few traces of their passage, and little is known about them. They appear to have been nomads, living in the canyon only in the winter, summering in the high valleys nearby.

The Indians whom the first explorers found living in the canyon and the surrounding mountains were probably not descendants of the earliest inhabitants, though their lifestyle appears to have been much the same. The project area had previously been home to two separate and distinct Native American tribes. At the south end of the canyon lived the Western Shoshone, a Basin Culture tribe; to the north, and claiming most of the canyon itself, the Nez Perce, who belonged to what is known as the Plateau Culture. There was open antagonism between the two tribes, as well as constant—if usually undeclared—warfare, in which the more powerful Nez Perce normally had the upper hand.

Early Euro-American exploration of Hells Canyon began in 1806 when Lewis and Clark entered lower Hells Canyon on their return from the Pacific. Fur trappers with the Wilson Price Hunt party of John Jacob Astor's Pacific Fur Company entered Hells Canyon in 1811 at the confluence of

Wolf Creek and the Snake River, about 25 miles upriver of the present location of Brownlee Dam (Carrey *et al.* 1979), eventually camping at the Oxbow (Beal and Wells 1959).

There were several historic mines in the canyon (Carrey *et al.* 1979, Lindgren 1901, Livingston and Laney 1920, Parks and Swartley 1916, Swartley 1914). Placer mining was going on in the Canyon proper during the 1880s. Mining activity resulted in the construction of the Kleinschmidt Grade, built by Albert Kleinschmidt between 1889 and 1891. The road connected the Peacock Mine, in the Seven Devils area, to the Snake River so that ore could be shipped by steamboat up river to Huntington or Olds Ferry railheads.

There were several ferry crossings in Hells Canyon. A cable ferry crossed the river from Robinette, and a ferry called the Brownlee transported cattle from the Idaho side to Oregon so that they could winter near Halfway. Brownlee Ferry operated after the 1860s. There was also a ferry at Ballard Creek, until 1926 when a bridge was constructed (Carrey *et al.* 1979).

There were many homesteads and cabins in Hells Canyon (Carrey *et al.* 1979). Further development was interconnected with the growth of mining, railroads, and early hydropower development in Hells Canyon.

The USFS has had an active role in management of recreation activities in Hells Canyon. For example, many of the homesteads previously listed reverted to USFS ownership, trails were built through the Canyon, and the HCNRA was created in 1975 (Carrey *et al.* 1979).

At some point very early in the twentieth century, there occurred a subtle but profound shift in how the Snake River was viewed. The Canyon was no longer an obstacle but a resource, a thing to be put to work. The very qualities that had repelled men earlier, the steepness and height of the walls and the power and impetuousness of the big river at their feet, were precisely the things that now gave it the most value. The age of electricity had arrived and Oxbow was one of the early sites identified for power site development. Construction of the first power generating plant at the Oxbow site was begun in the autumn of 1906 by the Idaho-Oregon Power Company.

In 1947 IPC sought permission from the Federal Power Commission (now FERC) to build a hydro project at the same Oxbow site on the Snake River where the financially troubled Idaho-Oregon Light and Power Company had previously constructed a makeshift power plant. In subsequent FPC applications, IPC added to its proposed development two additional plants, Brownlee and Hells Canyon. In 1955, in a unanimous decision, the FPC issued a license for the Company to launch its program for full development of the 100-mile stretch of the Snake with Brownlee, Oxbow, and Hells Canyon Dams.

Construction on Brownlee Dam was completed in 1959, at which time construction began on Oxbow Dam. Hells Canyon Dam, the last to be completed, was fully operational in 1968. In 1975, construction began on a fifth generating unit at Brownlee. It was completed in 1975 (Stacy 1991).

5.8.1.2. Overview of Current Land Use

The project region is still dominated by the land use patterns established at the turn of the century: irrigated and non-irrigated agriculture, livestock grazing, mining, large areas of open space and scattered rural development. The bottom lands adjacent to the reservoirs are generally used for grazing, some farming and recreational purposes.

The project region is crossed by an excellent system of federal and state highways. Secondary roads, owned and maintained either by IPC or the various counties, provide access to more remote areas of the project. Interstate Highway 84 crosses the region from northwest to southeast and provides access to the southern portion of the project near Huntington, Oregon. Oregon State Highway 86 connects with Interstate Highway 84 at Baker City and then travels 70 miles to the northeast where it terminates at Oxbow, Oregon. Baker County owns and maintains a 40-mile gravel surfaced road which provides access to the west side of Brownlee Reservoir between Huntington and Richland, Oregon. Hells Canyon Dam is reached via a 23-mile paved, two-lane highway which is owned by IPC and the federal government and maintained by IPC. IPC owns and maintains an additional 12-mile stretch of roadway which runs between Oxbow and the Oregon state line near Brownlee Dam. On the Idaho side, Adams County Road 71 provides access from Brownlee Dam to Cambridge, Idaho. The main line of the Union Pacific Railroad crosses the upper end of Brownlee Reservoir near Huntington, Oregon.

The predominant source of electricity is a region-wide grid system of public and private hydroelectric and thermal power plants coordinated under the Pacific Northwest Coordination

Agreement. The principal electric power utilities within the region are IPC, Washington Water Power Company, Oregon Trail Electric Coop, and the Bonneville Power Administration.

5.8.1.3. Existing Land Use and Ownership within Project Boundary

Approximately 46 percent of land (9,194 acres) within the project boundary is federally-owned and managed by the USFS or the BLM. IPC owns and manages about 51 percent (10,204 acres). Private ownership, other than IPC, accounts for about 3 percent of the total (589 acres). Less than 2 percent of land within the project boundaries (161 acres) is owned and managed by the States of Idaho or Oregon. Maps which show project boundaries and a description of the project lands are attached as Figures 2-2.1 through 2-5.3.

Project lands support recreational development such as campgrounds, picnic areas, boat ramps and trails. IPC has developed and maintains four full-service parks in the Hells Canyon area-Woodhead Park, along the Idaho side of Brownlee Reservoir; McCormick Park, on the Idaho shore of Oxbow Reservoir; Copperfield Park, just below Oxbow Dam on the Oregon side; and Hells Canyon Park, which is located on the Idaho side of Hells Canyon Reservoir. The BLM, USFS, the State of Oregon, and the counties also operate and maintain park and recreation facilities. Some private recreational developments are located on project lands. Fuel, overnight lodging, and meals are available at the Mountain Man Lodge and Marina, located at Dennett Creek on Brownlee Reservoir. For more information on existing recreation facilities, see Section 5.7.

Other areas within the project boundary support project facilities, livestock grazing, or natural resource management activities.

5.8.1.4

Existing Land Use and Ownership Adjacent to Project Boundary

The physical characteristics of the canyon narrowly restrict the possibilities for a wide range of land uses adjacent to the project boundary. The BLM, Boise and Baker Districts, and the USFS (Wallowa-Whitman National Forest, HCNRA, and Payette National Forest) are the two federal land management agencies responsible for managing these lands.

Private land-holdings are interspersed with federal lands, especially in the upper three-fourths of the project area. Forage is available on the sides of the canyon and is a major agricultural resource. Livestock ranching is of greatest significance in the upstream three-fourths of the reservoir basin. The lower canyon walls are generally too steep and are mostly composed of exposed bedrock which limits their usefulness for grazing purposes.

Lands suitable for crop production in the canyon are very restricted, consisting principally of narrow terraces or benches scattered along the Snake River, although larger cropped acreages are found in the valleys of Pine Creek and Powder River above the reservoir area. Most of the cultivated land in the reservoir area is irrigated, either by gravity flow or by pumping.

5.8.2. Land Management Framework

5.8.2.1 IPC Use Authorizations

5.8.2.1.1 General Land Management Policies

IPC developed its General Land Management Polices to ensure that proposed land uses are compatible with operation of project facilities, that operations are balanced with protection and enhancement of environmental, cultural and recreational resources, and that FERC license requirements are met. The General Land Management Policies help IPC to respond to increased public use of project lands and waters and increasing requests for use of IPC-owned lands. The foundation for the General Land Management Policies is:

- FERC land use regulations,
- Plans and policies of federal, state and local agencies and tribes,
- Existing IPC plans and policies, and
- General land management goals developed by IPC (1994, revised 1995).

IPC's General Land Management Policies apply to lands and waters within its FERC-licensed project boundaries and to IPC-owned non-project lands. IPC recognizes that it has only limited rights or authority to regulate land use in some cases, for example, flooding easements, federal and state lands, and privately-owned lands within project boundaries.

Among other uses IPC authorizes under its General Land Management Policies, IPC leases (to others) several parcels of project and non-project lands for farming or grazing purposes. The leased parcels are located in three separate areas, the Powder River/Eagle

Creek confluence, the Powder River/Snake River confluence, and the Burnt River/Snake River confluence. Presently, a total of approximately 200 acres of project lands are leased to others by IPC. This figure includes approximately 30 acres which are leased for the purpose of operating a commercial marina on Brownlee Reservoir (Mountain Man Resort and Marina).

5.8.2.1.2. Policy and Guidelines for Private Boat Docks

IPC administers a permit program in cooperation with various local state and federal agencies for the issuance of private boat dock permits. IPC's Policy and Guidelines for Private Boat Docks is intended to ensure compliance with local, state, federal and IPC standards regarding boat dock installation and maintenance.

5.8.2.1.3. Agency Land Management Plans

The Hells Canyon Project is surrounded by public lands administered under numerous land management plans. The Electric Consumers Protection Act of 1986, which amended Section 10 of the Federal Power Act, requires the Federal Energy Regulatory Commission, before licensing, to consider each proposed hydropower project's consistency with relevant state or federal comprehensive plans for developing or conserving a waterway.

On April 27, 1988, the Commission issued Order No. 481-A, establishing that the Commission will accord FPA Section 10(a)(2)(A) comprehensive plan status to any criteria or state plan that

1) is a comprehensive study of one or more of the beneficial uses of a waterway or waterways;
2) specifies the standards, the data, and the methodology used; and
3) is filed with the Secretary of the Commission.

IPC will evaluate the Project's consistency with identified comprehensive plans as part of the relicensing process. In the FERC's most recent Revised List of Comprehensive Plans, dated July 26, 1996, the following plans relevant to the project area were identified:

- Forest Service. 1988. Payette National Forest land and resource management plan;
- Idaho Department of Parks and Recreation. 1983. Idaho Outdoor Recreation Plan;
- Bureau of Land Management. 1990. Resource assessment of the Powder River;
- Bureau of Land Management. 1989. Baker resource management plan record of decision; and
- Oregon State Parks and Recreation Division. 1983. Statewide comprehensive outdoor recreation plan.

Other relevant management plans not on the FERC is list include the comprehensive plans and zoning ordinances of the Oregon counties of Baker, Malheur and Wallowa; and the Idaho counties of Washington and Adams. Development of a land management plan for the Hells Canyon Project (concurrently with relicensing studies), will also involve a detailed inventory of existing plans and policies, including additional USFS and BLM resource management plans.

5.8.3. Literature Cited

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5.9. Aesthetic Resources

5.9.1. Existing Conditions

Aesthetics studies conducted in the Hells Canyon Project area include agency inventory of the landscape aesthetic values, sensitive viewers and their viewsheds, and agency visual management objectives. Two national forests have completed these inventories, the Payette and the Wallowa-Whitman. Information available include variety classes, sensitive viewpoint and viewsheds, and Visual Quality Objectives (VQOs). The BLM has completed a similar visual inventory for lands under its jurisdiction. This information include scenic quality classes, sensitive viewpoints and viewsheds, and Visual Resource Management (VRM) classes. This information is available for national forest and public lands, and does not include private lands.

Assessment of visual impacts in the project area is limited to evaluation of projects proposed on federal lands, determining if the project is compatible with visual resource management objectives. Assessment of flow and reservoir levels from an aesthetic perspective has not occurred in the project area.

5.9.2. Literature Cited

U.S. Dept. of Agric., For. Serv. 1995. Landscape aesthetics, a handbook for scenery management. U.S. Dept. of Agric., For. Serv. Agricultural Handbook Number 701. 58pp

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VI.
Streamflow and Water Regime

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VI. STREAMFLOW AND WATER REGIME

VI.
STREAMFLOW AND WATER REGIME

6.1.
Gauging Station And Flow Data

As stated in Section 4.2.2.3.1., IPC's engineering calculations are based on inflow to the Brownlee Reservoir which is not measured directly, but is calculated as follows:

Brownlee Average Daily Inflow = Hells Canyon Dam discharge (cfs)

+ Change in Hells Canyon Reservoir storage (converted to cfs)

- Pine Creek discharge (cfs)

+ Change in Oxbow Reservoir storage (converted to cfs)

- Wildhorse Creek discharge (cfs)

+ Change in Brownlee Reservoir storage (converted to cfs)

The Brownlee inflow calculations are performed by IPC personnel and transmitted to the U. S. Army Corps of Engineers (COE), Walla Walla District, where it is stored in an electronic data base. The period of record utilized for IPC's engineering studies is from 1965 through 1995. The minimum, mean, and maximum Brownlee average daily inflows for the period are, respectively, 4,172 cfs, 19,894 cfs, and 84,721 cfs.

The Hells Canyon Dam discharge is measured at the U. S. Geologic Survey (USGS) Gauging Station Number 13290450, which is located 0.6 miles below Hells Canyon Dam. The Hells Canyon Dam gauge has been in operation since July of 1965.

Pine Creek discharge is measured at USGS Station Number 13290190, which is located 1.8 miles south of Oxbow and 1.9 miles upstream from the mouth of Pine Creek. The recording gauge has been in operation since November of 1966.

Wildhorse River discharge is measured at USGS Station Number 13289960, which is located about 300 feet upstream from the mouth of the Wildhorse River, and 1.1 miles north of Brownlee Dam. The recording gauge has been in operation since October of 1978.

Prior to the installation of the recording gauges on Pine Creek and Wildhorse River, flows were determined by IPC personnel using staff gauges and USGS stage discharge tables. The staff gauges were read once a week unless more frequent readings were requested.

Daily changes in reservoir storage are based on changes in reservoir elevation from midnight one day to midnight the next day. Since 1982, Oxbow and Hells Canyon reservoir data have been recorded electronically by IPC utilizing its SCADA (Supervisory Control and Data Acquisition) system. Brownlee data have been recorded electronically since 1983. Prior to such electronic data collection, reservoir data were recorded on hand-written log sheets at each plant.

The calculated values for Brownlee inflows have been recorded electronically since 1959. The inflow data for the period of January 1965 through December 1995 are presented in Section XI, Tables 6-1.1 through 6-1.31.

The records for the Pine Creek and Wildhorse River discharge are not readily available for the period prior to the installation of recording stream gauges. Flow data for Pine Creek for the period of November 1966 through September 1995 are presented in Section XI, Tables 6-2.1 through 6-2.30; data for Wildhorse River from October 1978 through December 1995 are presented in Section XI, Tables 6-3.1 through 6-3.18.

Reservoir data for prior to the time when data collection through the SCADA system was instituted, are not readily available. Reservoir surface elevation data, from which changes in reservoir content are derived, are presented in Section XI, Tables 6-4.1 through 6-4.13 for Brownlee Reservoir, Tables 6-5.1 through 6-5.14 for Oxbow Reservoir, and Tables 6-6.1 through 6-6.14 for Hells Canyon Reservoir.

6.2. Drainage Area

The Snake River drains 72,590 square miles above Brownlee Dam, and 73,300 square miles above Hells Canyon Dam. Geomorphically, the boundaries of the basin are composed of four major regions. One is the Rocky Mountain province, which includes the Grand Tetons and Yellowstone National Park in Wyoming. The second is the southwestern drainages of the South Central Idaho Batholith. The third is the Jarbridge-Owyhee volcanic uplands and mountains of southwestern Idaho and southeastern Oregon. The fourth is the

Eastern Columbia River Plateau in eastern Oregon and western Idaho. These geomorphic provinces are the main contributors to the Snake River as it flows to the Hells Canyon Complex.

Large irrigation and flood control reservoirs, such as American Falls, Palisades, Jackson Lake, Owyhee, and the Boise River system (Anderson Ranch, Arrowrock and Lucky Peak) significantly modify the runoff pattern in the Snake River above the Hells Canyon Complex.

6.3. Flow Periodicity

Most precipitation in the Snake River basin occurs during winter and spring, with the major portion occurring as snowfall during the winter months. Very little precipitation falls during the period from late spring until late fall. Consequently, the Snake River at Brownlee experiences an annual peak flow in the spring, generally during April or May, which corresponds to the peak runoff resulting from a combination of spring rains and snow melt in the surrounding mountains. Flow in the river declines rapidly beginning in June with the onset of the dry season and diversion of water for irrigation in the agricultural areas of the Snake River Plain. River flow remains low until irrigation diversions begin to decline and then increases fairly rapidly until the end of the irrigation season in mid-October.

6.4. Flow Rates And Durations

A flow-duration curve for the Brownlee inflows described in Section 6.1 is presented in Section XII, Figure 6 -1. Monthly flow-duration curves are presented in Section XII, Figures 6-2.1 through 6-2.12.

6.5.
Mean Flow Figures

Mean flow into Brownlee Reservoir was calculated for each day of the year using the calculated inflows for the period of January 1, 1965 through September 30, 1995. These data were used to plot daily stream flow curves in the form of hydrographs. A mean flow hydrograph illustrating the annual cycle of inflow to Brownlee Reservoir is presented in Section XII, Figure 6-3. Monthly mean flow hydrographs presented in Section XII, Figures 6-4.1 through 6-4.12.

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VII.
Existing Protection, Mitigation, and Enhancement Measures

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VII. EXISTING PROTECTION, MITIGATION AND ENHANCEMENT MEASURES

VII.
EXISTING PROTECTION, MITIGATION AND ENHANCEMENT MEASURES

7.1. Aquatic Resources

7.1.1. Issuance of License

On December 15, 1950 an application was filed by Idaho Power Company (IPC) for a license under the Federal Power Act to construct a hydroelectric development, known as Oxbow, on the middle Snake River. Public hearings were held on the Oxbow application during July 1952, in Baker, Oregon and Boise, Idaho, at which all persons desiring to speak either in favor of or against the issuance of a license were heard.

On May 15, 1953, IPC filed applications for licenses to construct two additional hydroelectric developments on the Snake River, known as Brownlee (App. No. 2133) and Hells Canyon (App. No. 2132). Subsequent to these filings, the Federal Power Commission (FPC), later the Federal Energy Regulatory Commission (FERC), consolidated the three applications for the purpose of holding public hearings. At this time, the three projects became known collectively as the Hells Canyon Project (designated Project No. 1971 by the FPC). On August 4, 1955, a license was issued to IPC by the FPC to construct the project.

7.1.2. Anadromous Fish Conservation

To mitigate for losses of anadromous fish associated with the construction of the Hells Canyon Project, Article 35 of the license states that:

> "*The licensee shall construct, maintain and operate or shall arrange for the construction maintenance and operation of such fish ladders, fish traps or other fish handling facilities or fish protective devices and provide fish hatchery facilities for the purpose of conserving the fishery resources and comply with such reasonable modifications of the project structure and operation in the interest of fish life as may be prescribed hereafter by the Commission upon its own motion or upon the recommendations of the Secretary of the Interior and the conservation agencies of the States of Idaho and Oregon.*"

A task force composed of representatives from each of the state and federal fish and wildlife agencies in the Pacific Northwest was formed to develop plans for handling the anadromous fisheries in the Hells Canyon reach of the Snake River. The studies of this group resulted in a decision to provide experimental facilities for both the upstream and downstream passage of anadromous fish around the three dams, to allow access to natural spawning and rearing areas (Haas 1965).

Implementation of IPC's fish conservation program began in 1956 with the construction of an upstream migrant trap at the outlet of the Brownlee diversion tunnel, consisting of a temporary experimental electric barrier across the outlet with an adjacent trap. The trap at Brownlee was soon replaced with an upstream migrant trap at the Oxbow dam site. Upstream migrants were transported approximately 1.5 miles above Brownlee Dam and released in the reservoir to continue their migration to the remaining portions of the Powder River (Eagle Creek) and the Snake and Weiser rivers above Brownlee. Later, during 1960 to 1962, approximately half of the fall chinook were transported to the upper end of the reservoir near Weiser, Idaho.

The downstream migrant facilities at Brownlee also consisted of a temporary experimental electric barrier and adjacent trap. The Brownlee downstream migrant facilities were later removed and a large net barrier, designed to trap and collect outmigrating smolts by means of an elaborate system of pumps and sluiceways, was installed in the forebay of Brownlee Reservoir in September 1958. The net barrier spanned the entire width of the reservoir, and extended to depths of 120 feet (Graban 1964; Haas 1965). Once collected, smolts were transported by truck to a release site below Hells Canyon Dam. After extensive testing (Graban 1964; Haas 1965), it was determined that slack water conditions created by Brownlee Reservoir interrupted the normal downstream migration of smolts, and resulted in insufficient collection of smolts at the net barrier. Downstream migrant collections dropped from 130,551 salmon and 18,250 steelhead in 1959 to 13,482 salmon and 1,212 steelhead in 1963 (Graban 1964). In December, 1963, the FPC issued an order which called for IPC to abandon the downstream migrant trap prior to the beginning of the 1964 outmigration season.

7.1.3. Hatchery Mitigation

With the failure of the intergovernmental task force plan in maintaining natural populations of chinook and steelhead in the Snake River, the decision was made by the FPC to develop an artificial propagation program to transplant these fish to selected locations in the Salmon River drainage. To accomplish this task, IPC would construct three new hatchery facilities and expand the operation of its existing Oxbow Hatchery, which was originally constructed in 1961 as an experimental fall chinook rearing facility (Figure 7-1).

Rapid River Hatchery was the first facility constructed following the FPC order to implement a hatchery mitigation program. Located on lower Rapid River, a tributary to the Little Salmon River near the town of Riggins, Idaho (Figure 7-1), construction of the Rapid River facility was completed in the summer of 1964. Upon completion, the facility was capable of holding approximately 300 adult spring chinook salmon or steelhead trout, and rearing approximately 600,000 juvenile spring chinook salmon or steelhead trout to smolt size. Initial efforts to incubate steelhead trout eggs at Rapid River were unsuccessful, most likely due to the high silt content of the Rapid River during the steelhead incubation period. Consequently, the steelhead program was discontinued and spring chinook propagation became the mainstay of the Rapid River facility. Over the next four years, additional rearing and holding ponds were constructed at Rapid River to allow for the production of up to 3 million spring chinook smolts annually.

The next facility to be built was Niagara Springs Hatchery (Figure 7-1). Completed in 1966, the Niagara Springs facility was designed to produce 200,000 pounds of steelhead smolts annually. Concurrent with construction of this facility, measures were taken to modify the operation of Oxbow Hatchery to allow for holding and spawning of steelhead broodstock trapped below Hells Canyon Dam. Eggs collected at Oxbow were then transferred to Niagara Springs for incubation and final rearing.

To complete the transplant efforts, the Pahsimeroi Hatchery was the last facility built by IPC (Figure 7-1). Constructed in 1967, the Pahsimeroi Hatchery consisted of two large smolt acclimation ponds, and an adult steelhead trapping and spawning facility capable of accommodating up to 3.3 million eyed steelhead eggs. Smolts reared at Niagara Springs were transported to the Pahsimeroi acclimation ponds by truck and allowed to migrate volitionally from the ponds. After establishing sufficient returns of broodstock to the

Pahsimeroi to meet production needs at Niagara Springs, steelhead spawning operations at Oxbow Hatchery were to be discontinued.

7.1.4. Development of Settlement Agreement

On February 9, 1976, the National Marine Fisheries Service (NMFS), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Game (WDG), and Washington Department of Fisheries (WDF) filed a petition with the FPC requesting that the Commission issue a declaratory order that would amend and supplement all previous orders prescribing fish facilities at the Hells Canyon Project. The petitioners alleged that previous measures had not accomplished compensation to pre-project levels for steelhead trout or chinook salmon. The petitioners further stated that the States of Oregon, Washington, and Idaho had severely reduced the catch of Snake River anadromous fish in an effort to maintain the runs in viable condition. This petition, and the ensuing four-year period of court hearings and negotiations, culminated on February 14, 1980 with the signing of the Hells Canyon Settlement Agreement. By entering into this agreement, the petitioners acknowledged,

> "*…that the numbers of fish herein agreed upon constitute full and complete mitigation for all numerical losses of salmon and steelhead caused by or in any way associated with the construction of, and operation within the existing license for, Project No. 1971. Idaho, Oregon, and Washington further agreed not to contend or support contentions by others before any agency or in any proceeding that additional fish or fish facilities are required by or in any way associated with the construction of, or operation within the existing license for, Project No. 1971.*"

7.1.5. Current Hatchery Operations

Pursuant to the terms of the Settlement Agreement, a number of changes occurred in the hatchery mitigation program. These changes included the construction of a permanent adult steelhead and chinook trapping facility on the Oregon shore of the Snake River immediately below Hells Canyon Dam, and the expansion or modification of the production goals at all four of IPC's fish hatcheries. Current production goals are listed below, by facility.

7.1.5.1. Oxbow Hatchery/Hells Canyon Trap

During the period May 1 through July 15 annually, trap sufficient numbers of adult spring chinook to permit the taking of a quantity of eggs reasonably necessary to produce one million smolts for release into the Snake River below Hells Canyon Dam. These adults will be transported to IPC's Rapid River Hatchery for spawning.

During the periods September 1 through December 20 and March 1 through April 30 annually, trap and transport to Oxbow Hatchery sufficient numbers of adult steelhead trout to reasonably provide for the annual production of 200,000 pounds of steelhead smolts.

Upon reaching maturity, spawn all trapped steelhead, fertilize their eggs, and incubate to eye-up. Upon eye-up, these eggs will be transported to IPC's Niagara Springs Hatchery for final rearing.

One additional goal of Oxbow Hatchery is to raise a total of 1 million fall chinook smolts annually.

The Hells Canyon Settlement Agreement states:

> "*Licensee will contract with appropriate state and federal agencies or otherwise provide for the trapping of sufficient adult fall chinook salmon and the fertilizing and eyeing up of sufficient eggs to permit raising up to 1,000,000 fall chinook smolts.*"

Pursuant to this provision, under a separate agreement with the U.S. Army Corps of Engineers (COE), up to 1.3 million fall chinook eggs were to be provided for this program from Lyons Ferry Hatchery in Washington. However, to date, no eggs have been available from Lyons Ferry and the fall chinook program at Oxbow has not been initiated.

The Hells Canyon Settlement Agreement also states:

> "*The eggs will be transported by Licensee to its Oxbow Hatchery for rearing. The facilities will be ready for use within 6 months of written notification by the fishery agencies of the availability of eggs.*"

No such notification has occurred. Nevertheless, IPC consults annually with agencies regarding this provision of the agreement.

7.1.5.2.
Rapid River Hatchery

Provide for the production of 3 million spring chinook smolts annually. This total shall be composed of 2 million smolts from Rapid River stock (adults trapped in Rapid River), and 1 million smolts from Snake River stock (adults trapped at Hells Canyon and transported to Rapid River for spawning). Release up to 2 million smolts directly into Rapid River. Transport up to 1 million smolts to Hells Canyon for release below Hells Canyon Dam.

7.1.5.3.
Niagara Springs Hatchery

Provide for the annual production of 400,000 pounds of steelhead trout smolts, with one-half of these smolts from Snake River stock (eggs received from Oxbow Hatchery) and one-half from Pahsimeroi River stock (eggs received from Pahsimeroi Hatchery). Transport the smolts from the Pahsimeroi River stock to the Pahsimeroi River hatchery facility for release, and the smolts from the Hells Canyon stock to Hells Canyon Dam for release. Should insufficient numbers of Snake River stock smolts be available to permit the stocking of 200,000 pounds below Hells Canyon Dam, Pahsimeroi River stock smolts may be taken to Hells Canyon Dam for release.

7.1.5.4.
Pahsimeroi Hatchery

Trap sufficient numbers of adult steelhead trout to reasonably provide for the production of 200,000 pounds of steelhead smolts annually. All eggs resulting from this effort will be incubated to eye-up and then transferred to Niagara Springs Hatchery for final rearing.

Trap and spawn sufficient numbers of adult chinook salmon to reasonably provide for the production of 1 million smolts annually. All juvenile chinook will be reared on site and released directly into the Pahsimeroi River.

7.1.6. Resident Fish Enhancement Projects

IPC has supported various clubs, such as Snake River Bass Masters, in aquatic habitat enhancement projects for Brownlee Reservoir. IPC has worked with the clubs on placement and anchoring of habitat structures, and has helped to fund, in part, activities related to the enhancement project. Contributions have been up to $250.00 per project. Activities of this nature have occurred annually, at least since 1989.

7.1.7. Literature Cited

Graban, J. R. 1964. Evaluation of fish facilities, Brownlee and Oxbow dams. Report to Idaho Dept. of Fish and Game., Boise, Id. 60pp.

Haas, J. B. 1965. Fishery problems associated with Brownlee, Oxbow, and Hells Canyon dams on the middle Snake River. Inv. Rep. No. 4. Fish Comm. of Oreg., Portland, Oreg. 95pp.

7.2. Terrestrial Resources

7.2.1. Issuance of License

Several articles in the existing Hells Canyon License relate to terrestrial resources.

Article 37

Article 37 states:

> "*The Licensee shall negotiate with the Game Commission of the State of Oregon and the Department of Fish and Game of the State of Idaho with respect to acquisition by the Licensee for the State agencies of island and marsh areas along the Snake River for development as substitutes for waterfowl nesting areas to be lost by reservoir inundation. Should the Licensee and State agencies fail to agree on the acquisition of such lands, the Commission reserves the right to make a final determination in this matter after notice and opportunity for hearing.*"

Pursuant to Article 37, IPC, the ODFW (previously the Oregon State Game Commission) and the IDFG, entered into an agreement on March 16, 1959. In this agreement, IPC agreed to purchase certain islands (stated below) and convey them to the states of Idaho and Oregon. The ODFG and IDFG agreed that the conveyance by IPC to the States of Idaho and Oregon of the islands constituted full satisfaction of the provisions of Article 37 of the License. IPC purchased and conveyed to the State of Idaho and on behalf of the IDFG, Gold Island, located in Canyon County, Idaho. The island was intended for use by IDFG as required in the restoration, protection and propagation of water fowl and upland game birds and for public hunting and fishing. Also, IPC purchased and conveyed Patch Island, Porter's Island, and Huffmann's Island, all located in Malheur County, Oregon, to the State of Oregon for and on behalf of the Oregon State Game

Commission. IPC also agreed to continue to negotiate with the owner of Goat Island, Malheur County, Oregon and purchase said island for an expenditure of up to $2,500.00. These negotiations were not successful and Goat Island was not purchased.

Article 61

Article 61 states:

> "*If any previously unrecorded archeological or historic sites are discovered during the course of construction or development of any project works or other facilities at the project, construction activity in the vicinity shall be halted, a qualified archeologist shall be consulted to determine the significance of the sites, and the Licensee shall consult with the State Historic Preservation Officer (SHPO) to develop a mitigation plan for the protection of significant archeological or historic resources. If the Licensee and the SHPO cannot agree on the amount of money to be expended on archeological or historic work related to the project, the Commission reserves the right to require the Licensee to conduct, at its own expense, any such work found necessary.*"

In recent years, IPC has routinely consulted with SHPO to develop mitigation plans as required by this article, for example, during the development of Woodhead Park, relocation of a transmission line at Hells Canyon Park, and maintenance of roads associated with transmission lines.

Article 401

Article 401 states:

> "*The Licensee shall design and construct the transmission line in accordance with guidelines set forth in "Suggested Practices for Raptor Protection on Power Lines" (Olendorff, R. R., A. D. Miller, and R. N. Lehman. 1981. Suggested practices for raptor protection on powerlines: the state-of-the-art in 1981. Raptor Res. Rep. No. 4. Raptor Res. Found., St. Paul, Minn. 111pp.)*
>
> *The Licensee shall consult with the U.S. Fish and Wildlife Service and the U.S. Forest Service in adopting these guidelines, and shall develop and implement a*

design that will provide adequate separation of energized conductors, groundwires, and other metal hardware, adequate insulation, and other measures necessary to protect raptors from electrocution hazards."

Article 401 was not required at the time of the original license. However, electrocution of large birds of prey does not normally occur on transmission lines with voltages above 115 kV. Only one line associated with Project No. 1971 is less than 230 kV. Proposed studies (in this formal consultation package) include an evaluation of existing transmission lines to assure that they comply with the requirements of "Suggested Practices for Raptor Protection on Power Lines, The State of the Art in 1996," which supersedes "Suggested Practices for Raptor Protection on Power Lines" (1981).

7.2.2. Winter Big Game Feeding

IPC, in cooperation with the ODFW and the Powder River Sportsmen (a local organization) has participated in winter big game feeding in the Powder River, Halfway and Richland, Oregon areas. IPC has provided funding, when requested by ODFW, to assist in purchasing and distributing feed to big game during extreme winter conditions and stress. This program has been ongoing since the mid-1970s.

7.2.3. Big Game Habitat Improvement Project

IPC, under a cooperative agreement with the ODFW, participated in the construction of 3.6 miles of fence to exclude cattle and improve forage for on critical big game winter range in the Pine Creek Big Game Management Unit. Under this agreement, ODFW provided fencing material, while IPC provided all equipment and labor. IPC also agreed to be responsible for all maintenance for a period of ten years.

7.2.4.
Cultural Resource Recovery Effort

IPC cooperated with the U.S. Forest Service (USFS) and the University of Idaho to conduct an archaeological field school at the Camp Creek archeological site (sites 35WA286 and 35WA288). This effort resulted in the recovery of important cultural resources, a successful information program presented to recreationists floating the Snake River below Hells Canyon Dam, and a technical report entitled *Archaeological Investigations at 35-WA-286 and 35-WA-288, HCNRA, Wallowa County, Oregon* (Letter Report 91-11, Alfred W. Bowers Laboratory of Anthropology, University of Idaho, Moscow).

7.2.5.
Cooperative Studies with State and Federal Agencies

7.2.5.1
Habits of Bald Eagles Wintering in Northeastern Oregon and Adjacent Areas of Washington and Idaho

(From Isaacs et al. 1992) (Cooperators: ODFW, University of Oregon, USFWS, Wallowa-Whitman National Forest, and IPC).

The ecology of bald eagles (*Haliaeetus leucocephalus*) in northeastern Oregon and adjacent areas of Washington and Idaho was investigated from November to April, 1988 to 1991. Objectives were to document eagle abundance, locate foraging areas, describe food habits, and locate and document use of night roosts. The estimated number of eagles on the study area peaked at 218 during early January 1989, 283 during mid-February 1990, and 291 during early February 1991. There apparently has been a substantial increase in bald eagle use of the area in recent years. Primary foraging areas were Brownlee (27 percent) and Oxbow (16 percent) reservoirs, the lower Wallowa and Grande Ronde rivers (23 percent), and the Wallowa Valley (15 percent); human activities could have substantial impacts on bald eagle use of those areas. Fish and large mammal carrion were the most obvious foods utilized; ground squirrels and waterfowl were also important. Forty-six night roosts were located and twelve more were suspected; many more roosts probably existed in inaccessible areas. The investigation helps facilitate habitat management activities such as maintaining or enhancing the prey base, providing perches where necessary in foraging areas, protecting roosts from timber harvest or other habitat degradation, and controlling human activities in areas where they conflict with bald eagle use.

7.2.5.2.
Validation of a Mountain Quail Survey Technique

(From Heekin and Reese 1995) (Cooperators: Wallowa-Whitman National Forest, IDFG, BLM, University of Idaho, Quail Unlimited, and IPC).

For the past several decades, mountain quail (*Oreortyx pictus*) populations throughout the intermountain region of the United States have been declining. As a consequence, managers have become concerned about the possibility of extirpation of remnant populations. However, because so few studies have been done on the species, information that would enable managers to develop effective management plans is unavailable. As a first step toward collecting more information on the species, managers have expressed a need for an economical and efficient means for surveying mountain quail. During May 1994, a calling survey was conducted in five areas in the Little Salmon River Canyon, in west-central Idaho. At least one radio-collared mountain quail was present in each area throughout the survey period. Therefore, calling surveys will be useful for detecting the presence of mountain quail in targeted areas, and this type of survey is the most efficient method available in terms of time and labor cost.

7.2.5.3.
Movements, Habitat Use, and Population Characteristics of Mountain Quail in West-central Idaho: Big Canyon Creek
(Cooperators: IDFG, Wallowa-Whitman National Forest, BLM, University of Idaho, Quail Unlimited, and IPC).

Mountain quail (*Oreortyx pictus*) in the intermountain region of the western U.S. have declined significantly during the past decades. This decline has been attributed to factors including:

1) the loss of winter habitat resulting from water impoundments on the Snake River;
2) a general loss of habitat due to increased agriculture along the Snake River corridor; and
3) an overall deterioration in habitat quality as a result of cattle grazing.

As a precursor to a comprehensive study of population declines in Hells Canyon, a pilot study was conducted to provide preliminary information about mountain quail distribution and abundance in Big Canyon Creek, Idaho. Winter flushing surveys began in early March. Survey methods included walking riparian habitats and attempting to flush or otherwise visually observe quail. No mountain quail were observed during this survey. Apparently, mountain quail no longer occupy this portion of Hells Canyon.

7.2.5.4.
Training Workshop to Identify Amphibians and Reptiles in the Hells Canyon Area
(Cooperators: Idaho State University, USFWS, and IPC).

Dr. C. Peterson, Curator of Amphibians and Reptiles at Idaho State University, gave a short course in March 1996 on identification, habitat use, and ecology of amphibians and reptiles known to occur or potentially occur in the Hells Canyon area. Its purpose was to provide all interested individuals working for state, federal, and private organizations the most recent information on identification, distribution, and ecology of amphibians and reptiles in the Hells Canyon area and expand the knowledge base pertaining to these species. The short course was hosted by IPC and was attended by representatives from the ODFW, IDFG, USFS, BLM, USFWS, Idaho State University, Boise State University, and IPC.

7.2.5.5.
Ecology of Hackberry, *Celtis reticulata*, in Idaho

(From DeBolt and McCune 1995)(Cooperators: University of Idaho, BLM, and IPC).

Netleaf hackberry was studied in Idaho to elucidate elements of the ecology of the species to evaluate the potential of the species in site enhancement and rehabilitation projects. Stands are typically represented by one dominant cohort; however, young, even-aged stands are rare and generally found along waterways on stream terraces or at the high-water line. Although slow-growing, netleaf hackberry shows promise for land managers interested in site enhancement. This native species is long-lived, produces fruit used by wildlife, and provides structural diversity in a semi-arid landscape. The species' persistence in heavily degraded ecosystems may speak to its suitability for rehabilitation projects as well.

7.3. Recreation Resources

7.3.1. IPC Recreation Facilities

IPC has made considerable investments over the last decade to enhance and improve recreational opportunities and facilities associated with the Hells Canyon Complex. These measures were not required as a condition of the original Hells Canyon License.

7.3.1.1. Hells Canyon Park

During 1994 and 1995, IPC constructed a new RV dump station at a cost of approximately $118,000.

7.3.1.2. Copperfield Park

In 1989, IPC completed reconstruction of Copperfield Park at a cost of nearly $2 million.

7.3.1.3. Copperfield Boat Ramp Facility

During 1994, IPC completed construction of this new facility at a cost of nearly $100,000.

7.3.1.4.
Oxbow Boat Launch

During the early 1990s, IPC installed a new composting toilet at a cost of approximately $15,000.

7.3.1.5.
Carter's Landing

During the early 1990s, IPC installed a new composting toilet at a cost of approximately $15,000.

7.3.1.6.
Woodhead Park

In 1995, reconstruction and expansion of Woodhead Park was completed at a cost of $7.5 million.

During 1996, the four-lane boat ramp was extended at a cost of nearly $82,000.

7.3.2.
Non-IPC Recreation Facilities

7.3.2.1.
Hells Canyon Creek Recreation Site

IPC has worked cooperatively with the USFS and other entities to improve the boat launching facilities. During 1992, IPC provided $20,000 toward improvements at this site.

7.3.2.2.
Deep Creek Access Trail

During 1989, IPC, USFS, and IDFG worked cooperatively to enhance the access trail from Hells Canyon Dam to Deep Creek. IPC's expenditures were approximately $31,000.

7.3.2.3. Big Bar

During 1996, IPC worked cooperatively with the USFS to enhance vault toilets, improve roads and establish some erosion control measures at Big Bar. IPC's expenditures were $5,000.

7.3.2.4. Hewitt/Holcomb Park

In 1986 and 1987, IPC provided a total of $69,670 to Baker County for the following improvements at Hewitt Park:

- shoreline stabilization and a walkway near the shoreline to provide access for the physically challenged;
- the boat ramp was extended to elevation 2048.5 msl, allowing better access to project waters; concrete steps to provide better access to docks; and
- asphalt surface to improve parking spaces for RVs.

In 1989, Baker County constructed an additional boat ramp and parking area known as Holcomb Park adjacent to Hewitt Park.

During the fall of 1996, IPC provided $35,000 for an additional extension to the existing boat ramp at Hewitt Park to make the reservoir accessible at an elevation of 2036 feet msl.

7.3.2.5.
Spring Recreation Site

In 1986, IPC provided $23,016 to assist in the placement of a single-phase power line to help meet the needs of the recreational facility and fire fighting crew.

7.3.2.6.
Steck Park

In 1990, IPC provided $20,000 to assist in the placement of a power line extension into Steck Park.

7.3.2.7.
Farewell Bend Recreation Area

IPC contributions to the Oregon Parks and Recreation Department for improvements at Farewell Bend have included:

- $58,739 to extend the existing boat ramp down to elevation 2048.5, allowing better access to project waters (1987);
- $25,000 for the construction of a new restroom facility adjacent to the park's boat ramp (1992); and
- $6,343 to enhance boating access facilities associated with the Farewell Bend Recreation Area (1996). Improvements included building an ADA-accessible fishing pier and footpath and repaving the existing boat ramp. In addition, IPC provided an interpretative sign for the boat ramp area at a cost of $2,463.

7.3.2.8.
BLM/IPC Memorandum of Understanding

During 1996, IPC contributed $30,000 to the BLM to implement measures identified in the MOU toward enhancements to facilities in Hells Canyon. IPC plans to contribute $7,000 toward additional efforts during 1997.

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Hells Canyon Formal
Consultation Package

VIII.
Proposed Resource Studies

VIII.
PROPOSED STUDIES

8.1.
Aquatic

8.1.1.
Title: Pollutant Sources to Hells Canyon Complex

Issues

A8. Water quality in Brownlee Reservoir.

A30. Evaluate the sources of water quality contamination in Brownlee Reservoir.

A60. Determine effects of all land management practices on water quality and aquatics.

Problem Statement

Pollutant loading to Brownlee Reservoir is resulting in substandard water quality conditions, as evidenced by fish kills and public health concerns.

Desired Future Resource Goals

Water quality in Brownlee Reservoir that fully supports all beneficial uses in the reservoirs and downstream.

Abstract

The goal of the study is to assess the pollutant sources to Hells Canyon Complex.

This study will focus on the contaminants identified as problematic from the results of the pollutant transport and processing study.

Introduction

This study will be closely coordinated with the pollutant processing and transport study. No additional data collection will be initiated until the transport and processing study has identified which pollutants are problematic. In 1995, Idaho Power Company (IPC) collected nutrient data for nonpoint sources from Swan Falls to Farewell Bend. These data will be summarized and analyzed prior to March 1998. Until the transport and processing study identifies other parameters of concern, no further design or action (beyond the report of the 1995 findings) on this study is warranted.

The objectives of the study are:

1) Identify pollutant sources and quantify loads.
2) Determine feasibility/options for reducing pollutant loads to the Hells Canyon Complex.
3) Determine load reductions needed to meet water quality standards or criteria.

State of Knowledge

Limited information is available on the sources of pollutants to the study area. Based on the limited development and tributary inflow to the reservoirs, it is reasonable to assume that most of the pollutants are being transported from upstream into the reservoirs by the Snake River. Nutrient data for point source discharges upstream of along the Snake River and tributaries should be available from NPDES (National Pollutant Discharge Elimination System) permits.

Methods

Existing data will be compiled and summarized to partition pollutant load sources to the Hells Canyon Complex. Additional field sampling and methodology cannot be developed until the problem pollutants have been identified.

Timetable

A report on the findings of IPC's 1995 sampling and literature search will be completed by October 1997.

Cooperation

Data will be compiled from NPDES permits and any other credible sources identified during the study. Agencies and IPC are expected to make a good-faith effort to identify and provide all existing relevant data.

Statement of Capabilities

The organization conducting the study will need experience and ability in currently accepted methodologies to calculate pollutant loads in the Snake River and any sources.

Deliverables

A report on the 1995 data collected by IPC on nonpoint source irrigation return water quality, and any point source data from NPDES permits or other sources will be completed for review by the Aquatic Resources Work Group in 1997.

8.1.2.
Title: Pollutant Transport and Processing Study

Issues

A8. Water quality in Brownlee Reservoir.

A20. Effects of operations on water quality below Brownlee Dam.

A21. Effects of the projects on mercury (also other heavy metals) within the system.

A22. Impacts of projects on downstream water quality.

A32. Effects on aquatic resources and water quality due to nutrient storage/buildup within all reservoirs.

A35. Accumulation of agriculturally based chemicals in reservoir sediment and effects on the aquatic species.

A41. Recreational impacts to water quality and aquatic resources(i.e. petroleum, waste dumping, oils, etc.).

A44. Nutrient cycling/processing in the impoundments.

A47. Water temperature effects, downstream, on aquatic resources.

A50. Evaluation of dissolved oxygen issues in Brownlee Reservoir when pool is low in the fall (fish kills have occurred).

A56. Stormwater impacts to water quality and aquatic resources due to maintenance and new construction.

A66. Meet water quality objectives for listed chinook and habitat in the lower Snake.

Problem Statement

Altered river transport and processing of pollutant loads as a result of project construction and continued operation has affected water quality in the reservoirs and downstream. Altered water quality affects beneficial uses (cold-water biota, warm-water biota, contact recreation). Metals, agricultural chemicals, low dissolved oxygen, high temperature, phytoplankton blooms, high nutrient levels, high pH, and suspended sediments are having a negative effect on beneficial uses in the reservoirs.

Desired Future Resource Goal

Water quality that fully supports all beneficial uses in the reservoirs and downstream.

Abstract

The transport and processing of pollutants through the Hells Canyon Complex, especially Brownlee Reservoir, has resulted in visible and obvious effects on beneficial uses. Fish kills, algae blooms, and health warnings related to fish consumption are examples of how this issue has been manifest in the past several years. Many of the pathways related to pollutant transport and processing are complex and not easily defined or understood. In order to complete this study within a reasonable time and budget, IPC proposes a phased approach. The first phase will be a reconnaissance-level survey to identify specific pollutants of concern. Only pollutants found to be problematic, or surrogates for problematic pollutants, will be studied beyond the first phase. The second phase will involve definition and quantification of pollutant loads and fate within the projects under current or altered operations. The goal of the study is to assess pollutant transport

and processing through the projects, and provide a mechanism for evaluating the effectiveness of protection, mitigation, and enhancement measures in ensuring beneficial uses are fully supported.

Introduction

The segment of the Snake River which contains the three projects has been designated by the State of Idaho as water quality limited (IDHW-DEQ 1992). A water quality limited segment is “any segment where it is known that water quality does not meet applicable standards or is not expected to meet applicable water quality standards even after the application of effluent limitations required by Sections 301(b)(1)(A) and 301(b)(1)(B) of the Clean Water Act.” Primary pollutants or stressors of concern include nutrients (including ammonia), sediment, bacteria, organic material, and temperature and dissolved oxygen.

Idaho is in the process of developing a database to evaluate the defensibility of the water quality limited status for designated streams. The methodology is so far only applicable to wadable streams, which do not include the Snake River within the study area. It is likely that Idaho will have to develop a Total Maximum Daily Load (TMDL) for the study area within the next five years. This current study is not being designed as a TMDL, but should provide valuable information that could be used in developing a TMDL.

This study is proposed in two phases to look at water quality indicators in the water column, sediments, and biological tissue. Before collecting additional data, IPC recommends a review of existing data with a written compilation and summary of all relevant data. The first phase will include a summarization of existing water column data for each of the parameters within the study area. Analysis will include an evaluation and description of the conditions that may be controlling pollutant processing in the complex (i.e. flow routing of nutrients, reservoir stratification, etc.). Data analysis will include summary of data relative to the Idaho and Oregon state standards, EPA Gold Book criteria, and trophic state indicators.

The first phase will also include a reconnaissance-level study for selected contaminants in biological tissue and sediments. Unlike water column data, IPC has not identified a significant amount of existing data. For this reason, immediate collection of data will be implemented. This part of the study will be similar to other reconnaissance contaminant studies in the upper Snake River, including the U.S. Geologic Survey (USGS) NAWQA project by Low and Mullins (1990), and an IPC survey of white sturgeon below Bliss Dam.

The second phase will predict the effects of protection, mitigation, and enhancement measures on pollutants which have been identified as being at levels of concern. This part of the study will involve identifying and quantifying pathways of pollutant sources, pathways and fate. IPC anticipates that conceptual and mathematical modeling will be a major part of this phase. Because of the potential complexity of this phase, only those parameters which have been confirmed during the first phase as concerns or a problem will be considered for detailed analysis.

The objectives of the study are:

1) Characterize the trophic state of the project through evaluation of existing data and additional monitoring.
2) Compare water quality in the projects with water quality standards and criteria.
3) Quantify the accumulation of metals and agricultural chemicals in fish or other indicator organisms.

4) Quantify the accumulation of metals and agricultural chemicals in sediment within the complex.
5) Predict the effects of proposed protection, mitigation, and enhancement measures, and operations on pollutant transport and processing through the projects.

State of Knowledge

Reservoirs are recognized as complex systems, with unique differences from rivers or lakes. Many of the processes involving pollutant routing and fate are not well understood. In addition, the unique nature of conditions in each reservoir adds complexity to understanding how a specific system is functioning.

Water quality problems in Brownlee Reservoir appear to occur frequently. In 1990, a major fish kill in approximately 10 miles of the upper end of the reservoir received widespread attention and publicity. The kill was attributed to low dissolved oxygen levels in the water column. Similar isolated kills, typically of small fish during summer months, are periodically reported. Transition zones in reservoirs where water quality is often diminished. The reservoir has been designated by the Idaho Department of Environmental Quality (DEQ) as water quality limited. This indicates that water quality is poor enough that not all designated beneficial uses are supported. In addition, fish tissue sampling for mercury has resulted in the issuance of health warnings. The warnings have been issued in response to levels of mercury that could be of concern to high-risk groups or to those eating large amounts of fish from Brownlee Reservoir. IPC has collected extensive data since the 1990 fish kill within the reservoir to identify water quality concerns. To date, these data have not been analyzed.

Methods

IPC has identified the water column, sediments, and biological tissue as the three compartments to evaluate for the presence of contaminants or pollutants. Table 8-1 identifies the water column parameters believed to be significant in describing water column quality, including trophic state. IPC has already collected a significant amount of data relative to these parameters. The parameters listed on Table 8-1 have been collected in Brownlee, Oxbow, and Hells Canyon reservoirs since 1991. Typically, monitoring occurred at least monthly, and mainly during the months of March through November. Monitoring occurred at multiple sites throughout the reservoirs, and also down through the entire depth of the water column. These data will be analyzed and summarized relative to the stated objectives of this study.

Sediments and biological tissue will be the focus of the screening efforts for contaminants. Most sampling will focus on biological tissue because of the obvious linkage within the food chain, and resulting effects on biological community health and human health. IPC anticipates that more sediment or water column sampling may be required if biological sampling indicates a reason for further concern. Additional sampling will then be required to evaluate sources and processing of the contaminant.

For biological sampling, IPC will sample five general locations during July or August 1997 (Table 8-2). Monitoring locations will include 5-mile segments of the river at the USGS gauges below C.J. Strike Dam, near Murphy, at Weiser, and Hells Canyon Dam, and in Brownlee Reservoir at Rock Creek.

Tissue samples will be collected for several species and size classes (Table 8-2). The samples will be analyzed for 33 contaminants (Table 8-3). Sampling will be limited to July or August for all species except white sturgeon. Five individuals of each species and size class will be collected at the USGS gauges near Murphy, near Weiser, and below Hells Canyon Dam, and in Brownlee Reservoir between Rock Creek and Mountain Man Lodge. White sturgeon will likely be an exception to the general sampling regime because of the relatively low density of these fish. Gonad tissue will be collected opportunistically throughout the year, and throughout the river rather than at one specific site. It is likely that the sampling team may be unable to collect five samples within each river segment.

The only site proposed for sediment sampling is in Brownlee Reservoir near Rock Creek, the location where substantial sedimentation is believed to be occurring. Sediment samples will be collected in Brownlee Reservoir (Table 8-3) between RM 320 and RM 310. Five samples will be collected at 2-mile intervals within this segment. A sample will be collected near the middle of the channel. A sample will consist of one 2-inch core. The core may be less than 50 cm in length, but length may vary based on the compactness of the substrate. The sample will be partitioned by particle size into a less than 63-µm fraction and analyzed for 29 compounds (Table 8-3). Contaminant analysis will only be conducted on this small particle-size fraction to enhance comparisons with published guidelines. Appropriate collection equipment will be used to avoid contamination of samples.

Timetable

Reconnaissance sampling will be initiated in the summer of 1997, with a completion report no later than December 1998. Development of methodologies for identifying transport and fate of problematic contaminants will begin in 1997. Final reports, which will include conclusions regarding potential protection, mitigation, and enhancement measures, will be completed no later than 2003.

Cooperation

Data will be compiled from Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), U.S. Forest Service (USFS), and any other resource agencies. Study scoping, design review, and semi-annual review will include all interested resource agencies and IPC.

Statement of Capabilities

The individual or organization conducting the study will require knowledge of the operations of the Hells Canyon Complex, knowledge and experience in sampling contaminants and other common water quality indicators, and the ability to coordinate and communicate with resource agencies and IPC.

Deliverables

A completion report for the reconnaissance levels of this study will be completed no later than January 31, 1998. The report will include data summaries and recommendations on subjects that warrant additional research.

8.1.3.
Title: Turbine Oil Losses from Hells Canyon Complex

Issue

P14A. Oil loss at turbines.

Problem Statement

Oil used for lubrication and/or pressurization of turbines and associated equipment has potential to leak into the river. Detrimental effects to downstream aquatic biota and recreational uses may occur.

Desired Future Resource Goal

To maintain a condition where no visible oil sheen or film on the water surface downstream of the project occurs.

Abstract

This study is proposed in response to a concern that operation of the Hells Canyon Complex is resulting in leakage of oil into the river. The study will determine how much oil, if any, is being leaked into the river, and what effects leakage may have on downstream resources.

Introduction

This study is proposed in response to a concern, raised at a public meeting, that IPC has to routinely add oil to powerhouse equipment. The implication is that the oil may be leaking into the river. At this point, the loss of oil has not been documented, nor has a detrimental effect to the river of any potentially leaked oil been observed.

The study has two objectives:

1) Quantify oil loss.
2) Describe the potential for visible or biological effects from leaked oil.

State of Knowledge

Oil is used in operating the generators. The formation of oil sheens or films downstream of the project as a result of operation of the project is not documented.

Methods

Operator records will be reviewed to identify how much oil is being used and at what replacement rate it is being added. If oil is being lost, a description of the quality of the oil and potential environmental impacts will be obtained from the manufacturer.

Timetable

The availability of records will be determined by April 1997, with preparation of a report by June 1997.

Cooperation

Study scoping, design review, and annual review will include interested resource agencies and IPC. Agencies and IPC are expected to make a good-faith effort to identify and provide all relevant data that currently exists.

Statement of Capabilities

The individual or organizations conducting the study will require the ability to compile data, research the potential effects of oil on aquatic resources, and communicate effectively with IPC and resource agencies.

Deliverables

A report of the results of the operator records, description of oil leaked, if any, and potential environmental impacts will be written and delivered to the Aquatic Resources Work Group by June 1997.

8.1.4.
Title: Oxbow Bypass Study

Issues

A2. Operational impacts to white sturgeon population.

A4. Effects of projects on bull trout.

A24. Impacts of power house operations on white sturgeon.

A37. Impacts of reach fragmentation and flow regulation on white sturgeon.

A48. Determine changes needed in dam operations and fish management programs to sustain a sturgeon fishery in Hells Canyon and Oxbow.

A53. Evaluate flow requirements for maintaining water quality in Oxbow bypass reach.

Problem Statements

1) Water quality in the Snake River from Oxbow Dam downstream to the powerhouse discharge (bypassed reach) has been altered by project operation.

2) Current status of native resident salmonid populations is unknown. Factors that may influence sustained viability may include: hatchery supplementation, isolation, land-use practices, loss of riverine habitat, water chemistry/quality/quantity, access to spawning tributaries, interactions with non-native species, modification of hydrograph, load-following, entrainment, food production.

3) White sturgeon populations are currently depressed and the probability of long-term persistence is in question. Causal factors may include: fragmentation of habitat, genetic isolation, food availability, modification of hydrograph, load following, modification of water chemistry quality, over-harvest, sediment transport, channel morphology, and entrainment.

Desired Future Resource Goals

1) Fully support all designated uses within the Snake River from Oxbow Dam downstream to the Oxbow powerhouse.

2) Ensure long-term persistence of resident native fish populations, not to exclude the optimization of a fishery.

3) Ensure long-term persistence of a self-sustaining population of white sturgeon not to exclude the optimization of a fishery.

Abstract

Construction of the Oxbow Development has resulted in reducing flow in a 1.5-mile segment of the Snake River. A flow of 100 cfs is currently maintained during all times except when the hydraulic capacity of the project is exceeded. During those times, water in excess of the hydraulic capacity is spilled through the bypassed reach. The Snake River upstream of the bypassed reach has been designated as water quality limited by the State of Idaho. Low flows in the bypassed reach will be expected to result in further degradation of water quality conditions. Water quality will be monitored throughout the reach under several flow levels and seasons. By defining water quality conditions under various flow conditions throughout the year, defensible flows required for maintaining water quality in the bypassed reach can be identified.

Flow versus habitat relationships as they relate to the minimum flow for bull trout, redband trout, and white sturgeon in the Oxbow bypass were identified as a concern. An Instream Flow Incremental Methodology (IFIM) study will be used to define these habitat-flow relationships to further evaluate minimum flow needs.

Introduction

Bypassing flows from the Snake River through the Oxbow powerhouse has resulted in altered physical, chemical, and biological conditions in the river. The Federal Clean Water Act requires IPC to obtain certification that operation of the project will not result in violation of state water quality standards (Section 401 certification). The bypassed reach has been identified by the DEQ for protection to support the designated beneficial uses of domestic water supply, agricultural water supply, cold-water biota, salmonid spawning and primary and secondary recreation.

The goal of this study is to determine what flow is required for maintaining water quality in the bypassed reach to fully support designated beneficial uses. Emphasis on supporting life stages of native salmonids and white sturgeon within the bypass reach will be used to evaluate the full support of cold-water biota. The specific study objectives are:

1) Determine parameters which are limiting the ability of the bypassed reach to support designated beneficial uses under the current 100 cfs minimum flow.
2) Define the relationship between flow and habitat parameters found to be limiting beneficial uses under the current 100 cfs minimum flow.
3) Identify a minimum flow required to support designated beneficial uses.
4) Determine habitat versus discharge relationships for appropriate life stages of white sturgeon, rainbow trout, and bull trout within the bypass reach.
5) Determine time periods and critical life stages of white sturgeon, rainbow trout, and bull trout within the bypass reach.

State of Knowledge

Flow in bypassed reaches is recognized as a controlling factor in water quality and habitat availability. Limited data exist on water quality conditions in the Oxbow bypass reach, and no information is currently available on flow versus habitat relations for any species of fish in the

Oxbow bypass. IPC collected data from April to September, 1994 at the head end of the bypassed reach, immediately below the spillway, and downstream at the tail end of the reach prior to mixing with the Oxbow powerhouse tailrace. Parameters measured included temperature, dissolved oxygen, pH, and conductivity. Temperature was the only parameter that was not within the limits of the state standards. Some vertical change in temperature and dissolved oxygen was evident through the water column under existing bypass flows. Conductivity appeared to decline through the reach, possibly suggesting significant processing of dissolved constituents within the bypassed reach. During July through September, inflowing water to the bypassed reach was warmer than the standard for cold-water biota. The current level of knowledge regarding the relationship of flow and water quality and flow and habitat availability for target fish species in the bypassed reach is not sufficient to properly define a minimum flow.

Methods

Physical habitat will be assessed using Instream Flow Incremental Methodology (IFIM) techniques. For assessing water column conditions, IPC has assumed that maintaining Idaho water quality standards will result in full support of all designated beneficial uses. The water quality portion of the bypass study is proposed as a two-year study. Year one will be used to describe existing conditions under the current 100-cfs minimum flow. If potential salmonid spawning habitat is found during the habitat survey, intergravel dissolved oxygen will be measured. Water column parameters to be measured include temperature, dissolved oxygen, pH, ammonia nitrogen, visible slime growths on substrate, and visible algae films on the water surface. Samples will be collected at the head end of the bypassed reach (see Table 8-5), the outflow from the bypassed reach, and in some cases at intermediate points within the reach. Some parameters will also be measured immediately upstream of the bypass intake to determine if inflow conditions meet standards.

Year two will determine the relationship between flow and the parameters found to be problematic under the current 100-cfs flow. Parameters limiting full support of the designated beneficial uses will be identified by the Aquatic Resources Work Group. Those parameters will then be evaluated to determine the minimum flow required to maintain standards.

Data will be collected for 12 water quality variables within the bypassed reach (Table 8-5). Sampling frequency will vary by parameter, ranging from once to hourly. Samples will be collected from April through October. Sampling locations will be immediately upstream of the spillgate, immediately below the spillway, immediately upstream of the confluence with Indian Creek, and at the tail end of the bypassed reach (RM 270). Consideration will be given to diel fluctuations of temperature and dissolved oxygen. Vertical profile measurements will be taken immediately upstream of the Oxbow Dam to identify the potential range of inflow water quality conditions. Existing data will be summarized and compared to Idaho and Oregon water quality standards, and EPA Gold Book criteria. For parameters found to be problematic, conditions will be monitored under a range of flow or operational scenarios to determine what flow will be necessary to remedy the problem.

The IFIM study will follow protocol established by the National Ecological Research Center (Milhous *et al.* 1984). Replicate cross-section transects representing identified meso-habitats classifications will be identified. Target species identified by the Aquatic Resources Work Group include bull trout, redband trout, and white sturgeon. A literature review will be conducted for information on habitat suitability for each species and life stage. If appropriate habitat use criteria cannot be located for a particular life stage or species, it may be necessary to use a surrogate. Any habitat use information collected during the priority drainage surveys may be useful if information for large rivers is not available. Habitat criteria will be determined by the Aquatic Resources Work Group.

Water surface elevations will be measured to represent two flow magnitudes: between 100 cfs and 1,000 cfs, and between flows of 1,000 to 10,000 cfs. If possible, water surface elevations will be measured for at least three flows in each of the above flow ranges. Continuous stage recorders will be used at each of the transects to assist in measuring water surface elevations. Because of the potential wide range in flows (100 cfs to more than 30,000 cfs), velocity measurements will be collected at a minimum of the present 100-cfs minimum flow to model the minimum-flow scenario, and at some moderate flow level that could be used for modelling periods when bypass flows are greater than 1,000 cfs. An underwater video system will be used to determine substrate classifications through out the bypass reach.

Timetable

The study will be initiated in April 1997. A summary of existing water quality data, and additional water quality data collection will occur during 1997. The Aquatic Resources Work Group will review the 1997 report, including study recommendations for 1998. Data collection in 1998 will be dependent on water quality measures that were found to be problematic under the current 100-cfs minimum flow.

Identification and classification of meso-habitats within the bypass reach using IFIM techniques will be completed in 1997. Literature review for habitat criteria will also be conducted during 1997. Water level elevations and velocity will be measured depending on flow availability and water years. Substrate mapping will begin in 1998. The timeline goal is to complete all model calibration measurements necessary by 1999 to allow adequate time for hydraulic and habitat modelling. The study will be complete by December 2000.

Cooperation

Agencies and IPC are expected to make a good-faith effort to identify and provide all relevant data that currently exists. Field data collection, analysis, and report writing will be the responsibility of IPC. Study scoping, design review, and review of draft deliverables will be the responsibility of the Aquatic Resources Work Group.

Statement of Capabilities

The individual or organization conducting the study will require knowledge of the operation of the Oxbow Project, knowledge and experience in monitoring standard water quality parameters and IFIM techniques, and the ability to coordinate and communicate with resource agencies and IPC.

Deliverables

A written report will be provided by December 2000. Periodic updates and reviews with Aquatic Resources Work Group members between 1997 and the time of final report completion will be conducted.

8.1.5.
Title: Total Dissolved Gas Study

Issues

A15. Effects of plant operation on total dissolved gas (TDG) levels.

Problem Statement

Under some operating scenarios, project operation results in elevated TDG levels which may adversely affect some aquatic species.

Desired Future Resource Goal

Maintain TDG levels within and downstream of the projects at levels less than 110 percent of saturation.

Abstract

Elevated TDG is known to have a detrimental effect on aquatic biota. The State of Idaho has established a standard of 110 percent of saturation for protecting aquatic biota. Water passing over spillways at dams is often found to have elevated levels of TDG. The goal of the study is to assess the effects of project operations on TDG. The study will yield the ability to predict the effects of operational and flow scenarios on TDG levels within and downstream of the projects. Results will be essential for evaluating the need for protection, mitigation, and enhancement measures to

minimize elevated TDG levels, as well as identifying potential operational measures to minimize supersaturation.

Introduction

The detrimental effects of supersaturation on aquatic biota including anadromous fish have been well documented. Supersaturation at dams downstream of the Hells Canyon Complex may be a significant factor affecting anadromous fish survival. TDG levels have been a concern below Hells Canyon Dam because of the presence of anadromous fish. Fall chinook spawn within 1 mile of Hells Canyon Dam, and spring chinook and steelhead adults are trapped and smolts released immediately below the dam.

The objectives of the study are:

1) Define the relationship between TDG and project operations.
2) Develop measures to predict TDG under a full range of operational scenarios.
3) Define dissipation of TDG below Hells Canyon Dam.

State of Knowledge

TDG monitoring downstream of Hells Canyon Dam has been conducted by IDFG, USFS, and ODFW. Existing data has documented the occurrence of supersaturation in excess of the 110 percent criterion below Hells Canyon Dam. Data have not been collected throughout the complex to identify cumulative increases or dissipation of gas at Brownlee or Oxbow under different flow and operating scenarios.

Methods

TDG levels will be monitored in inflowing water, spill, and tailraces at each of the three projects during periods of spill at any of the three projects. Spill may occur from February through June. Emphasis will be given to collecting data under the full range of spill conditions. Data from above and below each project during a given sampling episode will be collected within the shortest time possible to allow comparisons. Hand-held gas saturometers will be used. Periods of changing flow or operations will be avoided if possible. Regression analysis techniques will be used to quantify the relationship between inflowing TDG, spill scenarios, and outflowing TDG levels. Dissipation data (other than existing agency monitoring) below Hells Canyon Dam will not be collected in 1997. Existing data and spill to TDG relationships at Hells Canyon Dam developed by the 1997 monitoring will be used to design and conduct sampling below Hells Canyon Dam in 1998.

Timetable

The study will be initiated when spill first occurs in 1997 at any of the three projects. A report summarizing the existing data and data collected during any 1997 spill will be completed by October 31, 1997. The report will be provided to the Aquatic Resources Work Group for review and comment. Additional data collection will be dependent on the amount and range of data collected in 1997, and the comments of reviewers. If necessary, a report summarizing all data collection in 1997 and 1998 will be completed by October 31, 1998. The study is expected to be completed by the end of 1998, however, actual completion will be dependent on flow conditions and IPC’s ability to collect data under a full range of flows and operations.

Cooperation

Data from IDFG, ODFW, USFS, and any other resource agency with credible data will be compiled with TDG data. Study scoping, design review, and semi-annual review will include all interested resource agencies and IPC. All data collection, other than existing downstream monitoring, will be funded by IPC.

Statement of Capabilities

The individual or organization conducting the study will require knowledge of the operations of the Hells Canyon Complex, knowledge and experience in TDG monitoring, and the ability to coordinate and communicate with resource agencies and IPC.

Deliverables

A written report on existing data and data collected in 1997 will be provided by September 31, 1997. Analysis will include TDG, flow and operations relationships for each project. The report will also include recommendations for sampling at the dams, as well as sampling for dissipation below Hells Canyon Dam in 1998.

A written report compiling the first- and second-year findings will be provided by September 31, 1998. The report will include recommendations and justification for any additional sampling. The report will include potential measures for minimizing any elevated TDG levels identified during the study.

8.1.6.
Title: Sediment Transport Study

Issues

A9. Effects of sediment within all three reservoirs.

A10. Operational effects on downstream beaches.

A11. Effects of operations on downstream gravels and sediments.

P30A. Beach erosion from flow fluctuation.

P5T. Operation so as to provide more normal river flows so wildlife habitat and beaches are maintained.

P12T. Effects on beaches from jet boats.

P25T. Beach erosion.

P33R. Flow fluctuations (severe) affecting boat access and beaches.

Problem Statement

Sediment transport is reduced by lower water velocities in the impoundments. This affects downstream beaches, aquatic habitat, macroinvertebrate communities, and possibly cultural resources in the reservoirs and downstream.

Desired Future Resource Goal

Water quality will fully support designated beneficial uses within the Snake River from Brownlee Reservoir downstream to the HCNRA. Beneficial uses include:

- Cold-water biota.

- Salmonid spawning.
- Primary/secondary contact recreation.
- Domestic water supply.
- Agricultural water supply.

Beaches within the HCNRA are desired to support recreational use.

Abstract

This study is necessary because of the observed sediment deposition in Brownlee Reservoir, and the lack of sand deposition downstream of Hells Canyon Dam. The altered sediment deposition has changed the physical aquatic habitat and also riparian areas. Downstream riparian areas are of special interest to recreationists. The riparian areas have high recreational values as camping and resting areas. The goal of the study is to assess sediment transport and deposition through the projects. The study will allow assessment of the changes in sediment that have occurred within Brownlee Reservoir since impoundment. This information will be valuable in evaluating potential future changes to habitat. At this point, a significant portion of this study is not yet developed. Study designs and methodology for evaluating sediment deposition and transport downstream of Hells Canyon Dam will be developed through interdisciplinary coordination between aquatic, terrestrial, recreational, and hydraulic disciplines. Development of the studies will be initiated in 1997 by conducting a literature search, a bathymetric survey of Brownlee Reservoir, and aerial photography downstream of Hells Canyon Dam.

Introduction

Sediment transport and deposition have the potential to affect water quality, biological communities, and recreational use within the Hells Canyon Complex and downstream. Sediment loads entering the projects have not been quantified; however, turbidity and upstream land use practices indicate that sediment transport is likely an important process, especially in Brownlee Reservoir.

The issues associated with sediment are also linked to aquatic, terrestrial, and recreational resources. Lack of quantified relationships between suspended or deposited sediments and aquatic community structure and function may limit the results of this study. This study will require a high level of coordination between disciplines. The relationships of sediment, biological, cultural, and recreational uses must be defined before making objective conclusions related to protection, mitigation, and enhancement measures. This can be accomplished either through assumptions or empirical data collection. At this time, this aspect of the study has not been developed, but will be accomplished by an interdisciplinary study team.

A substantial component of this study must still be developed based on interdisciplinary relationships and linkages. An interdisciplinary team has been formed. The consensus of the team was that a literature search should be conducted in 1997 to provide information for refining issues and evaluating methodologies for studying the sedimentation issues downstream of Hells Canyon Dam. IPC has identified several questions or issues that may be resolved by the literature search, or may require additional study.

One question to be evaluated through the literature review is the quantity and quality of sediment available in-channel or from tributary sources for relocation or deposition below Hells Canyon Dam. Some sediment may be available within the river channel for relocation, and tributaries may also be sources of sediment.

A second question focuses on the sediment transport mechanisms and characteristics within the river downstream of Hells Canyon Dam. The Glen Canyon Dam experiment has been identified as an example of how reservoir management has been used to affect downstream sediment deposition. This experiment will be researched to determine how or if the experiment relates to Hells Canyon. Erosion by fluctuating water levels has been identified as a limiting factor to maintaining beaches below the complex. Public comments revealed the opinion that frequent flow fluctuations (caused by load following) downstream of the project eroded beaches that formed during periods of high flow.

A third question that should be answered with additional information collected in 1997 relates to the needs of each resource. IPC plans to evaluate the needs of each resource of concern, what will constitute enhanced or degraded conditions for each resource, and whether conflicts exist between resource needs.

A fourth question to be answered relates to the geomorphology of the downstream sand bars. Information about the evolution of the bars may be available from existing archaeological soils data. Additional information may be obtainable through coring. In both cases, studies of sand grain morphology and geochemistry may determine the extent to which Snake River sediments contribute to the construction of the bars.

The objectives of the study are:

1) Describe the quantity and quality of sediment deposits in Brownlee Reservoir since impoundment.
2) Describe locations and quantities of sedimentation areas between Hells Canyon Dam and the northern boundary of the HCNRA, using aerial photographs.
3) Conduct a literature review to scope and develop sediment studies downstream of Hells Canyon Dam.

State Of Knowledge

Grams and Schmidt (1991) noted a decline in sand beaches downstream of Hells Canyon Dam since installation of the project. Large sedimentation areas are visually apparent in Brownlee Reservoir. Visual comparison of the clarity of water entering and leaving the complex indicates substantial sedimentation in Brownlee Reservoir. IPC’s monitoring of turbidity and total suspended solids entering and leaving the projects shows that, on average, water entering Brownlee has a turbidity of 15 NTU and a total suspended solids concentration of 58 mg/l. After leaving Brownlee, the turbidity averages 2.6 NTU and the total suspended solids concentration averages 1.7 mg/l. Bathymetry data at seven transects within Brownlee Reservoir shows that substantial sediment deposition has likely occurred in the upper end of Brownlee Reservoir (Figures 1-8).

Methods

Hydroacoustic techniques will be used to survey the substrate within Brownlee Reservoir. Current bottom elevations will be recorded to allow for development of a bathymetric map of the entire reservoir. It is anticipated that depths will be recorded at 10-foot intervals along transects located approximately every 500 feet throughout the entire reservoir. Existing 20-foot contour pre-impoundment maps are available for comparison with maps developed during the bathymetric study. GIS technology (ArcInfo software) will be used to summarize and analyze data. Maps showing areas of deposition or erosion will be constructed to show spatial variation in deposition. Total volumes of accumulated or eroded material will be calculated for deposition/erosion areas within the reservoir. At a minimum, substrate sampling using a ponar dredge or coring device will be conducted within each area of deposition to determine the size fractions of material being deposited, and its organic content. This sampling will be limited to the upper 1 to 2 feet of the substrate. Areas of deposition/erosion and size characteristics of the substrate will be compared with velocity vectors within the reservoir. Velocity vectors will be modeled using CE-QUAL-W2-E. The model will be calibrated and verified using profile temperature and conductivity measurements taken throughout the reservoir. An estimate of the total amount (cubic yards) of material that has been deposited within Brownlee Reservoir will be calculated based on the bathymetric survey. Particle size composition will be used to partition out the amount of material with particle sizes smaller than cobbles.

A literature review will be conducted to identify research that has been conducted downstream of Hells Canyon Dam related to sediment transport. Also, literature on issues, studies, and management actions relative to loss of sediment recruitment in other systems will be compiled.

Color aerial photographs will be taken in 1997 during the time when high flows are receding. The exact timing will be dependent on flow conditions, weather, and shading conditions within the canyon. Photos will be taken from Hells Canyon Dam downstream to the northern boundary of the NRA. The scale of the photos will be taken in a manner to allow for identification and location of sediment deposition areas within the seasonal water level fluctuation zone. Photos will be taken in a manner to allow maximum comparison with existing historic photos.

If additional soils data need to be collected, sand bars will be cored according to a statistically designed sampling procedure. Sand grains, organics, and other soil constituents will be studied to determine the origin of the soils comprising the sand bars. This may provide insight into the proportional contribution of side-canyon sediments, and Snake River sediments in the deposition of the bars.

Timetable

The bathymetric survey for Brownlee Reservoirs will be completed by December 1997. Aerial photography will be conducted during summer 1997.

Cooperation

Study scoping, design review, and annual review will include all interested resource agencies and IPC. Study design and implementation will require multidisciplinary cooperation to ensure linkages between the physical processes and resource issues.

Statement Of Capabilities

The individual or organization conducting the study will require knowledge of the operations of the Hells Canyon Complex, knowledge and ability in conducting bathymetric surveys and sediment sampling, and expertise in resource issues related to sediment transport. The individual or organization will need the ability to coordinate and communicate with resource agencies and IPC.

Deliverables

A written report will be completed by October 31, 1998. The report will include bathymetric maps of Brownlee Reservoir including identification of deposition/erosion areas, and the quantity of deposited material within Brownlee Reservoir. The report will also contain a summary of qualitative characteristics of the deposited sediments. This will include particle size and organic content. The report will also include conclusions regarding the amounts and type of material that is likely being passed through Brownlee Reservoir based on the deposition patterns within the reservoir.

8.1.7.
Title: Evaluation of Anadromous Fish Potential within the Mainstem Snake River (RM 149 - RM 458) and Tributaries within the Hells Canyon Complex of Reservoirs.

Issues

A3. Effects of hydropower on anadromous fish above the Hells Canyon Complex and feasibility of reintroduction.

A7. Effects of hydropower on anadromous fish below the Hells Canyon Complex.

A11. Effects of operations on downstream gravels and sediments.

A16. Assessment of potential anadromous fish habitat in mainstem and tributaries above the projects.

A42. Evaluate alternatives for protecting fall chinook salmon spawning habitat below the Hells Canyon Complex.

A49. Evaluation of trophic structure in reservoirs and downstream including predation by squawfish on resident and anadromous fish.

A63. Evaluate present day and historical anadromous potential above the Hells Canyon Complex.

A66. Meet water quality objectives for listed chinook and habitat in the Lower Snake River.

Refined Issues

1) The status of anadromous runs (including Pacific lamprey) and available habitat in the Snake River Basin immediately prior to the Hells Canyon Complex construction.

2) The feasibility of re-establishing anadromous fish above the Hells Canyon Complex to Bliss Dam including tributaries contained within the Hells Canyon Complex.

3) Available habitat in the mainstem and tributaries above the Hells Canyon Complex.

4) The influence of the Hells Canyon Complex on trophic structure and inter- or intra-specific interactions between native and non-native species (includes squawfish predation and influence of salmon carcasses).

5) Opportunities and alternatives from the Hells Canyon Complex, or above the Hells Canyon Complex, for improving downstream anadromous fish flows for spawning, incubation, and passage.

6) Effects of Hells Canyon Complex construction on sediment transport in relation to aquatic resources.

Problem Statements

1) The Hells Canyon Complex and other barriers block access for anadromous fish to upstream mainstem and tributaries habitat.

2) Present availability of suitable anadromous fish habitat above and within the Hells Canyon Complex is unknown. Factors that may influence availability include: other dams, irrigation withdrawals, water quality, spawning habitat.

3) The loss of anadromous fish above the Hells Canyon Complex has altered the trophic structure and nutrient cycle, above and below the Hells Canyon Complex.

4) Flows and operations at the Hells Canyon Complex, which are influenced by upstream developments, has altered the natural hydrograph to the detriment of anadromous fish.

5) The Hells Canyon Complex has interrupted the transport of sediment and affected aquatic resources. Impacts may include a reduction in anadromous habitat and loss of aquatic invertebrates.

Desired Future Resource Goal

To provide conditions that will permit recovery and long-term persistence of anadromous fish (including Pacific lamprey).

Abstract

Anadromous fish studies associated with the Hells Canyon Complex will focus on two major areas:

1) feasibility of reintroduction of anadromous fish above the Hells Canyon Complex (including tributaries within the Complex), and
2) effects of the Hells Canyon Complex on physical habitat below Hells Canyon Dam.

Many factors may ultimately limit recovery of anadromous fish in these two areas, including influences beyond IPC's control. The study will focus on identifying limiting factors to anadromous fish in each of these river reaches. Limiting factor studies will focus on five major areas: water quality, water supply, habitat availability, barriers, and biological factors. Coordination with state and federal agencies will be critical to this study.

Introduction

The Aquatic Resources Work Group identified the following objectives for scientific studies related to anadromous fish and the Hells Canyon Complex:

1) Identify historic (immediately prior to construction of the Hells Canyon Complex) populations of anadromous fish by stream reach in the mainstem Snake River above Lower Granite Dam, and tributaries to the Snake River above Hells Canyon Dam.
2) Prioritize, by stream reach, limiting factors relative to restoring populations to historical levels. Potential limiting factors identified in the Aquatic Resources Work Group include various aspects of the following:
    a) Water quality.
    b) Water supply.
    c) Habitat availability.
    d) Barriers.
    e) Biological factors.
3) Evaluate restoration alternatives of anadromous fish in stream reaches relative to limiting factors.

State of Knowledge

The Snake River was once considered the most important tributary in the Columbia River Basin for production of chinook salmon (*Oncorynchus tshawytscha*) and steelhead *(O. mykiss*). Sockeye salmon (*O. nerka*) were prevalent in two tributaries of the Snake River, the Salmon and Payette rivers, and were associated with several high mountain lakes and tributaries. There is also some evidence that Coho salmon (*O. kisutch*) were present in the Bruneau River, a tributary to the middle Snake River (Armour 1990). In its natural condition, an estimated 1 million anadromous fish migrated to the Snake River above the present location of the Hells Canyon Complex (Armour 1990).

Beginning in the late 1800s, settlement and development of the Snake River Basin led to increased commercial harvest, habitat degradation, and construction of barriers to many of the tributaries and mainstem Snake River. The decline and ultimate elimination of some runs of anadromous fish were well underway even prior to the construction of Brownlee Reservoir in 1958. Swan Falls Dam, constructed by the Trade Dollar Mining Company in 1901, essentially became the terminus for migrating salmon in the Snake River, despite several efforts at fish ladder construction and modification. Sockeye salmon and other anadromous species were eliminated by several diversion dams and the construction of Black Canyon Dam on the Payette River in 1923. Anadromous runs on the Bruneau River were eliminated by dam construction near the mouth in the late 1800s (Evermann 1894). Placer mining throughout the Boise River drainage in the late 1800s significantly reduced runs in the Upper Boise River drainage. Barber Dam, constructed on the Boise River in 1906, eliminated anadromous runs above the city of Boise. In addition, several diversion dams constructed in the lower Boise River often rendered fish passage impossible during low water conditions (Parkhurst 1950). The Weiser River drainage was affected by water diversion dams throughout the mainstem and many of the tributaries, including the Galloway Dam, constructed in 1933 approximately 6 miles above the mouth. These diversion dams were often fish barriers, especially during times of low water caused by irrigation withdrawals (Parkhurst 1950). Construction of Owyhee Dam eliminated runs in the upper portions of the Owhyee drainage. In 1942, Parkhurst (1950) surveyed the lower portions of the Owyhee River and found that spawning conditions were unfavorable due to high water temperatures, diminished flows, and heavy siltation. The mainstem Malheur River had no complete barriers to fish prior to the Hells Canyon Complex, however, spawning conditions in the mainstem Malheur River prior to construction of Brownlee Dam were described by Fulton (1968) and Parkhurst (1950) as unfavorable due to low flows, excessive water temperatures, unscreened ditches, and siltation. The Middle Fork and the North Fork of the Malheur River were blocked by dam construction in 1919 and 1936, respectively. The Burnt River was found to be of little value to salmon by Parkhurst (1950). Mining and heavy agriculture influenced the quality of the river, and in 1936, the north and south forks of the Burnt River were blocked by construction of Unity Dam. Prior to construction of the Hells Canyon Complex, anadromous runs had been reduced to about 10,000 steelhead, 24,000 fall chinook, and 4,100 spring chinook (Armour 1990).

A lack of previous experience by federal and state resource agencies in passage of anadromous fish at high head dams such as Brownlee led to an understanding that passage efforts will be conducted on an experimental basis. Should passage efforts prove inadequate, the license agreement stipulated mitigation with a hatchery program (Haas 1965). After several years, downstream passage operations recommended by these entities were found to be inadequate and were discontinued in

1964. IPC then entered into an agreement with the Federal Power Commission (FPC), now the FERC, to construct and operate four hatcheries and transfer Snake River spring chinook and steelhead stocks to the Salmon River, pursuant to amended Article 35 orders (Fulton 1968). The completion of Hells Canyon Dam in 1968 constituted the new terminus of upstream migration.

Construction of dams in the Lower Columbia River and the Lower Snake River continued to impact returns of anadromous fish to the Snake River. At the time of completion of the Hells Canyon Complex in 1968, four lower Columbia River dams were complete, as well as Ice Harbor on the Lower Snake River. Two more dams on the Lower Snake River were completed by 1970, Lower Monumental and Little Goose. Lower Granite Dam, the fourth and uppermost lower Snake River dam, was completed in 1975. Snake River stocks of Pacific Salmon have continued to decline to very low numbers. Snake River sockeye salmon were listed as *endangered* under the federal Endangered Species Act on November 20, 1991, and Snake River spring/summer chinook and fall chinook were listed as *threatened* on April 22, 1992. In 1994, the listing for spring/summer chinook and fall chinook was reclassified to *endangered* under an emergency rule (NOAA 1995).

Present-day effects (not including the IPC anadromous hatchery program) of the Hells Canyon Complex on anadromous fish runs primarily centers around influence on habitats below the Hells Canyon Complex. These influences may include changes to the natural hydrograph as a result of operations of the Hells Canyon Complex, alterations to water quality, and alterations to spawning, incubating, and rearing habitat specific to fall chinook salmon.

Methods

1) Historic populations

Literature Review

The distribution and run sizes of anadromous fish immediately prior to construction of the Hells Canyon Complex will be determined by literature accounts and state or federal agency records. Early accounts of anadromous runs are included in Parkhurst (1950), Fulton (1968), Haas (1965) and Armour (1990).

2) Limiting Factors

A limiting factors approach will be taken to assess options of anadromous recovery below the Hells Canyon Complex as well as feasibility of reintroduction above the Hells Canyon Complex. The five areas of limiting factors identified by the Biological Subgroup of the Aquatic Resources Work Group include: water quality, water supply, habitat availability, barriers, and biological factors.

Water Quality

Water quality as a limiting factor will be examined by linking results of studies proposed by the Physical Subgroup of the Aquatic Resources Work Group. Studies will include: Total Dissolved Gas Study, the Sediment Transport Study, Pollutant Transport and Processing Study and Pollutant Sources to Hells Canyon Complex Study. Specific water quality parameters that will be linked as potential limiting factors will include temperature conditions during various life stages, dissolved oxygen concentrations, and total dissolved gas. Impacts of sediment transport will be assessed indirectly from results of sediment transport studies, and will also be assessed directly from artificial redds constructed with sediment intrusion baskets discussed later in this proposal. Another indirect qualitative assessment of sedimentation and sediment will be linked to the proposed Macrobenthic Invertebrate Study. Sediment transport relative to spawning sized gravels will be addressed in Section 2.3.2, Habitat Availability.

Water Supply

Objectives identified by the Aquatic Resources Work Group to examine water supply include:

1) Determine unaltered hydrograph at various locations along the Snake River.
2) Determine factors that influence altered hydrograph at various locations along the Snake River
3) Determine alternatives of changing hydrographs to maximize benefit to anadromous fish
4) Determine potential impacts to resident fish in the hydrograph alternatives.

Water supply objectives will be addressed in two sections:

1) inflows to the Hells Canyon Complex, and
2) outflows from the Hells Canyon Complex.

Inflows

Inflows to the Hells Canyon Complex are influenced by a complex system of multipurpose storage reservoirs in the Upper Snake River Basin (upstream of and including American Falls Reservoir) and irrigation withdrawals and returns throughout the length of the river. The majority of the reservoirs in the Upper Snake River Basin are under the control of the Bureau of Reclamation. The

Bureau of Reclamation is undertaking a process referred to as *SR*^{3} *- Snake River Resources Review.* The process involves development of a database referred to as a Decision Support System (DSS) for resource management decisions. Coordination with this process should meet objectives identified for studying water supply above the Hells Canyon Complex.

Outflows

Factors (other than inflow) that influence outflows from the Hells Canyon Complex will be identified. Known influences include: power generation, flood control, anadromous fish flows, and the IPC Fall Chinook Program. Criteria will be developed in coordination with the Biological Subgroup to determine what is optimal in terms of a hydrograph for maximum benefit to anadromous fish. Close coordination with the IPC Water Management Department will be maintained to develop operating alternatives. Impacts to the resident fishery will be determined by linking with the proposed Hells Canyon Complex Resident Fish Study, and the Status and Habitat Use of White Sturgeon in the Hells Canyon Complex Study, and various aspects of the habitat availability analysis.

Habitat Availability

Habitat availability and suitability will be assessed in the mainstem Snake River both above and below the Hells Canyon Complex for fall chinook spawning and incubation. The Swan Falls Instream Flow Study (Anglin *et al.* 1992) database will be used to evaluate habitat availability in the Swan Falls to Brownlee Reach of the Snake River. An instream flow study specific to known fall chinook spawning areas will be used to assess habitat availability below Hells Canyon Complex. Suitability will be assessed by the monitoring water quality and sedimentation in artificial redds in each river reach.

Habitat availability in the tributaries within and above the Hells Canyon Complex will be assessed for steelhead and spring/summer chinook based only on lineal miles of stream available and temperature conditions for various life stages. A literature review will be conducted for indications of suitability both before and after construction of the Hells Canyon Complex.

Spring/Summer Chinook and Steelhead Investigations

Spring chinook and steelhead were sympatric and the focus of habitat availability investigation for these species will be centered on tributaries upstream and within the Hells Canyon Complex. In a conceptual plan produced for the USDI Fish and Wildlife Serivce (USFWS), IDFG (1991) addressed reintroduction issues associated with the Boise, Payette, and Weiser Rivers as well as fall chinook reintroduction in the mainstem Snake River. A literature review will be conducted to estimate habitat available immediately prior to construction of Brownlee Dam. Specific drainages will include the Burnt, Powder, Malhuer, Owyhee and Wildhorse rivers as well as Pine and Indian creeks. All stream inventory and classification data available through state or federal agencies will be summarized and tabulated. A tabulation of lineal stream kilometers available to anadromous salmonids from the confluence of the above-mentioned streams with the Snake River to the first obstruction deemed impassable to anadromous fish will also be tabulated.

Thermographs will be placed in all seven of the above-mentioned Hells Canyon Complex tributaries and downloaded and redeployed four times a year. Data collected will be analyzed to determine if water temperatures remain within the critical ranges required to complete all freshwater life stages of spring chinook and steelhead trout.

Fall Chinook Investigations

Artificial Redds

Artificial redd sites will be selected that fall within optimal ranges of depth, substrate size distribution, water temperature and water velocity established by Raleigh *et al.* (1986). Three areas will be chosen for artificial redd construction:

1) below Swan Falls Dam in area of historic spawning,
2) below Hells Canyon Dam above the confluence of the Salmon River, and
3) below Hells Canyon Dam below the confluence of the Grande Ronde River.

Measurements will be made in and around the redds to determine the suitability of spawning substrates in relation to several variables that affect incubation conditions. Variables to be analyzed will include ambient and intragravel dissolved oxygen concentration, ambient and intragravel water temperature, and the accretion of fines over the typical incubation period of fall chinook. These variables, with the exception of fines, will be measured monthly from November through May for two consecutive years. Index values for fines will be determined immediately after redd construction in November, and in May at the end of what will be an incubation period.

Water velocities will be measured using a Marsh-McBirney electronic velocity meter to establish redd placement and measure velocities at the upstream edge of the artificial tailspill. Velocities will be measured at a point 20 to 25 cm above the substrate to approximate the "nose point" of spawning fish (Chapman *et al.* 1986). Intragravel dissolved oxygen values from within redds will be obtained by extracting water from a probe design similar to that described by Hoffman (1986). Ambient dissolved oxygen will be measured from water samples taken from the water column above the redd. A YSI Corp. dissolved oxygen meter will be used to determine dissolved oxygen concentrations in milligrams per liter (mg/l) and water temperature in degrees C.

Intrusion Baskets

Intrusion baskets (Burton *et al.* 1990; Arnsberg *et al.* 1992) constructed of extruded polyethylene will be fabricated and filled with substrate removed during artificial redd construction and placed in redds. One basket will be placed in each artificial redd. Half of the redds in each reach will have a second basket that will be removed immediately after completion of the redd. These baskets will serve as representative samples of disturbed substrates accumulating in the tailspill at the time of redd construction to establish baseline values (Burton *et al.* 1990). The remaining baskets will be removed in May. Fine sediments that accumulate over the incubation period will be dry-sieved and weighed and a percentage of fines in relation to total substrate composition (Burton *et al.* 1990) will be calculated for comparison to the scientific literature. A “Fredle index” value (Lotspeich and Everest 1981) will also be generated for comparison to scientific literature. Dissolved oxygen probes will be installed in all redds at time of construction. They will be placed in a horizontal position at a depth of approximately 20 cm (7.8 inches) to 25 cm (9.75 inches) and behind (downstream of) the intrusion basket. One redd per reach will be chosen at random and thermograph will be installed behind the dissolved oxygen probe.

Temperature

Water temperature will be recorded with thermographs distributed throughout the Swan Falls reach, and will be analyzed relative to critical life stages and durations. Temperature monitors will be placed within the main Snake River corridor below Hells Canyon Dam at approximately 10-mile intervals from near Redbird Creek (RM 156) upstream to Johnson Bar (RM 229). Additional thermographs will be placed within each of the three major tributaries: the Grande Ronde, Salmon, and Imnaha rivers. These instruments will collect water temperature data hourly, and will be periodically downloaded and reset. Data will be used to evaluate the relationships between temperature and spawning, incubation, and emergence.

Spawning Surveys

Spawning survey flights will be conducted along the main Snake River corridor between Asotin, Washington and Hells Canyon Dam during the fall spawning period. Flights will be performed on a weekly schedule and will begin in late October and continue through mid-December. Numbers and positions of new and old redds will be recorded during each flight on U.S. Army Corps of Engineers (COE) navigation charts of the Hells Canyon, Snake River. Ground observations will be used as needed to validate aerial data. These data will be used to:

1) describe the timing and distribution of spawning within the Snake River,
2) monitor redd numbers for trend analyses across years, and
3) locate representative spawning sites for habitat availability modeling.

Turbidity data will be collected during all aerial survey flights. Data will be collected at four locations:

1) downstream of the Grand Ronde River,
2) within the Grande Ronde River,
3) between the Grande Ronde and Salmon Rivers, and
4) upstream of the Salmon River.

These data will be used in the future, coupled with results from gravel mapping, to estimate the relative amount of habitat being observed during survey flights.

In order to evaluate the use of habitat in water too deep to be observed from above-water techniques, additional spawning searches will be conducted using remote underwater video. Selected sites will be intensively searched, and movement patterns of the camera will be surveyed from shoreline control points in order to evaluate the relative amount of habitat being searched each season. Prior to initiating each search, turbidity will be measured to determine the relative visibility and usefulness of the camera system. To provide a means of reproducing activities in following years, navigational aids will be placed on the shoreline, extending from a permanently marked location, through the length of the site. The remote underwater video camera will be placed on the nose of a 75-lb hydraulic sounding weight facing an upstream direction approximately 2 feet above the substrate.

Habitat Use Criteria

As spawning activity below Hells Canyon Dam declines in the fall, habitat use data will be collected at redds located during aerial and video-assisted spawning searches. Timing of physical habitat use data collection will be crucial in order to eliminate harassment of adult spawners, while maintaining conditions present during spawning activities. Physical data will be obtained at an anterior position on the perimeter of each redd depression. Variables measured at redds will include:

1) depth,

2) substrate characteristics,
3) mean water column velocity, and
4) water velocity at the substrate level (nose level).

Depths will be measured using either a top-set wading rod or a calibrated sounding reel. Water velocities will be measured with a Marsh-McBirney Model 2000 velocity meter. Substrate characteristics will be obtained by videotaping a portion of undisturbed material at the anterior of each redd, and comparing those images to reference video of known size characteristics. Data will be collected either:

1) by wading to redds at depths less than about 2 feet,
2) from an inflatable raft at redds between depths of about 2 to 6 feet, or
3) from a boat at redds deeper than about 6 feet.

Habitat Availability

The Swan Falls Instream Flow Study (Anglin *et al.* 1992) database will be used to evaluate habitat availability in the Swan Falls to Brownlee reach of the Snake River. Appropriate suitability curves will be used for freshwater life stages of fall chinook. Availability of habitat at representative spawning sites below Hells Canyon Dam will be accomplished through the use of standard instream flow hydraulic modeling data collection methods. A permanent control point and back sight will initially be marked at each site. Transects will be located throughout each site describing the downstream hydraulic control at locations where hydraulic conditions appear to change, and across areas where known or historical spawning occurred. Water surface elevations will be documented at each transect at a minimum of three stable discharges, representing a low flow, the spawning flow being provided, and a high flow. Velocity data describing the mean water column velocity will be collected at verticals across each cross section at least during the spawning flow. If possible, velocity data at verticals across each transect will also be collected during low and high discharge periods. Substrate data will be collected at each hydraulic transect using video methods described for habitat use description. Appropriate hydraulic models will be developed in cooperation with the U.S. Fish and Wildlife Service (USFWS), and will be used in conjunction with updated habitat use criteria to evaluate the relationship of habitat availability to discharge.

Additional substrate data will be collected throughout each site at transects placed at 50-foot intervals. A base contour map of each site will also be developed using standard survey techniques. Overlaying polygons will be developed describing the amount of area within each reference site covered by suitable depth, velocity, and substrate criteria at varying discharges. These polygons will be combined to produce models showing actual amount of habitat available within the reference sites in relationship to discharge.

Finally, all areas of current and historical spawning, as well as areas exhibiting potential spawning habitat below Hells Canyon Dam, will be identified and catalogued. Survey control points and back sights will be marked at each site, and the perimeter of suitable habitat will be mapped. Primary substrate of from 1 to 6 inches in diameter will be used as the criteria for grossly evaluating the quantity of habitat available in these areas. All data will be referenced to the stable spawning flow provided during the fall season. When completed, the analyses of these data will enable estimation of the production potential of the Hells Canyon reach of the Snake River. This data, when combined with turbidity data, will also allow indexing of the relative amount of habitat observed during aerial redd surveys, providing an objective means of analyzing trends across years.

Barriers

The Hells Canyon Complex

The Hells Canyon Complex currently has no fish passage facilities. A literature review will be conducted to describe problems associated with early efforts at downstream smolt passage through Brownlee Reservoir. A fish trap designed for capture of steelhead and spring chinook as part of the IPC Hatchery Program is operated below Hells Canyon Dam for truck transport to the Oxbow Hatchery or Rapid River Hatchery. No specific fish passage study for the Hells Canyon Complex will be proposed in conjunction with this study.

Above the Hells Canyon Complex

A pre-construction chronology of dam construction above the Hells Canyon Complex will be determined. To the degree possible, dams will include diversion dams that were known to be barriers to fish passage, and had influence on the distribution of anadromous fish. Present-day barriers will also be summarized.

Below the Hells Canyon Complex

A literature review will summarize the limiting factors relative to passage of anadromous fish at the eight federal hydroprojects on the Lower Snake and Columbia rivers, and the influence these barriers have had on returns of anadromous fish to river reaches influenced by the Hells Canyon Complex.

Biological Factors

A macrobenthic invertebrate study will be used to make a qualitative assessment of food availability for critical life stages of anadromous fish as a limiting factor for both above and below the Hells Canyon Complex. A literature review will be conducted on food habits of juvenile anadromous outmigrants.

A literature review will be conducted to assess potential impacts of squawfish and smallmouth bass predations on anadromous fish below the Hells Canyon Complex.

3) Evaluation of alternatives or needs for recovery of anadromous salmonids based on limiting factors.

In conjunction with the Aquatic Resources Work Group, alternatives will be developed for each stream reach to address recovery needs of salmonids. Alternatives will be developed based on the limiting factors analysis.

Timetable

1) Pre-construction chronology of anadromous run sizes and distribution.
   a) Literature Review - completed in 1997.
   b) Agency Records Review - completed in 1997.

2) Limiting Factors Analysis.
   a) Water Quality - timetable will be coordinated with water quality studies.
   b) Water Supply.
      - Inflows - Bureau of Reclamation SR^3 timetable.
      - Outflows - completed in 1999.
   c) Habitat Availability.
      - Above Hells Canyon Complex - completed in 1999.
      - Below Hells Canyon Complex - completed in 1999.
   d) Barriers - completed 1999.
   e) Biological Factors.
      - Aquatic Invertebrate Survey - timetable will be coordinated with aquatic invertebrate study.
      - Literature Review of Predation Impacts - completed in 1999.

3) Evaluation of Limiting Factors - completed in 2000.

Cooperation

External coordination will be required with the Bureau of Reclamation, ODFW, IDFG, USFWS, and the Nez Perce Tribe. Spawning survey flights, deep-water redd searches, and selection of representative spawning sites from modeling will be coordinated with and conducted cooperatively with the USFWS - Orofino.

Statement of Capabilities

IPC has the capability to conduct and successfully complete these studies with the resources available at the present time. The personnel required for this study are available from within the Aquatic Section staff and most of the equipment required, including vehicles and boats, is currently in department inventory.

Personnel directly involved in the study include: James Chandler, Fishery Biologist; Phillip Groves, Fall Chinook Biologist; and Robert Warburton, Environmental Assistant.

Deliverables

A final report will be prepared during the period 2000 to 2001.

8.1.8.
Title: Future Direction of IPC Anadromous Hatchery Program

Issues

A13. Evaluate existing IPC anadromous fish hatchery mitigation program.

Problem Statement

The existing IPC hatchery mitigation program may conflict with management plans designed to recover/protect wild stocks of anadromous fish.

Desired Future Resource Goal

Identify possible hatchery operations which will allow sport fishing opportunities for hatchery produced anadromous fish without detriment to the recovery and long-term persistence of wild stocks of chinook and steelhead.

Abstract

For years, fisheries managers have relied heavily upon hatchery production to maintain anadromous fish populations. Recent scrutiny of artificial propagation suggests that the role of fish hatcheries needs to be integrated into overall fisheries management plans in order to be successful. Through this study, IPC will describe the current hatchery mitigation program. Additionally, IPC will seek input from resource managers regarding the future role of the IPC hatchery program and how it may complement the long-term persistence of salmon and steelhead in Idaho.

Introduction

Artificial propagation has been an important tool to fisheries managers for the past 120 years (Mighetto and Ebel, 1995, Independent Scientific Group, 1996). Since their inception, hatcheries have been used primarily for harvest augmentation. Owing to the recent ESA listing of Snake River chinook, hatchery practices have received criticism for actually contributing to the decline of wild chinook and steelhead. Fisheries managers are now suggesting that the role of hatcheries in salmon production and restoration be redefined and coordinated into integrated management plans designed to protect and rebuild weak stocks. The IPC hatchery program is no exception. The purpose of this study is to identify reasonable objectives for the IPC hatchery mitigation program which will fully integrate it into future management of anadromous fish in Idaho.

Specific objectives of this study are:

1) Describe current hatchery mitigation program.
   a) History of program development.
   b) Current program goals.
   c) Results of current program:
      - Smolt to adult survival rates.
      - Estimated harvest rates.
      - Surplus production/contribution to other programs.

2) Determine components of future IPC hatchery mitigation program.
   a) Contract with a consultant experienced in conducting group surveys.
   b) Determine appropriate survey participants:
      - Collaborative team members.
      - Agencies and tribes.
      - Scientific community.

c) Identify information needed to determine role of IPC hatcheries in management of anadromous fish in Idaho:
   - Program goal (e.g. smolt production, adult returns, survival rate).
   - Program type (e.g. harvest augmentation, supplementation, captive brood).
   - Desired species and stocks.
   - Desired stocking locations.
   - Additional information.

d) Determine appropriate survey technique(s) for type of data required:
   - Written questionnaire.
   - Focus group.
   - Other.

e) Conduct survey.

f) Tally/compile results.

3) Prepare completion report for collaborative team.

State of Knowledge

Today about 80 percent of the adult salmon and steelhead entering the Columbia River are hatched and reared in a hatchery (Northwest Power Planning Council, 1992). Despite significant improvements in hatchery practices over the past 120 years, fisheries managers have been unable to completely offset the impacts of habitat degradation, overharvest, and loss of natural production through the liberal use of artificial propagation. Nonetheless, the use of artificial propagation is well engrained in fisheries management philosophy and remains widely used today. To illustrate, approximately 50 percent of the increase in salmon production predicted to come from the Northwest Power Planning Council’s program is expected to come from artificial propagation (Independent Scientific Group, 1996).

During the past two decades, fisheries managers have begun to place greater emphasis on habitat protection and enhancement to protect natural fish populations. This does not mean, however, that hatcheries no longer have a place in fisheries management. Hatchery-produced fish do contribute significantly to sport fisheries. Additionally, hatchery supplementation may play an important role in restoring depressed populations. The role and objective of hatcheries in salmon production and restoration need to be clearly defined and integrated into overall management plans.

Methods

Program History

IPC and IDFG historical records will be used to describe results of the current hatchery program. Annual spawntake, smolt production levels and adult rack returns will be compiled. Smolt-to-adult survival rates and harvest estimates will be calculated by brood year.

Future Program Direction

IPC will contract with a independent consultant for the purpose of identifying the key components of a hatchery program which will be fully integrated into the management of anadromous fish in Idaho. Specific methodologies necessary to obtain this information are yet to be determined, but may include written questionnaires or focus group interviews with selected resource managers and other fisheries professionals. The ultimate goal of this effort will be to determine each participants specific management objectives for salmon and steelhead and what role (if any) hatcheries may play in meeting these specific management goals. Results of surveys will then be compiled and a report on potential hatchery operations developed.

Timetable

The study will be initiated in 1997 and completed by 2001.

Cooperation

This study will be conducted in consultation with all agencies and interested groups participating in the relicensing process for the Hells Canyon Complex. Much of the historical data necessary to describe the results of the existing IPC hatchery program is contained in IDFG hatchery reports. Access to their archived material will be necessary. Input will be solicited from IDFG, ODFW, USFWS, and National Marine Fisheries Service (NMFS) (possibly others) to identify long-range management goals for anadromous fish and possible hatchery operating scenarios.

Statement of Capabilities

IPC has the personnel and equipment to successfully complete this study. The IPC principal investigator will be Paul Abbott. Mr. Abbott holds a B.S. degree in fishery biology and has been responsible for oversight of the current IPC hatchery program for the past seven years.

The consultant chosen to prepare and conduct the informational survey will be required to demonstrate extensive experience in this field of data collection.

Deliverables

Annual progress reports will be presented to the Aquatic Resources Work Group for guidance and recommendations. Additional updates and/or solicitation of input from collaborative team members will be done as necessary at critical stages of the study. A draft report will be available by July, 2001 and finalized by October, 2001.

8.1.9.
Title: Status and Habitat Use of White Sturgeon in the Hells Canyon Complex

Issues

A2. Operational impacts to white sturgeon population.

A5. Status of white sturgeon population in Brownlee Reservoir, Swan Falls reach (reproductive spawning).

A24. Impacts of powerhouse operations on white sturgeon.

A28. Evaluation of fish passage options (upstream and downstream) for resident and anadromous fish.

A37. Impacts of reach fragmentation and flow regulation on white sturgeon.

A48. Determine changes needed in dam operations and fish management programs to sustain a sturgeon fishery in Hells Canyon and Oxbow.

A55. Model the long-term probability persistence (how long can they last) of white sturgeon under current operating conditions.

A58. Evaluate historic hydrographs as they relate to present river flow conditions to assist with determination of operational changes needed to sustain sturgeon population.

Problem Statement

White sturgeon populations are currently depressed and the probability of long-term persistence is in question. Causal factors may include: fragmentation of habitat, genetic isolation, food availability, modification of hydrograph, effects of load following, modification of water chemistry quality, over-harvest, sediment transport, channel morphology and entrainment.

Future Desired Resource Goal

To ensure long-term persistence of a self-sustaining population of white sturgeon not to exclude the optimization of a fishery.

Abstract

Assessment of white sturgeon (*Acipenser transmontanus)* in the Hells Canyon Complex is proposed. Study objectives include evaluation of the population's status, suitability/availability of habitat used by various life stages and identifying appropriate enhancement measures to mitigate for potential limiting factors. Methodologies employed in IPC's ongoing white sturgeon research will be used to provide continuity to the Hells Canyon Complex studies.

Introduction

Members of the Aquatic Resources Work Group, with representatives from state, federal, tribal, and public entities, identified the white sturgeon as one of several aquatic species influenced by the Hells Canyon Complex. The Work Group expressed concern over impacts to the viability and persistence of sturgeon populations isolated by dams in the Middle Snake River. Current information on sturgeon in the project area is limited, which warranted investigation of their status and potential impacts from the Hells Canyon Complex. White sturgeon are considered a State of Idaho *species of special concern* (Mosley and Groves 1990) with limited access to historical habitat due to development of the Snake and Columbia River hydrosystem.

The proposed study objectives by the Aquatic Resources Work Group are:

1) to determine existing status by reaches including age structure, abundance, reproductive potential, genetic viability, distribution, relative condition,
2) to determine existing habitat use/ suitability/availability by reach and different life stages, and
3) to identify potential limiting factors by reach.

The goal of this study is to provide data necessary for identifying potential protection, mitigation, and enhancement opportunities for sturgeon. Participants of the Work Group concurred that existing passage alternatives and technology will be evaluated if Hells Canyon Complex study results indicate passage is the limiting factor critical for sturgeon persistence in the Snake River.

The study objectives are consistent with IPC's on-going sturgeon surveys upstream from the Hells Canyon Complex. During relicensing consultation of Upper Salmon, Lower Salmon, Bliss and C.J. Strike, the White Sturgeon Technical Advisory Committee (WSTAC) identified, developed and coordinated potential white sturgeon studies that were considered necessary to maintain a viable, wild, and naturally producing population in the Middle Snake River. Study goals developed by WSTAC participants (IPC, IDFG, and USFWS representatives also involved in the Aquatic Resources Work Group) for sturgeon in the Middle Snake River were to assess the population status and determine possible protection, mitigation, and enhancement strategies. Specific study objectives were

1) evaluate the gear used to sample white sturgeon,
2) determine population status with regard to population abundance, structure, and health,
3) describe movement and physical habitat use for each lifestage of white sturgeon, and
4) document the occurrence of spawning and describe the physical habitat associated with spawning.

The proposed study objectives and methodologies for the Hells Canyon Complex will provide continuity with IPC's existing sturgeon research and form an integral part in identifying limiting factors and appropriate enhancement measures for sturgeon throughout the Middle Snake River.

State of Knowledge

Many factors, including the construction of dams, habitat alterations, pollution, and historical exploitation, have all contributed to the current status of sturgeon in the Snake and Columbia rivers. White sturgeon have population characteristics that include slow growth, delayed maturity, and low spawning frequency. During the late 1800s, the biology and reproductive potential of sturgeon were not understood, which allowed for quick overharvest. This became apparent during the commercial fishery harvest on the lower Columbia River in 1892, which peaked at 5.5 million pounds and subsequently collapsed by 1894 (Hanson *et al.* 1992).

Similarly in Idaho, abundance of sturgeon in the Snake River was apparently declining by the late 1930s and investigation of spawning, feeding, and migratory habits was in order to determine proper seasons and manner of taking (The Idaho Wildlife Review 1956). Regulations were first implemented in 1943 and became increasingly restrictive until 1970 when a catch-and-release fishery was adopted for the entire Snake River in Idaho (Table 8-6). Prior to 1943, sport and commercial sturgeon fishing in Idaho was not regulated (Hanson *et al.* 1992). Commercial fishing for sturgeon in Idaho began in the mid-1890s and lasted for approximately 48 years until eventually prohibited in 1943.

It was following the collapse of commercial sturgeon fisheries (and general decline in their abundance throughout the Snake and Columbia rivers) that numerous mainstem hydroprojects were built, altering the riverine habitat. During this era of powerplant construction, passage facilities specifically for sturgeon were not considered. Many of the projects were built with inadequate (overflow weir-type ladders designed for salmon and steelhead migrations) or no passage facilities, which isolated sturgeon within various reaches (Table 8-7). The success of sturgeon persistence within isolated reaches now relied on the remaining population size, reproductive potential, harvest restrictions, project operations, and suitable habitat available to complete their life cycle. Although many ladders for salmon and steelhead have undergone design improvements as new biological knowledge became available (Warren and Beckman 1993), no advances in passage technology to benefit sturgeon have been made.

Current abundance of white sturgeon in the Snake River today varies considerably by reach. Although sturgeon remain relatively abundant between Hells Canyon and Lower Granite dams (Cochnauer 1985, Lukens 1985), abundance upstream from Hells Canyon Dam to Swan Falls appears considerably lower (Table 8-8). Current information on the status of sturgeon and their habitat use in the project area is limited. Habitat use relative to all life stages has not been assessed throughout the Middle Snake River prior to the initiation of IPC's white sturgeon studies in the Bliss reach. Previous research specific to the Hells Canyon Complex area was primarily descriptive for subadult/adult abundance and distribution (Cochnauer 1983, Cochnauer 1985, Lukens 1984, Coon *et al.* 1977, Coon 1978).

Methods

Study Area

The study area for white sturgeon encompasses 270 miles of Snake River from Swan Falls Dam (RM 458) downstream to the mouth of the Salmon River (RM 188; Figure 2.1). The furthermost upstream dam in the Hells Canyon Complex is Brownlee Dam (RM 284.6) which is the largest reach. Brownlee Dam impounds water for 55.4 miles and has approximately 1,000,000 acre-feet of active storage, with a surface area of 6,100 acre-feet at full pool (2077 ft msl). Average depth is 32 m with a maximum depth of 92 m. Reservoir draw-downs approaching 30 m are common during winter months for Corps flood control requirements. Brownlee Reservoir serves as a storage project providing power, flood control, and recreational benefits.

The Snake River above Brownlee Reservoir is free-flowing for 118 miles upstream to Swan Falls Dam (Figure 2.1). The upper 8 miles of river from Swan Falls Dam (RM 458) to RM 450 is high gradient with vertical canyon walls, high-velocity narrow runs, rapids, and intermittent deep pools. The area downstream from this section is shallow and low gradient, with numerous island complexes and braided channels. This portion of the river extends for 110 miles through agricultural farmlands before entering Brownlee Reservoir. Nutrient loading from agricultural and municipal sources and industrial practices is high in this reach. Several large tributaries occurring within this reach include the Boise, Malheur, Payette, and Weiser rivers.

The second project, Oxbow Dam (RM 272.2) is located 12 miles downstream from Brownlee Dam. The tailrace from Brownlee Dam to the mouth of Wildhorse Creek (1.6 km) is a high-velocity narrow channel. Oxbow Reservoir's maximum depth is 24 to 30 m and daily fluctuations up 1.2 m are common. Shorelines are primarily basalt outcrops and talus.

The final dam in the three-dam complex is Hells Canyon Dam (RM 247.0) which impounds water for 22 river miles. The reservoir has a surface area of 2,412 acres at normal full pool surface elevation of 1688 feet msl. Total storage at normal full pool is approximately 167,720 acre-feet. The reservoir has a maximum depth of 60 m and is also characterized by steep shorelines with basalt outcrops and talus slopes. The Snake River below Hells Canyon Dam flows 107 miles through the deepest gorge in North America before entering Lower Granite Reservoir. This portion of Snake River is high gradient with numerous large rapids, deep runs, and pools.

Sampling Design

Brownlee Reservoir to mouth of the Salmon River

The Snake River will be divided into 0.1-river-mile increments from Brownlee Reservoir to the mouth of the Salmon River (RM 188). Each 0.1-river-mile increment will represent a potential sample transect and will be categorized into one of three depth ranges: shallow (0 to 20 feet.), mid (21 to 40 feet.) and deep (>40 feet.). Sample transects within each project reach will be randomly selected in proportion to the depth categories identified within their respective reach. A minimum of five sample passes using standardized collection methods will be conducted within each project reach for population determinations. Collection gear for sturgeon will be set in the deepest cross-section (thalweg) of the channel. Additional gear sets will be deployed in areas adjacent to the thalweg (typically on elevated benches if present) when sampling Brownlee, Oxbow and Hells Canyon reservoirs. Information collected below Brownlee, Oxbow and Hells Canyon dams will focus on operational influences for sturgeon.

Above Brownlee Reservoir

Preliminary sampling for sturgeon was conducted by IPC during August to November 1996 to determine initial abundance, distribution and develop sampling protocols upstream of Brownlee Reservoir for 1997. A ten-week synoptic survey from the upper half of Brownlee Reservoir (RM 320) to Swan Falls Dam captured 27 sturgeon. One sturgeon was collected near the upper end of Brownlee Reservoir. The remaining 26 fish were sampled within 8 miles of Swan Falls Dam. No sturgeon were sampled in the expansive and low gradient section of river between Celebration Point (RM 449.5) and the upper end of Brownlee Reservoir.

Based on information collected from the synoptic survey and the need for timely field collections, sampling efforts in the free-flowing river above Brownlee Reservoir will focus only at the top of the reach where sturgeon were captured. A minimum of five sample passes will be conducted from Swan Falls Dam downstream to RM 447. Monitoring radio/sonic tagged sturgeon will be conducted throughout the reach. The baseline data collected below Swan Falls Dam will be used to describe the population status and potential impacts to sturgeon from Brownlee Dam; however, specific impacts to sturgeon by Swan Falls operations will be further addressed in studies associated with the relicensing of Swan Falls Dam between 2002 and 2005. The federal license for Swan Falls Dam expires in 2008.

Collection Gear

Baited setlines and experimental gill nets will be used to assess relative and absolute abundance of sturgeon upstream from Hells Canyon Dam. Downstream from Hells Canyon Dam, setlines will be the primary collecting gear, while use of gill nets will be limited and will serve as a supplemental effort. Nets will be fished only when migrating adult/smolt salmon and steelhead are not present in the study area. Setlines will be deployed over a three-day interval and checked at regular intervals. All gill net sets will be restricted to a one-hour sampling duration.

Each setline will consist of a 27-m mainline of 0.64-cm (0.25-in) diameter twisted, medium-lay nylon rope. A gangen line with a main line clamp is attached every 3 m for a total of six hooks per line. Gangen lines consisted of a 4/0 ball bearing swivel attached to a stainless steel hog ring, and a cadmium-tin coated circle tuna hook (Mustad 39965, size 16/0, 14/0, 12/0). Each setline contains six hooks consisting of two each of size 16/0, 14/0, and 12/0 hooks rigged in random order. Some setlines will be rigged exclusively with

10/0 hooks in an effort to capture smaller white sturgeon. Line weights (10 kg) will be attached to each end of the setline. A float line and buoy tethered to each setline will facilitate retrieval. Experimental sinking gill nets, constructed of multifilament twine, will be used extensively in reservoirs and in areas where low water velocity permits. Nets are constructed with five 25-foot panels with bar mesh ranging from 1 to 5 inches.

Corrections for gear selectivity will be made using mark-recapture data. Vulnerability will be estimated using the ratio of recaptures to marks-at-large within 20-cm (7.8 inches) fork-length (FL) intervals. A smooth function will be fitted to the data and the observed length frequency distribution will then be corrected by dividing the observed frequency in each size class by the predicted vulnerability (Beamesderfer and Rieman 1988).

Capture and Handling

Captured white sturgeon will be placed into a vinyl stretcher with water supplied via bilge pump allowing the fish to respire throughout the handling time. Fish too large to handle onboard will be examined alongside the boat. Pectoral girth, fork, and total length (TL) will be recorded to the nearest cm. Weight will be recorded to the nearest 0.1 kg (0.22 pounds). White sturgeon will be tagged with 125-kHz Passive Integrated Transponder (PIT) tags. PIT tags are inserted into the musculature at the base of the right side of the dorsal fin. White sturgeon greater than 150 cm (58.5 inches) TL will be surgically examined for sex and maturity (Table 8-9) by methods outlined in Conte *et al.* (1988) and Beamesderfer *et al.* (1989). Oxytetracycline (OTC; 200 mg/ml) will be injected in the dorsal musculature at a dose of 5 mg OTC/kg of body weight to serve as a post-surgery antibiotic.

Habitat Use

Physical habitat used by sturgeon will be determined by measuring depth, water velocity (surface, mean column and near-substrate), dissolved oxygen, temperature and substrate at each gear set. Water depth will be recorded to the nearest 0.1 m (4 inches) with a calibrated sounding reel attached to a boat-mounted boom assembly. A Marsh McBirney MMI 2000 Flo-Mate portable flowmeter with 6.8-kg (15-pound) to 34-kg (75-pound) sounding weights will be used to quantify water velocities. Surface and near-substrate temperatures and dissolved oxygen readings will be recorded with a Hydrolab Surveyor II. Additional hourly temperature data will be collected with Hobo thermograph recorders placed throughout the study area. Substrate type will be determined by a ponar dredge and/or remote underwater video camera.

In addition to habitat data collections, adult and juvenile white sturgeon will be fitted with combination radio/ultrasonic transmitters to monitor fish movement and identify habitat use by various life stages. Transmitters will be mounted externally by passing a braided stainless wire through the flesh just below the anterior and posterior edges of the dorsal fin. Tags will operate on various frequencies (kHz) and emit unique codes for individual fish identification. A directional hydrophone and receiver (Sonotronics Model USR-4D) will be used to locate sonic-tagged sturgeon in reservoir habitat. Three-and six-element directional yagi antennas with a Lotek SRX 400 radio receiver will be used to locate sturgeon in shallower riverine environments. Attempts to locate tagged sturgeon will be made at least every two weeks to describe seasonal movement and habitat use.

Habitat use curves will be constructed from data collected at sampling sites. Habitat associated with spawning areas will be described in detail, including mapping of flows, substrates, and changes in discharge. Information from existing IFIM studies conducted in the Middle Snake River will be incorporated where appropriate.

Spawning and Early Life

Efforts to identify spawning sites from Swan Falls Dam to the mouth of the Salmon River will focus on areas conducive for sturgeon spawning based on information collected in the middle Snake River. Monitoring reproductive radio/sonic tagged sturgeon will also aid in identifying potential spawning locations and focus egg /larval fish collection efforts.

Spawning activity will be documented using artificial substrate mats as described by McCabe and Beckman (1993). Mats will be deployed March to June for egg and larval collection. Mats will be checked at least once per week. All eggs and larvae will be fixed in 10-percent unbuffered formalin and preserved in 70-percent alcohol. Eggs and larvae will be assigned a developmental stage (Beer 1981). Time of fertilization will be estimated with the relationships developed by Wang *et al.* (1985).

Population Abundance

The sturgeon population between the mouth of the Salmon River and Hells Canyon Dam will be estimated using a Jolly-Seber open population model (Ricker 1975). A computerized Jolly-Seber model performs the matrix calculation and 95 percent confidence intervals.

$$N_i = (M_i * n_i)/m_i$$

where:

N_i = population estimate at *i*th interval

$M_i = (Z_i * R_i + m_i)/r_i$

Z_i = individuals marked prior to *i*th interval but not caught in *i*th interval

R_i = number released with marks

r_i = number of ni observed after time *i*

m_i = number recaptured at time *i*

Abundance of sturgeon in Hells Canyon and Oxbow reservoirs will be estimated using a modified Schnabel multiple mark recapture estimator with a less than 10-percent recapture rate (Ricker 1975):

$$N = \sum(C_t * r_t)/ ((\sum r_t) + 1)$$

where

C_t= total sample taken during pass t,

m_t= total marked fish at start of pass t,

r_t= number of recaptures in the sample C_t.

Confidence intervals (95 percent) were calculated by:

$$r' = (\sum r_t) + 1.92 +- 1.96 * (sqrt (\sum r_t + 1))$$

White sturgeon recovered in the same sample interval in which they were marked will not be counted as recaptures in the population estimate. Relative abundance and distribution of white sturgeon will be determined by computing catch rates (fish/hr) by gear type.

Population Structure

Adjusted length frequency distribution of white sturgeon will be used for evaluation of the population structure. Fork length (cm) and weight data (kg) will be fitted to a standard allometric function: $W = a\,l^{b}$ to determine condition factor. Condition factor of sturgeon will be compared among reaches with estimates of mean relative weight based on the standard weight equation(W_s): $W_s = 2.735E\text{-}06\ FL^{3.232}$ (Beamesderfer 1993). Surgical inspection of gonads will provide estimates of sex ratio, stage of maturity, and proportion of females spawning each year.

A small section of fin ray from the leading edge of the left pectoral fin will be removed from each captured sturgeon. Fin sections will be transversely sectioned and mounted on a glass microscope slide. Each continuous translucent growth ring will be considered an annulus and used for age determination.

Mortality will be determined from catch curves corrected for gear selectivity. Instantaneous total mortality (Z) is calculated from the slope of the descending limb of a log transformed catch curve (Ricker 1975). Natural log of catch is then fitted with a linear regression on greater than five observations to determine absolute Z. Approximate

95-percent confidence limits about Z will be estimated from the regression as ± 2 SE. Total annual mortality (A) can be derived as A = 1-S where survival rate (S) = e^{-Z}.

Genetic composition of sturgeon within and between reaches will be determined using DNA techniques. Blood (2 ml) will be taken from each captured sturgeon from the ventral surface of the caudal peduncle posterior to the anal fin. Blood will be collected in heparinized vials using sterile collection techniques. Samples will be kept on ice in the field and frozen as soon as possible. Duplicate blood samples will be taken to insure against lost information. A maximum of 100 blood samples from wild sturgeon will be collected in each reach. Genetic analysis will be contracted to a genetics lab for DNA analysis.

Timetable

Field studies identified for white sturgeon during the consultation process will begin in March 1997 and are targeted for completion by June 2001 (Table 8-10).

Brownlee Reservoir

Preliminary scoping was conducted in 1996 from Brownlee Reservoir upstream to Swan Falls Dam to identify initial abundance and distribution of sturgeon. Sampling in Brownlee Reservoir and the section of river between Swan Falls Dam and RM 447 will begin in March 1997 and be completed by June 1997. Efforts to identify spawning activity below Swan Falls Dam will be conducted from March to June during years 1997 to 2001.

Monitoring radio/sonic tagged sturgeon from Brownlee to Swan Falls dams will occur for the duration of the tag life (approximately 50 months).

Hells Canyon Dam to the Mouth of the Salmon River

Preliminary scoping below Hells Canyon Dam will be initiated in September through August 1997 to identify logistic constraints and initiate preparation for 1998 field activities. Field collections will be completed by June 2001. Sample efforts addressing spawning activity will occur from March to June. Setline and gill net sampling will occur from July to November.

Oxbow Reservoir

Field studies between Oxbow and Brownlee dams will begin in 1998 and are targeted for completion in 2001. Sample efforts addressing spawning activity will occur from March to June. Setline and gill net sampling will occur from July to November.

Hells Canyon Reservoir

Field studies between Hells Canyon and Oxbow dams will begin in 1998 and are targeted for completion in 2001. Collection gear used to address spawning activity will be deployed from March to June. Setline and gill net sampling will occur from July to November.

Data analysis and a draft report are scheduled for completion by December 2001 (Table 8-10). Application for license renewal is scheduled for filing with the FERC in 2003. Federal licenses for the Hells Canyon Complex expire in 2005.

Cooperation

White sturgeon studies will be developed in consultation with all interested agencies and groups participating in the relicensing process of the Hells Canyon Complex. Field activities will be conducted by IPC personnel and coordinated with IDFG and the ODFW regional personnel.

Statement of Capabilities

Project biologist and principal investigator for the white sturgeon study will be Ken Lepla. Mr. Lepla holds a M.Sc. in Fisheries Resources and has conducted cooperative sturgeon studies associated with IPC's relicensing efforts in the Middle Snake River since 1992.

Jim Chandler will oversee project activities by assisting in study design, data collection and analysis. Both Mr. Chandler and Mr. Lepla have extensive experience in the Middle Snake River with sampling logistics, protocols specific to sturgeon capture/ handling, data analysis and synthesizing technical reports. Mr. Lepla will also be assisted by Phil Bates and Steph Eisenbarth. Mr. Bates and Ms. Eisenbarth hold B.S. degrees in biology and have been associated with IPC's sturgeon research program since 1994. Both project assistants have considerable experience with project sampling methodologies.

Deliverables

Annual WSTAC meetings will be held each spring to discuss study progress and summary results (Table 8-10). A draft report will be prepared by December 2001.

8.1.10.
Title: Status, Distribution, and Limiting Factors of Redband Trout and Bull Trout Associated with the Hells Canyon Complex.

Issues

A1. Reservoir level effects on resident fish.

A4. Effects of projects on bull trout.

A12. Impacts of construction/operation on native trout populations in mainstream and tributaries (i.e., genetic and hatchery interactions).

A17. Effects on native species of introducing non-native resident fish species.

A28. Evaluation of fish passage options for resident and anadromous fish.

Refined Issues

1) Examine the long-term probability of persistence for native resident salmonids as influenced by the Hells Canyon Complex.
2) Examine passage needs and opportunities for resident fish.
3) Evaluate the impacts of reservoir water level fluctuations on the aquatic community.

Problem Statement

Current status of native resident salmonid populations is unknown. Factors that may influence sustained viability may include: hatchery supplementation, isolation, land-use practices, loss of riverine habitat, water chemistry/quality/quantity, access to spawning tributaries, interactions with non-native species, modification of hydrograph, load-following, entrainment, food production.

Desired Future Resource Goal

To ensure long-term persistence of resident native fish populations, not to exclude the optimization of a fishery.

Abstract

A study to determine the status, distribution, and limiting factors of populations of bull trout and redband trout associated with the Hells Canyon Complex is proposed. The first phase of the study will explore existing databases and literature to establish known status. Data gaps and priority drainages will be identified which may require additional study to define status of the populations. A genetic analysis may be necessary to explore the impact of non-native salmonid introductions. In addition to the status survey, access to tributaries as a result of reservoir operations will be assessed. Efforts will focus on determining potential limiting factors for populations of redband trout and bull trout populations.

Introduction

A wide variety of potential impacts to populations of native, resident salmonids may be attributed to the construction and operations of the Hells Canyon Complex. Potential impacts include habitat fragmentation and isolation, and loss of anadromous resources. Other impacts not directly related to project operations may include exotic species interactions and land-use practices. Primary native resident salmonids of concern are bull trout (*Salvelinus confluentus*) and redband trout (inland rainbow trout; *Oncorhynchus mykiss gibbsi*). Bull trout are presently listed as a *candidate* species under the federal Endangered Species Act, as well as a *species of special concern* in Idaho (CDC

1994) and a Critical species in Oregon (ONHP 1993). On June 12, 1995, the USFWS precluded listing of the bull trout because of higher priority listing actions, although evidence was sufficient to warrant listing. Redband trout are an ill-defined group of inland rainbow trout that includes interior populations of the Columbia, Fraser, and Sacramento river basins, as well as the ancient lake basins of the northern Great Basin (Currens 1996, Behnke 1992). Redband trout are classified as a *species of special concern* in Idaho (CDC 1994) and a Vulnerable species in Oregon (ONHP 1993).

The objectives of this study are:

1) Identify priority drainages for populations of redband and bull trout in tributaries to the Hells Canyon Complex.
2) Determine status of existing populations within the tributaries and reservoirs in the Hells Canyon Complex.
3) Assess water level and discharge fluctuations in relation to migratory access to tributaries above and below the Hells Canyon Complex.
4) Identify limiting factors of priority drainages.

State of Knowledge

Redband and bull trout are sympatric throughout much of their distribution, and as such have been exposed to similar impacts and causes of declines. Bull trout have been described as the ‘least studied salmonid in Idaho’ (Schill 1992), and only recently, has research accelerated to understand bull trout populations throughout their distribution (State of Idaho 1996). Because it is not possible to distinguish redband trout based on meristic or morphological characteristics from non-native strains of rainbow trout, much of their status remains unknown. Redband trout have displayed a broad range of adaptations and tolerance to local environments throughout their range (Currens 1996). Most notably, redband populations have been documented in extremely harsh, warm-water environments of the arid desert basins in southeastern Oregon, southwestern Idaho, and northern Nevada (Behnke 1992). Bull trout are less tolerant of the two species, with specific requirements for cold, clean water (Rieman and McIntyre 1993).

Redband trout and bull trout demonstrate a complex of different life history forms. Both species have various aspects of resident and migratory forms, including anadromy for redband trout throughout much of the range (Behnke 1992, Currens 1996). Maintenance of various life history forms within these two species is probably critical to their persistence. Habitat fragmentation and population isolation through loss of connectivity by the creation of barriers (physical, thermal, habitat quality) have led to losses of various life history forms and has caused decreased genetic diversity. Genetic introgression, competition, and predation from introductions of non-native species or strains have also been major components in the decline of native populations. Eastern brook trout (*Salvelinus fontinalis*) have been introduced throughout the distribution of bull trout. The presence of brook trout has been a causal factor in the decline of bull trout populations either through direct competition or hybridization. Hybridization may be more critical in isolated drainages, or in drainages that have lost migratory forms of the species (Rieman and McIntyre 1993). In redband trout, introduction of hatchery-reared rainbow trout has led to interbreeding and subsequent genetic introgression. Most hatchery stocks of rainbow trout are from coastal rainbow strains. Responses of redband populations to hatchery rainbow introductions have varied from no evidence of hatchery introgression to allele and meristic features being intermedial between native redband trout and coastal strains of rainbows (Currens 1996).

The status of redband trout and bull trout populations in the vicinity of the Hells Canyon Complex is not known. Bull trout have been documented in several of the drainages that are tributary to the project vicinity including Indian Creek and Wildhorse River in Idaho, and Pine Creek and the Powder River in Oregon. In addition, a bull trout was spotted in the Oxbow bypass of the mainstem Snake River in November of 1993. The importance of the Hells Canyon Complex reservoirs in maintaining connectivity to various drainages within individual reservoirs is not known. Use of the reservoirs by bull trout, however, is probably limited to periods when temperatures are below 15^{o}C. Redband trout are probably much more widely distributed in the tributaries and within the reservoirs of the Hells Canyon Complex. Cursory tributary surveys in the lower 1 mile of most perennial tributaries in the Hells Canyon Complex by IPC biologists found wild populations of rainbow trout. Presumably, these populations are redband trout, however, with the high degree of hatchery stocking over the life of these reservoirs, genetic introgression of hatchery stocks may be highly prevalent. Currens (1996) examined the genetic status of several populations of redband trout including those within tributaries of the Powder River (Summit and Sutton Creek), Pine Creek (North Pine Creek, and Lonesome Creek), Conner Creek (tributary to Brownlee Reservoir at RM 313.6) and McGraw Creek (a tributary to Hells Canyon Reservoir RM 259). North Pine Creek and Summit Creek trout had genetic characteristics consistent with redband trout, while Conner Creek and Sutton Creek fish showed characteristics closer to non-native coastal strains of rainbow trout. Most populations examined had intermediate characteristics of redband trout and coastal rainbow trout. Redband trout collected above a barrier in McGraw Creek were characteristic of a small population isolated over a long period of time, suggesting a genetic drift from more typical redband trout populations. Rainbow trout are frequently sampled in the reservoirs. However, the use of the reservoir for various life history forms of wild trout within the Hells Canyon Complex is not known.

Methods

Study Area

The study area consists of Brownlee, Oxbow, and Hells Canyon reservoirs and portions of the Snake River below Hells Canyon Dam, as well as tributaries associated with these mainstem reaches. The specific scope will be decided depending on decisions of priority drainages, but may extend to the headwater areas of associated tributaries.

Priority Drainages

Criteria for selection of priority drainages will be developed through consultation with state and federal agencies in the work group process for selection of priority drainages.

A major component of prioritization will be an in-depth review of existing information on populations of redband trout or bull trout within tributaries associated with the Hells Canyon Complex. Several sources and individuals have been identified in the work group to identify known distributions of these two species. The review will include all available literature and data base files in consultation with state and federal agencies. Available stocking records will also be reviewed and overlaid with known distributions of these populations.

Land use information will be critical to understanding potential factors influencing status and spatial distribution of redband trout or bull trout populations and may be important in identification of priority drainages. Land use activities will be described for each tributary within the Hells Canyon Complex and may include: land ownership designations, dominant land use activities, dominant vegetation cover, and geomorphology. Sources of information include state and federal agency management plans, state and federal GIS databases, and coordination with other IPC Hells Canyon studies.

Other factors that may influence selection of priority drainages include known barriers to connectivity within drainages, drainage size, stream order classifications, and water temperature gradients within priority drainages. A review of available information will be conducted and data gaps will be identified.

Anadromous life history stages were removed from populations of redbands within tributaries above the Hells Canyon Complex. A reference drainage will be selected below Hells Canyon Dam with similar characteristics to at least one drainage above Hells Canyon Dam to assess differences in population status and structure. Although anadromous fish runs have severely declined within accessible drainages below Hells Canyon Dam and wild populations of steelhead may have hatchery influence, it is likely that similar life history strategies remain.

Status of Known Populations

Within identified priority drainages, population status surveys may be necessary. Protocol for various fish population surveys relating to EPA 303D classified streams has been established for both the states of Oregon and Idaho. Protocol for fish population surveys will be defined based on accepted standard methods for stream fisheries including snorkeling counts and electrofishing collections. Some priority drainages may require stratification by stream reach according to thermal or habitat gradients within the drainage. The information that will be collected on fish populations includes size structure of all species present in survey, collection of scales for aging redband trout and bull trout, and relative densities of all fish species observed. A global positioning system (GPS) reading will record sampling locations for transfer into the GIS database. Sections of fins of redband and bull trout will be collected and preserved in alcohol for possible genetic analyses. Electrofishing will be used to collect fish for these specific fish metrics. Genetic analyses will be contracted to a genetics lab for DNA analyses.

Reservoir surveys will concentrate near the mouths of priority drainages and in the Oxbow bypass. Surveys will be limited to periods when reservoir temperatures are below 15^{o}C during fall and spring periods. Collection methods may include trap nets, short duration gill net sets, snorkeling, and electrofishing. Similar information will be collected from reservoir sampling as in stream sampling, including fin clip collections for possible genetic analyses. If sampling suggests significant movement into or out of a stream, trap weirs may be considered to describe movement between the reservoir and streams. The potential of radio telemetry will also be explored if larger individuals are captured near the mouths of these streams.

Less intensive presence/absence surveys may be performed in drainages not identified as priority but which appear to have the potential of supporting populations of redband or bull trout based on drainage characteristics. The purpose of this type of survey will be to expand knowledge of the distribution of these populations within the Hells Canyon Complex. Genetic sampling may occur in some of these drainages to further characterize the extent of hatchery introgression.

Tributary Access

An approach similar to Instream Flow Methodology (IFIM) will be used to assess stream access to tributaries above and below the Hells Canyon Complex. This analysis will primarily be limited to tributaries to Brownlee Reservoir and below the Hells Canyon Complex to the Salmon River. Stream depth and water velocity will be measured at three different water levels (if possible) in Brownlee Reservoir, representing full pool (2077 feet msl), mid-drawdown level (near 2050 feet msl), and low drawdown level (near 2034 feet msl). This analysis will be influenced by volume of water in the tributary, and will be conducted over different seasonal tributary flows. Each survey will involve photo documentation of each flow level. A similar approach will be used with changing discharge below Hells Canyon Dam. A list of tributaries to consider will be developed during the priority drainage analysis and in consultation with the state and federal agencies participating in the Aquatic Resources Work Group discussions.

Hells Canyon and Oxbow reservoirs do not experience a wide range of fluctuations. However, placement of culverts during construction may have created barriers to some of these tributaries. Passage potential at culverts will also be examined for these drainages.

Limiting Factors

Information on status of populations and community structures combined with the physical and land use characteristics of drainages and the reservoirs will be used to assess potential limiting factors to redband trout and bull trout. Data overlays within a GIS database may reveal commonalities among areas with similar fish population characteristics. In addition, populations will be examined relative to the risk of extinction following criteria outlined in Rieman and McIntyre (1993).

Timetable

1997

1) Literature review
2) Develop list of tributaries and drainages.
3) Database collection from state and federal agencies on known distributions of these two species, land use activities, land ownership, etc. Includes existing GIS sources as well as other forms of data or gray literature within state and federal agencies.
4) Develop GIS database for identification of priority drainages.
5) Choose priority drainages, and design sampling strategies and schedule of sampling (if necessary).
6) Initiate reservoir surveys during fall and winter months in the Oxbow bypass and near the mouths of Pine Creek, Indian Creek, Wildhorse River, Brownlee Creek, and Powder River.

7) Distribute thermographs in drainages listed in Item 6.
8) Develop RFP for genetic analyses.
9) Develop timetable and priority streams for access analysis.
10) Check on feasibility of radio telemetry studies.
11) Work group updates.

1998

1) Conduct population status surveys during September and October in priority drainages.
2) Conduct presence/absence surveys during July and August in non-priority drainages.
3) Conduct surveys in Oxbow bypass and mouths of priority drainages during November.
4) Radio telemetry initiation (?) November through April (monthly ??).
5) Tributary access surveys (during March to April drawdown periods, and September to October drawdown periods for Brownlee Reservoir, and during low flow summer periods for below Hells Canyon Dam).
6) Update GIS database (November).
7) Recover thermograph data.
8) Work group updates.

1999

1) Conduct population status surveys during September and October in priority drainages.
2) Conduct presence/absence surveys during July and August in non-priority drainages.
3) Tributary access surveys (during March to April drawdown periods, and September to October drawdown periods for Brownlee Reservoir, and during low flow summer periods for below Hells Canyon Dam).
4) Conduct surveys in Oxbow bypass and mouths of priority drainages during November.
5) Radio telemetry initiation November through April.
6) Update GIS database (November).
7) Recover thermograph data.
8) Work Group updates.

2000

Report preparation/final presentation to work groups.

Cooperation

Cooperation and coordination with several state and federal agencies will be required, especially in obtaining existing databases on redband trout and bull trout distributions and status. All aspects of study progress will be communicated to aquatic work groups on an annual basis.

Statement of Capabilities

IPC has the personnel, equipment, computer software and expertise necessary to conduct the study. Consultants chosen to conduct genetic analyses will be carefully screened for extensive experience in this areas.

Deliverables

A draft report will be available in July 2000 and a final report will be completed by October 2001. Annual progress updates will be presented to the Aquatic Resources Work Group for guidance and recommendations.

8.1.11.
Title: Hells Canyon Complex Resident Fish Study Plan

Issues

A1. Reservoir level effects on resident fish.

A17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species).

A18. Evaluation of water fluctuations on warm-water fisheries within all reservoirs.

A27. Impacts of Hells Canyon Dam—Is there a loss of resident game fish during high discharge?

A38. Effects of daily and seasonal reservoir fluctuation on large/smallmouth bass and crappie (specific to the reservoirs) recruitment (non-spawning success).

A49. Evaluation of trophic structure in reservoirs and downstream including predation by squawfish on resident and anadromous fish.

A62. Impacts of high flow releases below Hells Canyon Dam on smallmouth spawning success and recruitment.

Refined Issues

1) Evaluate impacts of reservoir water level fluctuations on the aquatic community.

2) Evaluate entrainment of reservoir species from Hells Canyon Complex.

Problem Statement

Present reservoir operations may affect the reproduction potential of introduced species in the Hells Canyon Complex reservoirs. Influencing factors may include: water level fluctuations, affects on spawning, rearing, recruitment, and food supply; water quality; entrainment; retention time; and reservoir limnology.

Desired Future Resource Goals

To optimize recreational opportunities for non-native resident fish consistent with the protection of native species. Non-native fish include hatchery production of rainbow trout and white sturgeon.

Abstract

Reservoir operations may affect the delicate balance of the fish community. Status of the reservoir fish community will be related to operations of the projects. The effects of reservoir operations on the spawning, rearing, and recruitment of smallmouth bass, black and white crappie, and channel catfish in this system will be examined. An individual-based model will be developed to investigate changes in reservoir operations on the spawning success of smallmouth bass and crappie in Brownlee Reservoir.

Introduction

Water level fluctuations during critical times in the life history of resident fish can influence year class strength and, ultimately, an entire reservoir fishery. Critical periods can range from the spring spawning to larval drift to the pelagic over winter stage. Resident fish of primary concern in the

Hells Canyon Complex are smallmouth bass (*Micropterus dolomieui*), white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus*), channel catfish (*Ictalurus punctatus*), and rainbow trout (*Oncorhynchus mykiss*). This study will provide baseline information necessary for making objective decisions regarding protection, mitigation, and enhancement measures in the Hells Canyon Complex reservoirs.

The objectives of the study are:

1) Determine status of fish community within the Hells Canyon Complex:
   a) resident fish species composition.
   b) relative density.
   c) population structure characteristics.
   d) fish growth patterns along a longitudinal gradient.

2) Determine impacts of reservoir operations on community structure. Impacts may include:
   a) water level fluctuations-
      - resident fish (bass, crappie and catfish) spawning-timing, site selection, nest densities.
      - resident fish (bass, crappie and catfish) early rearing success.
      - develop a model that can predict the potential reduction in year-class strength of centrarchid populations in reservoirs from the loss of nests due to water-level fluctuation.
   b) entrainment.
   c) habitat availability, including reservoir limnology:
      - substrate.
      - slope.
      - depth.
      - temperature.
   d) food availability.

State of Knowledge

Water-level fluctuations during spawning and early development may be crucial to year-class formation of centrarchids (Keith 1975, Aggus 1979, Beam 1983, Ploskey and Aggus 1984). Lowering of water levels during the spawning season may adversely affect survival of crappie (Siefert 1969, Ginelly 1971) and smallmouth bass nests (Montgomery *et al.* 1980). High water levels in the spring have increased recruitment of both black crappie and white crappie (Walburg 1976, Paragamian 1977). However, it is not clear if increased recruitment caused by high spring water levels will apply to reservoir systems that lack a significant riparian zone, such as Brownlee Reservoir. The highest densities of larval crappie in Chickamauga Reservoir, Tennessee, occurred when water temperatures the week prior to spawning were between 18 and 20^{o}C, and when discharge though the reservoir was low during the spawning period (McDonough and Buchanan 1991). The relationship of larval crappie densities to water level and discharge suggests that reservoir releases could be managed to enhance crappie spawning success. The influence of water level management on crappie production has been previously reported (Mitzner 1981, Beam 1983).

Water levels, water storage, wind, turbidity, water and air temperatures, and substrate types and firmness are many of the environmental variables that have been studied in relation to nesting success and recruitment (Fry and Watt 1957, Brauhn *et al.* 1972, Jackson 1979, Mac Crimmon and Robbins 1981, Powles and Warlen 1988, McDonough and Buchanan 1991). Most fish species have a required temperature range for spawning and egg maturation (Brown 1976). Temperature must remain in the spawning range for adequate periods to allow final egg maturation, ovulation, and spawning (Fry 1971). White crappie may spawn from 14 to 23^{o}C, but generally spawn when water temperatures range from 16 to 20^{o}C (Siefert 1968). Black crappie prefer spawning temperatures of 17.8 to 20°C (Schneberger 1972). Smallmouth bass typically move into spawning areas when water temperatures range from 4.4 to 15.6°C, and spawning activities commence when temperatures range from 14.4 to 21.2°C. A drop in temperature may cause nesting to stop (Emig 1966).

Fry and Watt (1957) found that the variation in smallmouth bass yield from the year classes in Lake Huron correlated directly with the algebraic sum of the monthly deviations from mean air temperatures over the months of July through October of the year of hatch. Forney (1972) provided evidence that strong year classes were produced in years when June temperatures were above normal in Oneida Lake, New York.

Temperature alone may not trigger spawning. Numerous studies have linked temperature with photoperiod as a required co-factor for successful spawning in many species (Matthews 1939, Henderson 1963, Hubbs and Strawn 1957). Another mechanism that may prevent or inhibit spawning success is poor water clarity. Low light levels caused by high turbidities may result in nest abandonment (Breder and Rosen 1966, Vasey 1973, Coutant 1975). Grinstead (1969) found that nest depth was negatively correlated with turbidity for white crappie.

Little is published on the nesting requirements of the resident fish in Brownlee Reservoir. Bell (1961) made some observations on temperatures when smallmouth bass were observed spawning. However, research emphasis has been directed towards limnological surveys related to downstream passage of anadromous fish through the reservoir (Bell 1961, Ebel and Koski 1968). More recently in 1984, the IDFG conducted research to evaluate the fish community in Brownlee and describe smallmouth bass population characteristics and food habits (Rohrer 1984, Rohrer and Chandler 1985, Dunsmoor 1990).

Methods

Study Area

Milligan *et al.* (1983) classified Brownlee, Oxbow and Hells Canyon reservoirs as meso-eutrophic reservoirs. Brownlee and Hells Canyon reservoirs thermally stratify during the summer months with a resulting hypolimnetic anoxia (Ebel and Koski 1968).

Above Brownlee Reservoir

The Snake River from RM 340 to RM 458 is a free-flowing river. Characterized by braided river channels, many islands, and a relatively shallow water depth, this section has high nutrient loads. Several large tributaries in this section are the Boise, Malheur, Payette, and Weiser rivers. This section of river is comprised of eight strata (15 river miles per stratum).

Brownlee Reservoir

Brownlee Reservoir, constructed in 1958, is the uppermost in a series of three reservoirs on the Snake River known as the Hells Canyon Complex. Brownlee Reservoir is a large storage reservoir with approximately 1,000,000 acre-feet of active storage. At full pool (2077 feet-msl), Brownlee has a surface area of 6,100 hectares (2,470 acres) and is 92 km (57 miles) long (Ebel and Koski 1968).

Average depth is 32 m (105 feet) with a maximum depth of 92 m 302 feet) near the dam. Reservoir drawdowns are common over winter, approaching 30 m (98 feet) for COE flood control requirements. Water level fluctuations during the spring and summer months are common but of considerably less magnitude, ranging from 1 m (3.3 feet) to 10 m (33 feet). Shoreline areas are typically steep and consist of bedrock or mixtures of boulders, sand, and gravel substrate. Brownlee Reservoir has substantial effect on the downstream system in part due to the deep water releases. The lower end of Brownlee Reservoir commonly experiences blue-green algae blooms from early June to late September. Brownlee Reservoir water temperatures in the upper 10 m stay above 21^{o}C from July to September with peaks approaching 26 to 29^{o}C in late summer (Ebel and Koski 1968, Goodnight 1971, Rohrer 1984). Typically, water temperatures existing Brownlee Reservoir during the summer are cooler then inflowing temperatures. During the fall, outflowing water temperatures are warmer then inflowing water temperatures (Ebel and Koski 1968). Brownlee Reservoir was arbitrarily divided into five strata (13.6 river miles per stratum). Stratum 3 is the sharp transition zone between the deep lacustrine environment of strata 1 and 2 and the shallower riverine conditions of stratum 4. The Powder River is the fifth stratum.

Oxbow Reservoir

Oxbow Reservoir, constructed in 1961, is a small run-of-the-river reservoir which is approximately 19 km (62 feet) long. The Snake River from the tailrace of Brownlee Dam to the mouth of Wildhorse Creek (1 mile) is a high-velocity narrow channel. Oxbow is relatively narrow and shallow, with maximum depths approaching 24 m (79 feet) to 30 m (98 feet). Frequent daily fluctuations upwards of 1.2 m (4 feet) are common. Shorelines are primarily basalt outcrops and talus, except for areas of alluvial input from small tributaries. Oxbow Reservoir was not divided into strata due to its small size.

Oxbow Bypass

The unique design of the Oxbow powerhouse and dam leaves a 3-km (1.9-mile) stretch of the original river channel from Oxbow Dam to the outflow of the powerhouse with a minimum flow of 100 cfs. This creates a relatively shallow backwater with low velocities. Indian Creek enters the Snake River in this reach. Oxbow Bypass is a separate sampling unit.

Hells Canyon Reservoir

Hells Canyon Reservoir, constructed in 1967, is 35 km (21.7 miles) long, and approaches a maximum depth of 60 m (197 feet). Shorelines in the reservoir are in general very steep with substrates primarily of basalt outcrops and talus slopes. Hells Canyon Reservoir was divided into two strata between the Oxbow Powerhouse and Hells Canyon Dam (13 river miles per stratum).

Resident Fish Community

Resident fish communities will be sampled by electrofishing six to ten randomly selected 100-m (330-foot) sections of shoreline in each strata of each reservoir, during both spring and fall. Electrofishing will be done at night using a Smith-Root 220-volt 5.0 GPP jet boat electrofisher or a Smith-Root 110-volt model 1.5-KVA driftboat electrofisher (used in the Above Brownlee and Oxbow Bypass reaches). The Above Brownlee reach will be shocked during the day in the fall only. All stunned fish will be collected, and species, total length, and weight will be recorded. Scale samples will be collected from all game fish for age and growth analysis. A pectoral spine will be removed for aging of channel catfish.

Species composition and relative density (catch per unit effort) for each species of fish will be calculated. Length and condition factors of fish will be compared by reservoir section. Condition factors will be calculated to standardize the length-weight relationship (Anderson and Gutreuter 1983). Length frequency will be used as an indicator of the general age distribution of fish species by reservoir.

Age and growth determinations will follow standard methods outlined by Jerard (1983) and Carlander (1982). Scales will be pressed on acetate slides and imprints will be projected on a Micron microfiche reader. Channel catfish spines will be sectioned as described in Jearld (1983). Annuli will be identified, measured, and age assigned.

Spawning Characteristics

Nesting observations will be made at depths up to 6 meters (20 feet) using SCUBA. SCUBA surveys were limited to Oxbow, Hells Canyon and the lower half of Brownlee Reservoir where turbidities allow for observations. Two survey approaches will be used - fixed sites and random sites. Fixed sites will be subjectively chosen based on habitat type. Each site will be 10 meters (33 feet) wide and 10 meters (33 feet) deep. There will be a total of ten fixed sites, five for bass, and five for crappie. Each nest inside the site will be numbered and the species, depth, nest number, inside nest substrate, and stage of nest development will be recorded. Each site will be visited at least twice a week. During one year of the study, nests will be visited six days a week. Nest timing, nest duration, and nest success rate can then be determined using this data. Random sites will be assigned as 2-meter-wide (6.5-foot-wide) vertical transects that reach depths of 6 meters (20 feet). Substrate and depth will be recorded every 2 meters (6.5 feet) along the transect. When nests are encountered nest depth, substrate and stage will be recorded. These random sites will supply information needed for substrate, depth, and slope availability and use, and it will also allow nesting densities to be calculated without bias.

Early Rearing

Larval fish will be collected weekly between April and September using paired circular 0.5-m-diameter cone-shaped ichthyoplankton nets constructed of 750-micron mesh. Oblique tows (0-4 m; 1min per depth) will be made at night at permanent stations on Brownlee, Oxbow, and Hells Canyon reservoirs. Larval fish will be identified to species and total length will be recorded. Subsamples of larval crappie and catfish will be aged by reading daily growth increments on the sagittae otolith. Weekly larval growth, mortality, and densities will be calculated.

Smallmouth bass will not be sampled during larval tows. Sampling for young-of-the-year smallmouth bass will be done by monthly shoreline electrofishing. Total length will be taken and five fish from each size group present (under 90 mm (3.6 inches)) will be sacrificed for otolith examination.

Modeling

Oak Ridge National Laboratory (ORNL), through the Electric Power Research Institute (EPRI), will develop an individual-based model to predict potential reduction in year-class strength of centrarchid populations in reservoirs from the loss of nests due to water-level fluctuation and other mechanisms of nest failure, and will use the empirical data collected from Brownlee Reservoir to calibrate this model. A crappie life cycle model will be developed to aid in assessing losses due to entrainment.

Habitat Availability

Substrate, slope, and depth parameters will collected during random nesting site surveys. Temperature will be recorded daily from March through September using HOBO temperature monitors. Temperature and dissolved oxygen will be collected through the IPC limnological studies.

Food Availability

A qualitative assessment of food availability will be addressed with the macrobenthic invertebrate study and a literature review on food habits of resident gamefish species.

Timetable

Brownlee Reservoir

The study was initiated in 1991 and is expected to be completed in 2001. Continued limited monitoring past the completion date is expected.

Oxbow Reservoir

The study was initiated in 1993 and is expected to be completed in 2001.

Hells Canyon Reservoir

The study was initiated in 1993 and is expected to be completed in 2001.

Above Brownlee

The study was initiated in 1995 and is expected to be completed in 2001.

Modeling

The modeling was initiated in 1995 and is expected to be completed in 1998.

Oxbow Bypass

The study will begin in 1997 and is expected to be completed in 2001.

Cooperation

This study will be conducted by IPC personnel. Field efforts will be coordinated with IDFG and ODFW regional personnel, as required by IDFG and ODFW collection permits. Modeling tasks will be completed in conjunction with ORNL through EPRI.

Statement of Capabilities

IPC has the personnel, computer software, and equipment necessary to conduct the study.

Tracy Richter (IPC Hells Canyon Complex resident fisheries biologist) and Jim Chandler (IPC fisheries biologist) have extensive fisheries experience. Ms. Richter has eight years of reservoir fisheries experience, both in graduate school (M.Sc. degree in Fisheries Biology) and over a four-year period working for IPC on Hells Canyon Complex reservoir fisheries projects. Mr. Chandler has 12 years experience describing fish communities associated with Snake River reservoirs, both in graduate school (M.Sc. degree in Fisheries Biology) and 7 years of fisheries work with IPC.

Deliverables

A project progress report will be completed every third year with a final report for the ten-year period at the completion of the project. All reports will be written and submitted in a digital format acceptable to IPC. Software for the model will be submitted to IPC to run on a personal computer along with reports and/or manuscripts ready for publication.

8.1.12.
Title: A Survey and Study of Benthic Macroinvertebrates in the Hells Canyon Complex, including Upriver and Downriver Adjacent Reaches

Issues

The following issues from the Collaborative Team consultation efforts may be directly or indirectly related to benthic macroinvertebrates.

A9. Effects of sediment within all reservoirs.

A14. Impacts of operations on aquatic invertebrates, downstream.

A34. Determine changes to macroinvertebrate populations with reservoirs and determine availability within the food chain.

A43. Determine impacts to reservoir drawdowns on bugs.

A46. Effects of operations on downstream invertebrates.

A49. Evaluate trophic structure.

A52. Study zooplankton as a food resource for fish.

Problem Statement

The following problem statements reflect the desire to address parts of the aquatic biological component of the aquatic ecosystem under study. Although benthic macroinvertebrates may not be directly mentioned, they are an integral part of that whole. Factors identified as being related to benthic macroinvertebrates are typed in bold font.

1) White sturgeon populations are currently depressed and the probability of long-term persistence is in question. Causal factors may include; fragmentation of habitat, genetic isolation, **food availability**, modification of hydrograph, load following, modification of water chemistry quality, over-harvest, sediment transport, channel morphology and entrainment.

2) Current status of native resident salmonid populations is unknown. Factors that may influence sustained viability may include; hatchery supplementation, isolation, land-use practices, loss of riverine habitat, water chemistry/quality/quantity, access to spawning tributaries, interactions with non-native species, modification of hydrograph load-following, entrainment and **food production**.

3) Present reservoir operations may affect production potential of introduced species in the Hells Canyon Complex reservoirs. Factors that may influence include water level fluctuation affecting spawning, rearing, recruitment and **food supply**. Water quality, entrainment, retention time and reservoir limnology are also influenced.

4) The loss of anadromous fish above the Hells Canyon Complex has altered the **trophic structure** and nutrient cycle, above and below the Hells Canyon Complex.

5) The Hells Canyon Complex has interrupted the transport of sediment and affected aquatic resources. Impacts may include a reduction in anadromous habitat and **loss of aquatic invertebrates**.

Desired Future Resource Goals

1) The goal or desired future condition is to ensure long-term persistence of a self-sustaining population of white sturgeon not to exclude the optimization of a fishery.

2) The goal or desired future condition is to ensure long-term persistence of resident native fish populations not to exclude the optimization of a fishery.

3) The goal or desired future condition is to optimize recreational opportunities for non-native resident fish consistent with the protection of native species. Non-native fish include hatchery production of rainbow trout and white sturgeon.

4) The goal or desired future conditions is to provide conditions that will permit recovery and long-term persistence of anadromous fish (including Pacific lamprey).

Abstract

Assessment of benthic macroinvertebrates (community structure, function and stability) in the Hells Canyon Complex and particular free-flowing segments is proposed as part of IPC's relicensing efforts. The study will evaluate qualitative distribution and abundance of benthic macroinvertebrates within the system and their role as fish food organisms. Further objectives will evaluate load following and reservoir fluctuation effects of the Hells Canyon Complex on benthic macroinvertebrate communities. Assumptions are that ongoing research will show benthic macroinvertebrate communities continue to occupy energy processing roles in this system and that they are available for fish to eat. Results of this study will be essential to determine how the benthic macroinvertebrate community of the Hells Canyon Complex is or can be related to protection, mitigation, and enhancement measures.

Introduction

The rivers of the western United States, with few exceptions, are regulated by dams and reservoirs. The Snake River of Idaho, Oregon, and Washington supports many dams for the purpose of irrigation, flood control, commercial navigation and hydropower generation. The largest of these is the Hells Canyon Complex (three dams and three power plants, Brownlee, Oxbow, and Hells Canyon) owned and operated by IPC. The Hells Canyon Complex is responsible for over two-thirds of the power generated by IPC. As a producer of nearly 1.2 megawatts and because it is a non-federal water power dam(s), the Hells Canyon Complex is licensed and regulated by the FERC. The FERC issued limited term licenses for the Hells Canyon, Oxbow and Brownlee operations in 1955; construction was initially completed in 1959, 1961, and 1968 for Brownlee, Oxbow and Hells Canyon respectively. The licenses will expire in the year 2005.

Pursuant to the Federal Power Act, the FERC regulates and licenses most non-federal hydropower dams on rivers in the United States. FERC, by law, gives equal consideration to power and non-power values, other values may include recreation, industry and environmental concerns regarding wildlife and their habitats. According to the FERC Hydroelectric Project Relicensing Handbook (1990), the recipient of a license must "adequately protect, mitigate for damage to, and enhance fish and wildlife, along with their habitats".

The FERC license for the Hells Canyon Project will expire in the year 2005. IPC has initiated the relicensing process and consultation with resource agencies is underway. At the beginning of this study proposal, issues related to aquatic biota and their habitat were listed. These issues came out of the collaborative process involving all of those stakeholders who chose to participate. One theme related to aquatic benthic macroinvertebrates, major prey for fishes at most fish life stages, emerged several times: are they there and are they available as food (energy) for the higher organisms? And, does the operation of the Hells Canyon Complex eliminate this part of the trophic structure in the aquatic ecosystem(s) under study? The study will be approached from the standpoint of benthic macroinvertebrate persistence in the system, thus indicating their availability as food items. To demonstrate white sturgeon and fall chinook consumption is not possible, because stomach analyses will not be performed on either of these species. Determination and rectification of measured impairment or significant limitation of the original trophic structure caused by project construction and operation, is also not possible since little is known about the pre-project trophic interactions in this river segment, nor does the FERC typically require applicants to mitigate for impacts of original construction when relicensing. Consequently, this study is proposed to address those questions of food production and availability for fishes in the current system.

State of Knowledge

The Snake River is a large, complex lotic ecosystem, the ecological community consisting of aquatic and terrestrial organisms and geological components. By completion of the Hells Canyon Complex in 1968, the ecosystem inhabited by Snake River benthic macroinvertebrate species had been affected by continued habitat modifications and deteriorating water quality from agricultural practices, industry, and hydropower generation. Historically in other large rivers, associations between riverine fauna and environmental factors have been studied based on partitioning rivers into natural discrete units from headwaters to mouth (Illies and Botosaneanu 1963, Hawkes 1975, Vannote *et al.* 1980). However, a survey of the Snake River macroinvertebrate communities within any naturally discrete zonation scheme and characteristics affecting the distribution of these communities was not done before or after construction of the project in the Hells Canyon Complex or adjacent free-flowing areas. Benthic macroinvertebrate species are an integral part of any large river ecosystem and can be indicators (shown by their diversity and described ecosystem roles) of the integrity of that system.

The distribution and status of benthic macroinvertebrates are mostly influenced by substrata characteristics, be it organic or inorganic substrata (Cummins 1962, Hynes 1970 and Minshall 1984). Of course, they are also directly and indirectly influenced by ongoing environmental processes (e.g. flow regulation, impoundment) affecting the ecosystem. Regardless of their distribution or regardless of countless other effects, benthic macroinvertebrates play important roles in the trophic structure and energy/food processing of an aquatic ecosystem. They are usually the consumers of the primary producers (periphyton and macrophytes or those organisms that directly convert the sun's energy into food). They also consume detritus (all non-living particulate organic matter) converting CPOM (coarse particular organic matter) to FPOM (fine particular organic matter). This particular heterotrophic energy pathway is more important in lotic systems than primary production. They are the secondary producers and they serve as prey items for fish, birds, and some small mammals.

Many studies have been done addressing the effects of flow regulation on benthic macroinvertebrates (Stanford and Ward 1980a, 1980b, 1980c; Stanford and Ward 1981; Stanford and Ward 1982a, 1982b; Brusven 1984; Munn and Brusven 1987; Palmer and O'Keefe 1990; Anderson 1992; Camargo 1992; Cobb *et al.* 1992; Webb and Walling 1993). And, although macroinvertebrates as fish food have long been studied (evidenced by Needham 1928), there has been no thorough research on interactions between invertebrates and fish in highly modified and flow-regulated systems (Bain and Boltz 1989). However, in 1973, Brusven *et al.* did study the aquatic insects below Hells Canyon Dam. They investigated standing crops at different flow stages, drift rates of principal insect species, and insect stranding. They also studied the "catchability and feeding habits of fish" for 24 hours during sequential reductions in flows. They speculated from this eight-day study that "water fluctuation causes ecological instability to the biota exposed during dewatering as well as deeper zones through disruption of normal photosynthesis and the decomposition processes." They found the "drift results indicated an obvious diel cycle." They concluded "drift propensity of aquatic insects generally increased during reduction of flows." They found insects, sculpin, algae, crayfish, and small clams in the stomach contents of rainbow trout, Dolly Varden, channel catfish, northern squawfish, carp, largescale sucker and smallmouth bass at incremental flow reductions beginning with 27,000 cfs down to 5,000 cfs. Because the 1973 study was only conducted for an eight-day period, trends in the benthic community, long-term effects from load-following, and to what extent those effects were negative or positive was not established. Therefore, detailed knowledge of benthic macroinvertebrate habitat and biological relationships throughout particular biomes (i.e., large units of biological study defined by a continuum of similar confining geology and topography with its own distinct biological community) of the Snake River and the Hells Canyon Complex will be investigated during this study.

Keeping in mind the introduction, what we want to know, and the state of knowledge, what is known, the following objectives are proposed for study in particular free-flowing segments of the Snake River and in the Hells Canyon Complex:

1) Describe the existing benthic macroinvertebrate community in terms of structure and function.
2) Describe the benthic macroinvertebrate in association with the substrata.
3) Note and record the presence of ESA species and former ESA *candidate* species.
4) Study long-term reservoir fluctuation effects on benthic macroinvertebrates.
5) Study long-term load-following effects on benthic macroinvertebrates.

Methods

Description of Study Area

The benthic macroinvertebrate study area will extend through 274 miles of the Snake River from Swan Falls Dam (RM 458.0) downriver to the confluence of the Salmon River (RM 183.3).This stretch of the Snake River can be divided into the following biomes;

entrenched or gorge section from Swan Falls to Walters Ferry, Idaho; valley section from Walters Ferry to Olds Ferry near Weiser, Idaho; grand canyon section from Olds Ferry to the mouth of the Salmon River (Stanford 1942) and the Hells Canyon Complex reservoirs. The Hells Canyon Complex is located 173.5 miles downriver from Swan Falls Dam and consists of three dams. Brownlee Dam (RM 284.6) contains approximately 55 miles of reservoir and 118 miles of free-flowing environment. Oxbow Dam (RM 272.2) is located approximately 12 miles below Brownlee and impounds water up to Brownlee Dam's tailrace. Hells Canyon Dam (RM 247.0) the final dam comprising the Hells Canyon Complex impounds water for approximately 25 miles. These hydroelectric facilities provide hydropower, flood control and recreational benefits. The Snake River below the Hells Canyon Complex consists of free-flowing river and continues for 47 miles before reaching the mouth of the Salmon River. The entire 274 miles of river will be viewed as a patch-mosaic characterized by the different biomes with different physical and biological environmental conditions (Pringle *et al.* 1988). Each biome will be divided into biotopes or habitat types. The habitat types are defined as:

1) whitewater (areas where surface breaks into whitewater),
2) run (fast, deep water with no surface breaking),
3) pool (deep, slow, backwater and eddy), and
4) littoral (river edge and fluctuation zone).

Once these segments of biomes and biotopes types have been broadly identified, suitable collection methods will be determined and employed. The segments will be identified at the beginning of the survey.

Methods for Benthic Macroinvertebrate Survey

Once the biome classification has been established and mapped, the collection methods will include excavation via dredge while diving (SCUBA) and artificial substrate samplers depending on effectiveness, appropriateness, and safety concerns. The dredge consists of an intake (suction) hose, a return (discharge) hose, and a generator (engine) that operates as a Venturi loop. An area of substrata (50 cm sq.) will be excavated through the suction nozzle which is operated by divers and carried in laminar flow to collection buckets at the surface. Due to safety precautions this method of collection will take place in depths of 60 feet and less, and divers will make no more than four dives per day. The artificial substrate samplers are minnow traps, constructed from rust-resistant, galvanized ¼-inch wire mesh and steel, filled with local substrata and lined with nylon nitex material. The purpose of the lining is to minimize loss of macroinvertebrate organisms when retrieving the artificial substrate samplers. The devices will be placed on the substrata near the bank for a minimum of six weeks and will be monitored for colonization. The number of samples and artificial substrates collected per biome will depend on the actual size of the segment and the effort that can be completed in one year with available personnel and equipment.

In order to make environmental sense of the biological findings, a framework that includes the physical and chemical characteristics of the study system will be included. The physical and chemical parameters of water quality will also be monitored by collecting water temperature, dissolved oxygen, pH, depth, and specific conductivity at each survey site with a Hydrolab (H2O® Multiprobe). The substrata at each survey site will be analyzed as well. The substrata will be broadly classified using a 50-cm.-sq. sampling frame; the sampling frame will be divided into nine smaller squares. The substrata in each of the nine square areas within the sampling frame will be identified according to the Wentworth (1922) geological classification. The identified substrata will be given a code number and quantitatively analyzed with the biological data to investigate biological community associations with substrata.

Reservoir Fluctuation Effects

The study will be conducted in Brownlee, Oxbow, and Hells Canyon Reservoirs. Six cross-section transects will be chosen for sampling, two in each reservoir. The transects will be as similar in geology and terrain as possible. Each of the transects will extend from the most discernible high-water mark on one side of a reservoir to the most discernible high-water mark on the other side of the reservoir. Benthic macroinvertebrate samples along the transect will be collected once each month in fixed locations, meaning that some locations will be dewatered at certain times of the study and other locations will always be watered. There will be eight locations per transect for a total of 16 collections per reservoir/monthly. The study will be conducted for 12 months and repeated for a total of two years. The dredge method described in the survey methods will be used.

Load Following Below Hells Canyon Complex

Sample sites will be located below the Hells Canyon Dam (RM 247.0), the first one within immediate tailrace influence, the second site at Johnson Bar (RM 229) and the third site will be Pittsburg Landing (RM 214.7). These sites are subject to change; the fixed locations will depend on personnel and available transportation. Fixed locations for collecting will be established in transects from the load-following high-water mark as opposed to spring run-off high-water mark, from one side of the river to the other at each site. Benthic macroinvertebrate samples to determine benthic biomass and richness, 12 in each transect (six samples collected during lowest stage and six collected during highest stage), will be collected monthly during a 24-hour period to capture daily high and low flow load-following conditions. Since they will be collected once a month, the flows will also differ due to natural hydrograph, flood control and salmon water releases. Stage recorders will be installed at these three sites to monitor fluctuation zone and duration of dewatering. The study will be conducted for 12 months and repeated for a total of two years. The dredge method described in the survey methods will be used.

An insect drift study will be conducted along with the benthic sampling, according to Brusven *et al.* (1973).

Handling Of Collections

The contents from the synoptic survey and water fluctuation studies will be sieved, placed in plastic sampling containers, and fixed on site with 70 percent ETOH. All samples will then be shipped to an independent contracted laboratory, sorted, enumerated, and identified to the lowest possible taxonomic level. Voucher specimens will be collected and will be reposited with the Orma J. Smith Museum of Natural History in Caldwell, Idaho.

Timetable

Pending approval or modification, this work will take place over a four-year period starting in January of 1998. The first year will consist of scouting and identifying biomes within the reach; after determination of the biomes, sampling will follow. The load following and reservoir fluctuation portions of the study will be conducted in 1999 and repeated in 2000. Analysis of the data collected and report completion will take place in 2001. This timetable may be subject to change.

Cooperation

The benthic macroinvertebrate study will be conducted in consultation with all interested agencies and groups participating in the relicensing process of the Hells Canyon Project.

Statement of capabilities

The IPC principal investigator for these studies will be L.D. (Dianne) Cazier. Ms. Cazier holds a M.Sc. in Aquatic Entomology and Aquatic Ecology and has six years of experience managing studies in lotic systems. She will be assisted by Ron Piston and Brad Alcorn. Mr. Piston holds a B.S. in Environmental Studies and Mr. Alcorn holds a B.S. in Fisheries Resource Management. The benthic macroinvertebrate samples will be processed by Ecoanalysts, Inc. of Moscow, ID.

Deliverables

A final report will be completed and distributed in January of 2002.

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8.2. Wildlife

8.2.1. Title: A Description of the Small Mammal Community in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe the wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Twenty-nine small mammal species and seven medium-sized mammal species may occur in the general vicinity of Hells Canyon (Marshall 1986). The objective of this study is to describe existing small mammal resources in the Hells Canyon Study Area. Species composition and relative densities will be estimated using trap lines. Results will be presented in a technical report.

Introduction

Asherin and Claar (1976) censused small and medium-sized mammals in the Hells Canyon Study Area. Species occurrence was documented primarily by trapping with snap, pit, and live traps. Brownlee Reservoir was most diverse with nine species, followed by Oxbow and Hells Canyon Reservoirs (both with five species). Six species were recorded below Hells Canyon Dam.

The general objective of this study is to describe existing small mammal resources in the Hells Canyon Study Area. The specific objectives are to determine presence and relative abundance of small mammals in each major vegetation cover type, and to identify special animal communities.

State of Knowledge

In the general vicinity of the Hells Canyon Study Area, 29 small mammal species and 7 medium-sized mammal species have been reported (Groves and Marks 1985, Marshall 1986). Asherin and Claar (1976) found that Brownlee Reservoir had the most diverse small mammal community with nine species, followed by Oxbow and Hells Canyon Reservoirs (both with five species). Six species were recorded below Hells Canyon Dam. Deer mice (*Peromyscus maniculatus*) comprised the majority of small mammals caught (86 percent), followed by house mice (*Mus musculus*) (4 percent), and montane voles (*Microtus montanus*) (3 percent). Other species, the western harvest mouse (*Reinthrodontomys megalotis*), Great Basin pocket mouse (*Perognathus parvus*), Ord's kangaroo rat (*Dipodomys ordii*), vagrant shrew (*Sorex vagrans*), golden-mantled ground squirrel (*Spermophilus lateralis*), and bushy-tailed woodrat (*Neotoma cinerea*), each comprised fewer than 1 percent of the total number of animals caught. Species diversity was much higher in riparian areas than in upland plant communities.

For medium-sized mammals, yellow-bellied marmots (*Marmota flaviventris*) were found along the entire river corridor. Yellow-bellied marmots were abundant along Oxbow and Hells Canyon Reservoirs and other places where rock piles were available along roads. Porcupines (*Erethizon dorsatum*) were also noted in the study area, but in low numbers. Mountain cottontail (*Sylvilagus nuttallii)* was abundant throughout the study area, particularly in shrub-steppe plant communities and riparian areas. Pygmy rabbits (*Brachylagus idahoensis*) were not noted, although the species is suspected to occur in the shrub-steppe habitats at the southern end of Brownlee Reservoir. Likewise, black-tailed jackrabbits (*Lepus californicus*) were expected but were never observed.

Methods

Study Design and Field Methods

Small mammal population densities can be expressed either per unit of area or in relative densities (i.e., catch per effort). The capture-recapture procedures, which estimate density, require strict adherence to assumptions (e.g., closed population) (Caughley 1977, Davis and Winstead 1980). Because it is difficult to meet these assumptions, capture-recapture methods will not be considered. Instead, relative densities of small mammal populations will be estimated using trap lines.

Sites will be selected based on the following criteria:

1) at least 10 hectares (25 acres) in size, and
2) accessible by either vehicle, ORV, boat, or limited hiking.

Similar criteria will be used to select suitable locations in riparian habitat. Trap sites will be selected randomly from available suitable sites. Trapping effort will be similar above and below Hells Canyon Dam.

Trapping procedures described by Call (1986) and Johnson and Keller (1983) will be followed. Each site will be trapped for three consecutive days. The traps will be set in late afternoon to early evening and checked the next morning. Breeding condition will be determined for all captured individuals (Groves and Keller 1983, Groves and Steenhof 1988). Trapped individuals will be weighed. Individuals caught in live traps and pit traps will be color marked and released. Unknown specimens will be collected and deposited at the Idaho Museum of Natural History, Idaho State University, Pocatello.

Analyses

All captures will be tabulated by year, habitat type, trap site, type of trap, species, sex, age group (sub-adult and adult), and reproductive condition. Because similar trapping procedures are followed at each trap site, comparisons of small mammal communities among different vegetation cover types will be possible.

Small mammal communities at trap sites will be classified based on the composition of dominant species using *TW*o-way*IN*dicator *SP*ecies *AN*alysis (Program TWINSPAN) (Hill 1979). TWINSPAN constructs ordered two-way tables. The two-way table shows the differential species and differential species groups sorted into blocks and separated from the other species. Shannon's diversity index (HU) will be calculated for each trap site and trapping year. Evenness (E) will be calculated as HU/ln(S), whereby S is the total number of species reported. Community coefficients are a measure of similarity in species composition between vegetation communities. Relationships between small mammal populations and habitat variables will be determined using standard univariate and multivariate statistical procedures.

Timetable

The study will be initiated by February 1997 with completion of the study proposal. Field work will begin on 15 April 1997 with establishment of the trapping sites. Following surveys and data collection, data analyses, and preparation of a progress report will be completed by January 1999. Completion of the final report will be contingent upon preliminary findings.

Cooperation

Resource agencies with potential interest in studying small mammals in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Dr. Toni Holthuijzen. Dr. Holthuijzen will be assisted by Frank Edelmann and at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in wildlife biology and Mr. Edelmann has a Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by January 1997. Preliminary findings will be evaluated to direct the project in following years. Upon completion, final results will be presented as a technical report.

8.2.2.
Title: A Description of the Nongame Bird Community in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirements to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Seventy-six passerine species are associated with riparian and upland areas in Hells Canyon. The goal of this study is to describe nongame bird communities in Hells Canyon. Survey technique for sampling avian communities in upland cover types are both line transects and point counts. Only point counts are being used for riparian cover types. Final results will be presented as a technical report.

Introduction

Taylor (1989) reported that 108 bird species were sighted along the Snake River where it runs through Hells Canyon. Of these, 76 passerine species are associated with riparian and upland areas in Hells Canyon. Many of these are dependent on the riparian areas for food, cover, and nesting. The riparian habitat in Hells Canyon is often structurally complex, and as a consequence, supports a diverse avifauna (Carothers *et al.* 1974, Asherin and Claar 1976, Knopf *et al.* 1988, Ohmart *et al.* 1988, Lee *et al.* 1989). Most bird species that nest in riparian habitats are neotropical migrants. These species comprise between 60 percent and 85 percent of the landbirds (Knopf 1985, Dobkin and Wilcox 1986, Saab and Groves 1992). Probably most migrant landbirds in the western United States are associated with riparian habitats during the breeding season (Ohmart *et al.* 1986). Woody riparian provides cover and food during the winter season for a variety of birds and may be critical to local populations (Lewke and Buss 1977). Rare bird sightings in Idaho, including the study area, are summarized by Taylor and Trost (1987).

The objectives of this study are to determine:

1) abundance and relative densities,
2) community composition during spring and fall,
3) relative population numbers during the year, and
4) habitat relationships of avian communities during the nesting season.

State of Knowledge

Specific information on avian communities, their composition, dynamics, and habitat relationships in Hells Canyon and vicinity is sparse. Two books on Idaho's ornithology (Larrison *et al.* 1967, Burleigh 1972) contain only a few references from Hells Canyon. However, numerous records are available for Lewiston (Burleigh 1972), and an annotated list is available from the Weiser Valley, south of Hells Canyon (Newhouse 1960). In Oregon, a bird species list is available for Union and Wallowa Counties from the Grande Ronde Bird Club. In Idaho, the avifauna of many counties is only superficially known (Taylor and Trost 1987). General information on Idaho bird distribution on a county basis can be found in Stephens and Sturts (1991). For Oregon, the avifauna of the Blue Mountains Province, which adjoins the Snake River is reviewed by Marshall (1986) and Thomas (1979).

No group of birds, with the notable exception of some upland game bird species, is currently being monitored over a substantial portion of its range in either Idaho or Oregon (IDFG 1991, Marshall 1986). Systematic censusing is restricted to the Breeding Bird Survey (Robbins *et al.* 1986), and the Christmas Bird Counts (Root 1988). Neither of these surveys is conducted near Hells Canyon.

Methods

Study Design and Field Methods

Three broad counting techniques are currently used in ornithological research. These are mapping techniques, line-transects, and point counts (Verner 1985, Bibby *et al.* 1992). Line transect sampling and point counts are widely used to estimate bird density. Point counts and line-transect counts are basically the same because point counts are line transect counts conducted at zero speed (Buckland *et al.* 1993). Both line-transects and point counts are considered more efficient than spot mapping (Verner 1985, Bibby *et al.* 1992). Line transect counts can be well applied in large areas that are relatively uniform (Franzreb 1981, Wakeley 1987, Bibby *et al.* 1992, Buckland *et al.* 1993).

Line transects are particularly well suited to study bird communities in shrub steppe habitat (Rotenberry and Wiens 1980, Smith *et al.* 1984, Wiens 1986, Rotenberry and Knick 1991, Buckland *et al.* 1993). Point counts, in contrast, are particularly applicable for patchy, fragmented, irregularly sloped habitat patches (i.e., riparian habitat in the study area), or where terrain is rough, making transects difficult to establish and follow (Dawson 1981, Bibby *et al.* 1992, Buckland *et al.* 1993). Therefore, upland bird communities will be surveyed using both line transects and point counts, while riparian areas will only be sampled using point counts. Any existing special vegetation communities are also likely to be sampled using point counts.

Upland Habitat

Areas surveyed in upland habitats depended on ease of access (Bibby *et al.* 1992). Although probability theory suggests that a valid estimate of the sampling variance could only be obtained from a random sample, the remote and rugged landscape of the Hells Canyon Study Area precludes a random assignment of transects. Therefore upland areas that had at least a minimum of vehicular (automobile, all terrain vehicle, or boat) access were selected for sampling so as to increase sampling efficiency. These areas were delineated on topographic maps and were assumed as independent, thus treated as sampling units (i.e., replicates).

Each line transect was approximately 1000 m in length. However, because of the steep terrain, line transects were restricted to roadbeds and trails. Establishing lines on roads facilitate safe walking and increase the time observers search for birds and decrease the time spent negotiating the travel route (potential biases of systematic transect placement with topographic features such as roads, will be noted). The significance of biases associated with surveying from roads/trails will be assessed by comparing density estimates from line transects to those of Point Counts.

Riparian Habitat

Bird communities in riparian habitat were surveyed using point counts. Most riparian habitat in the study area is patchy, linearly oriented, and fragmented. The general narrowness of riparian habitat complicates measuring total available habitat from aerial photographs or using remote sensing techniques. This limits attempts at stratification and possibly eliminates sampling cover types proportional to size. Starting in 1994, sample sites were located in homogeneous patches of riparian vegetation where point counts were conducted. Each point count was classified according to vegetation cover type (e.g., *Scrub-Shrub Wetland* and *Forested Wetland*) and dominant shrub and overstory plant species (i.e., to determine vegetation association).

Analyses

Based on Emlen's method (1970), the effective width of upland line transects and radius of plot counts will be determined. The large number of species occurring in the study area will make it impossible to determine the effective width and radius for each species. Instead, representative species will be selected from the pool of species surveyed for which sufficient information is available to determine effective widths and radii. These species will function as models for other species that have similar detectabilities. Bird densities and diversities will be calculated for each year, season, and vegetation cover type.

Anova will be used to determine differences among years, seasons, and cover types in bird densities and diversity. Sorensen's community indices will be calculated for each bird community in each vegetation cover type to investigate similarities among these bird communities. TWINSPAN will be used to ordinate bird communities in sampled cover types to investigate relationships among these communities, and to determine if any indicator species can be identified. Principal Component Analysis (PCA) or Canonical Analysis (CA) will be employed to ordinate both species and sample locations to provide further insight into relationships and similarities among bird communities and sample locations.

Timetable

The study was implemented in 1995. Surveys will be completed both above and below Hells Canyon Dam in 1998. Following surveys and data collection, data analyses and preparation of a progress report will be completed in 2000. Completion of the final report will be contingent upon preliminary reviews.

Cooperation

Resource agencies with potential interest in studying nongame birds in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Dr. Toni Holthuijzen. Dr. Holthuijzen will be assisted by Frank Edelmann and at least one wildlife technician. Toni Holthuijzen holds a Ph.D. in wildlife biology and Mr. Edelmann has a

Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by January 1998. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.3.
Title: A Description of the Raptor Community Nesting in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Little historic information is available on raptor populations in Hells Canyon. Therefore, objectives of this study are to determine the composition of raptor species nesting in Hells Canyon, and estimate the number of nesting raptors based on occupancy surveys. Ground surveys will be used to identify nesting territories of diurnal raptors. Territories, defined as a confined locality where nests are found and where no more than one pair has ever bred at one time, will be plotted on field maps. The number of occupied nesting territories will be calculated per kilometer. Final results will be presented as a technical report.

Introduction

Little historic information is available on bird of prey populations in Hells Canyon, with the exception of surveys for peregrine falcons and bald eagles (Isaacs *et al.* 1992, Akenson 1996). The limited historic information available is mainly based on data collected by Asherin and Claar (1976), and Levine and Erickson (1990). Therefore, objectives of this raptor survey are to describe the current status of diurnal raptor resources in Hells Canyon. Specifically, this includes determining the species composition of nesting diurnal birds of prey, and the population size of nesting raptors, based on occupancy surveys. Baseline data on nesting raptors will be useful to state and federal resource agencies in their efforts to protect and conserve this *sensitive* group of birds.

State of Knowledge

Raptor nesting surveys were conducted along the three Hells Canyon reservoirs in 1974 and 1975 (Asherin and Claar 1976). Ten diurnal raptors were found nesting:

1) northern goshawk (*Accipiter gentilis*),
2) Cooper's hawk (*A. cooperii*),
3) sharp-shinned hawk (*A. striatus*),
4) northern harrier (*Circus cyaneus*),
5) red-tailed hawk (*Buteo jamaicensis*),
6) Swainson's hawk (*B. swainsonii*),
7) golden eagle (*Aquila chrysaetos*),
8) prairie falcon (*Falco mexicanus*),
9) American kestrel (*Falco sparverius*), and
10) turkey vulture (*Cathartes aura*).

The highest diversity of diurnal and nocturnal raptors was recorded for Brownlee Reservoir (11 species), followed by Oxbow and Hells Canyon Reservoirs, and the river reach below Hells Canyon Dam. The American kestrel, closely followed by the red-tailed hawk, was the most numerous raptor nesting along the three reservoirs.

Levine and Erickson (1990) subsequently conducted a raptor survey in the Hells Canyon Recreation Area in 1990. Thirty-one survey points were used to observe sections of cliff for one to four hours to determine occupancy of nesting territories. Seven species of diurnal raptors were recorded. In order of frequency these were:

1) golden eagle (27 pairs),
2) American kestrel (10 pairs),
3) red-tailed hawk (7 pairs),
4) northern goshawk (3 pairs),
5) Cooper's hawk (1 adult),
6) prairie falcon (1 pair), and
7) turkey vulture (1 pair).

Levine and Erickson (1990) considered the number of located golden eagle nesting pairs to be conservative. Isaacs and Opp (1991) reported on numbers, distribution, and productivity of golden eagles in Oregon over the period 1965 to 1982. Fifteen nesting attempts were recorded for Baker County and seven for Wallowa County.

Methods

Study Design and Field Methods

Raptor survey techniques have been reviewed by Call (1978), Fuller and Mosher (1981, 1986) and Kochert (1986). Methods can be categorized as:

1) aerial,
2) calling, and
3) ground.

Aerial surveys are effective when used for species that have large, conspicuous nests. Calling surveys are mainly used with Strigiformes, but may be used for some Falconiformes (Fuller and Mosher 1981). Ground surveys include searches by foot, boat, and land vehicle. All types of ground surveys allow time for close inspection of specific sites, and may be used as combinations (Kochert 1986). Ground surveys are believed to provide the best coverage of small areas, and most effective for secretive raptors (Fuller and Mosher 1981, 1986; Kochert 1986). Therefore, ground surveys are used for raptor inventories in the Hells Canyon Study Area.

Most diurnal raptors in southwestern Idaho lay eggs between early March and the middle of April (USDI 1979). Therefore, surveys are being conducted during the last two weeks of March to determine occupancy of a nesting territory, or more specifically, to count the number of pairs associated with nesting territories and the number of pairs with eggs (Kochert 1986). A nesting territory is defined here as a confined locality where nests are found, usually in successive years, and where no more than one pair has ever bred at one time (Steenhof 1986). All identified, known, or suspected nesting territories will be plotted on field maps. Each traditional nesting territory will be assigned a name. River mile and UTM coordinates of the center point of activity of a nesting territory, a nest, or an aerie will be recorded for each nesting territory observed.

Occupancy classification requires at least one of the following observations:

1) evidence that an egg was laid (incubating birds, eggs, eggshells, young, or a decorated nest),
2) observations of two breeding-age birds that appear to be paired, or

3) observations of one or more birds attending a nest, engaging in reproductive behavior (e.g., copulating), or defending an area.

A pair will be considered breeding only if eggs were laid (Kochert 1986, Steenhof 1986). For all species of raptors, not listed as *threatened* or *endangered*, the "occupancy" survey will be conducted. If nestling prairie falcons, red-tailed hawks, and ferruginous hawks are encountered during these and other surveys, they will be aged using aging guides by Moritsch (1983*a*,*b*,*c*). Young of golden eagles will be aged using Hoechlin (1976). A nesting attempt will be considered successful if it produces one or more young that reach a pre-specified age (80 percent of fledge age; Steenhof 1986). Young are large enough at this age to be counted, and mortality after this age until fledgling is usually minimal (Steenhof 1986).

Analyses

Occupied nesting territories will be identified based on the behavioral data collected during the survey. Nesting territories will be plotted on 1:24,000 scale USGS maps. The number of occupied nesting territories will be calculated per kilometer.

Timetable

The study was initiated in 1995. Two years of field data have been collected above Hells Canyon Dam. No surveys will be conducted below Hells Canyon Dam. One additional year of data collection is anticipated. Following surveys and data collection, data analyses and preparation of a progress report will be completed by January 1998. Completion of the final report will be contingent upon preliminary findings.

Cooperation

Resource agencies with potential interest in studying nesting raptors in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Dr. Toni Holthuijzen. Dr. Holthuijzen will be assisted by Frank Edelmann and at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in Wildlife Biology and Mr. Edelmann has a Master’s Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by January 1998. Preliminary findings will be evaluated to direct the project in following years. Upon project completion, final results will be presented as a technical report.

8.2.4.
Title: A Description of the Amphibian and Reptile Community in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Eleven herptile species with federal status under the Endangered Species Act and/or state *species of special concern/sensitive* species status potentially occur in Hells Canyon. Hence, objectives of this study are to determine the general distributions, habitat associations, and relative abundances of these amphibians and reptiles in Hells Canyon; and to develop, test, and refine spatial distribution models for amphibians and reptiles in Hells Canyon. For amphibians, the primary sampling technique will be visual encounter surveys at wetland sites. For reptiles, the main technique will be drift fences with funnel traps and pitfall traps. Upon completion of the project, final results will be presented as a technical report.

Introduction

Amphibians and reptiles are important functional components in many ecosystems (as predators, prey, biomass, and transporters of nutrients). For example, in the eastern portion of the Snake River Birds of Prey Area, snakes comprised 65 percent of the biomass that red-tailed hawks were feeding to nestlings. Consequently, proper management of such areas requires a basic understanding of the common amphibian and reptile species, as well as those classified as *sensitive*, *threatened*, or *endangered*.

The general objectives of this study are to determine the general distributions, habitat associations, and relative abundances of amphibians and reptiles in Hells Canyon through the use of a variety of sampling techniques, and to use those data to develop, test, and refine several types of spatial distribution models (spectral reflectance, cover type, Gap Analysis, and others) for amphibians and reptiles in this area.

State of Knowledge

Eleven species of herptiles with federal status and/or state *species of special concern/sensitive* species status potentially occur in the Hells Canyon Study Area. Also, the study area potentially contains most of the species of amphibians and reptiles that are of special concern in Idaho and eastern Oregon. This includes the Great Basin/Oregon population of spotted frogs (*Rana pretiosa),* a USFWS *candidate* species; the Idaho population of tailed frog (*Ascaphus truei),* a USFWS *species of concern*; the Idaho population of spotted frogs (*Rana pretiosa),* a USFWS *species of concern*; and the sagebrush lizard (*Isceloporus graciosus),* also a USFWS *species of concern*. These following *sensitive* species or *species of special concern* may also occur in Hells Canyon:

1) tiger salamander (*Ambystoma tigrimum*),
2) western toad (*Bufo boreas*),
3) leopard frog (*Rana pipiens*),
4) Mojave black-collared lizard (*Crotaphytus bicinctores*),
5) ringneck snake (*Diadophis punctatus*),
6) longnose snake (*Rhinocheilus lecontei*), and

7) ground snake (*Sonora semiannulata*).

Methods

Study Design and Field Methods

IPC will use several sources of information to describe the distribution, habitat relationships, and relative abundance of amphibians and reptiles in the study area. These will be:

1) The literature, including published books, papers, and agency reports and unpublished documents (theses, surveys, etc).
2) Museum specimen records from all known United States and Canadian collections.
3) Observations reported to the Idaho Conservation Data Center and the Northern Intermountain Herpetological Database (Llewellyn and Peterson 1995).

For all sites searched or trapped, differentially corrected UTM coordinates will be determined with a Trimble GeoExplorer Global Positioning System and basic habitat types will be recorded. The site coordinates will be provided to the persons conducting the vegetation surveys for a more thorough characterization.

1996: Above Hells Canyon Dam

For amphibians, the primary sampling technique is visual encounter surveys at wetland sites identified from topographic maps, National Wetland Inventory maps, aerial photographs, Gap cover-type maps, and sites reported by the IPC field crew and agency personnel. Standard amphibian survey protocol, as developed by Dr. Stephen Corn of the National Biological Service, are being followed. Also, one fixed, automated recording system (FrogLogger) was used to sample calling amphibians at a known reference wetland site and two mobile FrogLoggers were used to sample other potential amphibian breeding sites.

The main sampling technique for reptiles is installation of drift fences with funnel traps and pitfall traps. The array design was similar to that used for a 1995 snake study at C.J. Strike Reservoir (Beck and Peterson 1995), with the exception that a cross ("X") arrangement was used rather than a "T" design. Funnel traps are placed at the ends of the drift fence arms. A pitfall trap is in the center of the array. Approximately 50 arrays were used in 1996, sampling riparian and upland habitats. Incidental observations were also incorporated into the herpetological database.

1997: Below Hells Canyon Dam

The limited access will not allow the use of trapping arrays over most of this portion of the study area. Consequently, the general plan is to survey 12 drainages from the Snake River to one km up tributary streams (six per side of the river). One-day visual encounter surveys will be conducted for both amphibians and reptiles per stream/canyon. Each site will be surveyed twice, if possible (i.e., once in the spring and once in the summer). Access will be by jet boat or raft.

1998: Entire Study Area

After the 1997 field season, the survey data will be used to evaluate the Gap Analysis and other models/maps. These models will be revised to better fit the situation in the Hells

Canyon area. During the field season of 1998, the revised models will be tested by sampling new sites throughout the study area (approximately half of the number of sites done in the previous two years).

Analyses

Numbers and species of reptiles and amphibians will be compiled. Trapping techniques will also be evaluated, particularly the possibility of using traps without associated drift fences to capture snakes and lizards. This will greatly enhance the opportunity to trap in smaller fragments of specific cover types. Information collected will be used to determine the distribution and possibly status of reptiles and amphibians in the study area. Modeling using GAP data will be used eventually to predict and test the distribution of reptiles and amphibians in the Hells Canyon Study Area.

Timetable

Field work began in mid-March 1996 and will continue through 1997. Trapping arrays will be operated from the middle of April through the middle of July during both years. Searches of riparian habitat both above and below Hells Canyon Dam will also be carried out during this period. Following surveys and data collection, data analyses and preparation of a progress report will be completed by November 1998. Completion of the final report will be contingent upon preliminary findings.

Cooperation

Resource agencies with potential interest in studying herptiles in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator is Dr. C. H. Peterson, Curator of Herpetology at Idaho State University. Dr. Peterson will be assisted by one research associate. Dr. Peterson has extensive experience in conducting herpetological studies in Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by November 1997. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.5. Title: A Description of the Bat Community in Hells Canyon

This is a descriptive study being conducted by the USFS/HCNRA, with assistance from IPC. IPC was invited to participate in this cooperative study because the HCNRA lies within IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information collected during this study could assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of resources as required by FERC's relicensing process.

Abstract

At least 13 of the 14 bat species that occur in Idaho are believed to inhabit the HCNRA. At least three Idaho State *species of special concern* have been documented along the Snake River corridor; the Townsend's big-eared bat, fringed myotis, and western pipistrelle have been found in Hells Canyon. Objectives of this study are to: build on existing data regarding bat habitat in Hells Canyon, monitor known hibernucula and maternity colony sites, and collect baseline data for future monitoring of additional maternity, hibernucula, and roost sites. Suspected bat use sites will be selectively sampled using harp traps, mist nets, hand nets, and Anabat Recorders. Numbers and species of bats will be tabulated for each of the sites visited. Upon completion of the project, final results will be presented as a technical report.

Introduction

At least 13 of the 14 bat species of Idaho are suspected to inhabit Hells Canyon. Preliminary information has been gathered on species presence at selected sites along the Snake River corridor, primarily through mist-netting and diurnal searches of mines and caves. These data suggest that the Snake River corridor in Hells Canyon provides habitat for large numbers of bats and numerous bat species. At least three Idaho State *species of special concern* have been documented in Hells Canyon. These are Townsend's big-eared bat (*Plecotis townsendii*), fringed myotis (*Myotis thysanodes*), and western pipistrelle (*Pipistrellus hesperus*). The objectives of this study are to:

1) build on existing data regarding bat habitat in Hells Canyon,
2) monitor known hibernucula and maternity colony sites, and
3) collect baseline data for future monitoring of additional maternity, hibernucula, and roost sites.

State of Knowledge

Asherin and Claar (1976) collected bats in Hells Canyon by shooting, mist-netting, and diurnal roost searches. Seven species of bats were collected. These were, ranked in frequency of collection:

1) big brown bat (*Eptesicus fuscus*) (30 percent),
2) yuma myotis (*Myotis yumanensis*) (27 percent),
3) western pipistrel (*Pipistrellus hesperus*) (18 percent),
4) little brown myotis (*Myotis licifugus*) (13 percent),
5) small-footed myotis (*Myotis leibii*) (7 percent),
6) silver-haired bat (*Lasionycteris noctivagans*) (4 percent), and
7) pallid bat (*Antrozous pallidus*) (1 percent).

In general, these bats appeared to be dependent on riparian vegetation, as most species roost in trees or tree cavities, and most feed over water, deriving food from insects produced in riparian vegetation communities. Based on species occurring in the Blue Mountains Province, additional species can be expected in Hells Canyon. Larrison and Johnson (1981) report ten likely and two possible species for the Hells Canyon vicinity, while Groves and Marks (1985) listed 13 species. Larrison (1967) reported 12 species for areas of extreme southeast Washington, northeast Oregon, and western Idaho that border the Snake River.

Previous work has identified a Townsend’s big-eared bat population in Hells Canyon; one maternity colony site and one hibernaculum have been identified. These two sites, which are gated mine tunnels, account for less than 50 percent (75 animals) of the suspected population at the maternity site and a small fraction of hibernating bats. Several other sites have been identified to have seasonal aggregations or use by Townsend’s big-eared bats. A challenge cost-share grant with the USFS was executed in 1996 to gain further information on bats.

Methods

Study Design and Field Methods

This study is designed to provide more detailed monitoring and survey data for bat populations and habitat occurring in the Snake River corridor of the Hells Canyon Recreational Area. Vast amounts of bat roosting habitat may exist in Hells Canyon; there are approximately 80 known mine tunnels and numerous natural rock shelters in this area. To date, signs of some bat use have been recorded for about 20 tunnels.

To gain further information on bat use sites, several selected mines, caves and known night-hang-ups will be examined during three 10-day periods. For each sight, bat numbers and species will be recorded. Drop-cloth collections will be made under selected maternity colonies for samples of droppings on known dates. Also, suspected bat use sites will be selectively sampled using harp traps, mist nets, hand nets and Anabat systems (recorders). All bats caught will be processed for basic biological information and banded.

Analyses

Numbers and species of bats will be tabulated for each site visited. All sites will be identified using GPS coordinates. This information will provide additional information about the distribution and numbers of bats, specifically the Townsend's big-eared bat along the Snake River corridor.

Timetable

A study proposal will be developed in cooperation with study participants in 1997. Sample sites and field methodologies will be selected at that time. Field work will commence in late spring or early summer of 1997. A draft report will be prepared in the fall of 1998 and submitted to participants for review. Upon review of the document, revisions will be made. A final report will be submitted to cooperators in November 1999.

Cooperation

Other resource agencies with potential interest in studying bats in Hells Canyon will be contacted. Currently, this project is being conducted cooperatively with the USFS as a challenge-cost share project.

Statement of Capabilities

Consultants with the appropriate expertise in bat ecology will be contacted to conduct this study. A single consultant will be selected. The selected consultant may utilize services of other subcontractors to perform elements of the work. A Request For Proposal (RFP) will be developed in cooperation with interested agencies and other groups to solicit bids from interested consultants.

Deliverables

Initial results will be prepared as a progress report to be completed by November 1997. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.6.
Title: Distribution and Abundance of Wintering Bald Eagles in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

During the winter season, bald eagles (*Haliaeetus leucocephalus*) reside in substantial numbers along the Snake River and particularly concentrate along the Snake River Reservoirs. The goal of this study is to determine the numbers and distribution of wintering bald eagles in the Hells Canyon Study Area. Aerial surveys will be used to count and monitor bald eagles. Numbers, location, and age class (immature, subadult, and adult) will be recorded. Counts will then be summarized by river mile. Upon completion of the study, final results will be presented as a technical report.

Introduction

During the winter season, bald eagles reside in substantial numbers along the Snake River and particularly concentrate along the Snake River reservoirs (Isaacs *et al.* 1992). Concern about the potential impacts of habitat alteration and other human activities on the species, and the need to identify important wintering areas, resulted in a study on wintering bald eagles in northeastern Oregon from 1988 to 1991 (Isaacs *et al.* 1992). Similar trends in numbers of wintering eagles were found between the winters of 1988 to 1989 and 1989 to 1990. Numbers increased from November through December, peaked in January and February, and declined rapidly through April (Isaacs *et al.* 1992). Average weekly counts in 1989 to 1990 were 67 in November, 168 in December, 231 in January, 263 in February, 141 in March, and 34 in April. The highest count was in the middle of February with 282 bald eagles. Forty-nine percent of all bald eagles were observed at the three Hells Canyon reservoirs in 1988 to 1989 and 56 percent in 1989 to 1990. The goal of this study is to determine the numbers and distribution of wintering bald eagles throughout the Hells Canyon Study Area.

State of Knowledge

Historic and present distribution of the bald eagle are essentially the same. However, numbers of eagles in the continental United States have decreased dramatically in the last 200 years. In response to this decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous United States and *threatened* in the remaining states, including Oregon. Bald eagles historically nested along the Snake River in the Hells Canyon Study Area. One pair reportedly nested at the mouth of Two Creeks in the early 1900s (Taylor 1989). At least five other sites have been reported as historically used by bald eagles (Isaacs *et al.* 1989).

Twenty-seven night roosts have been located and an additional 27 were suspected. Exceptional roost counts were at two bald eagle roosts along IPC reservoirs: 55 at Eagle Island Creek and 100 at Soda Creek. Midwinter bald eagle counts, organized by USFWS, started in 1979 in the Hells Canyon Study Area. Numbers of wintering bald eagles along the Snake River Canyon have doubled over the period 1988 through 1992 (□ = 59.2 bald eagles) compared to the period 1979 through 1983 (□ = 26.2 bald eagles) (Isaacs 1992). In 1990, 53 occupied bald eagle territories were estimated to occur in Idaho and 175 in Oregon (Bald Eagle Working Team 1990, Kjos 1992). The USFWS is reviewing the status of the bald eagle in preparation of a proposal to downlist this species (Federal Register Volume 61, No. 40, February 28, 1996).

Methods

Aerial bald eagle surveys will be conducted in the Hells Canyon Study Area. Bald eagle numbers, locations (river mile, plotted on 1:24,000 USGS maps) and age classes (immature, subadult, and adult) will be recorded. To minimize variation in surveys, a strict adherence will be placed on using the same sampling routes and survey protocol. A number of factors may potentially affect the survey data (e.g., weather conditions, icing of the river). These factors are anticipated to be included in the data analysis when data collection has been completed. Numbers of eagles, partitioned by age class, will be summarized by river mile for the Hells Canyon Study Area.

Timetable

This study was initiated in 1994 and is anticipated to continue through at least 2000. The same survey protocol will be used as in previous years. The bald eagle survey will take place in early January. Timing will coincide with the USFWS Midwinter Bald Eagle Count, if possible. Upon completion of the surveys in 2000 or a later date, all data will be summarized and presented in a final report.

Cooperation

Resource agencies with potential interest in studying bald eagles in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. IPC's principal investigator will be Dr. Toni Holthuijzen. Dr. Holthuijzen will be assisted by Frank Edelmann and at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in Wildlife Biology and Mr. Edelmann has a Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho. Frank Edelmann has five years of experience conducting wildlife studies in Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by December 1998. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.7.
Title: Distribution of Nest Sites and Productivity of Nesting Peregrine Falcons in the Hells Canyon Study Area

This is a descriptive study being conducted by the USFS/HCNRA, with assistance from IPC. IPC was invited to participate in this cooperative study because the HCNRA lies within IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information being collected will assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

Monitoring of historic and potential peregrine falcon (*Falco peregrinus*) nest sites in Hells Canyon has been limited to two studies and incidental observations. The objectives of this study are to: determine occupancy of historic, active, and potential peregrine falcon nest sites, document nesting suitability of cliffs within a mile of the Snake River, and document the presence of peregrine falcons. Historic aeries and sites where peregrine falcons have been observed during recent years will be surveyed. Nest sites will be reported and plotted, and nest success will be documented. This information will determine the status of the peregrine falcon in Hells Canyon. Upon completion of the study, final results will be presented as a technical report.

Introduction

Peregrine falcons nested on the cliffs and bluffs above the Snake River prior to 1950 (Bechard *et al.* 1987). Since 1987, the Peregrine Fund, IDFG, ODFW, and the USFS have cooperatively released approximately 62 peregrine falcons at three locations in or adjacent to the Hells Canyon Recreation Area. Monitoring of historical and potential nest sites has been limited to two studies (Levine and Erickson 1990, Akenson 1996), and incidental reports. Therefore, the objectives of this study are to:

1) determine occupancy of historic, active, and potential peregrine falcon nest sites,
2) document nesting suitability (cliff rating) of cliffs within a mile of the Snake River, and
3) document the presence of peregrine falcons.

State of Knowledge

Historically, the peregrine falcon was known to nest at two known locations along the Snake River in Hells Canyon (Bechard *et al.* 1987). One historical site was in Oregon near Hells Canyon Dam. The other site was near the confluence of the Grand Ronde and Snake Rivers. Until 1967, the Grande Ronde site produced wild young. Peregrines were reintroduced at this site in 1987 (Bechard *et al.* 1987). Since 1987, the Wallowa-Whitman National Forest has cooperated with ODFW and the Peregrine Fund to annually release peregrines at P.O. Saddle in Hells Canyon. In 1990, peregrine were also released from High Dive, located in the Payette National Forest, eight miles east of Hells Canyon (Levine and Erickson 1990). In 1990, a peregrine survey of the HCNRA was conducted, but peregrines were not observed (Levine and Erickson 1990).

Methods

Study Design and Field Methods

Historic aeries of peregrine falcons located near project facilities in the Hells Canyon Study Area will be surveyed annually during the nesting season. Likewise, nesting sites where peregrine falcons have been observed during the past years will be included. A pilot study conducted during the 1995 nesting season may provide insight into potentially important parameters for selecting suitable survey sites (*IPC unpub. data*). Surveys will be conducted in early to late March to count the number of pairs associated with nesting territories (Kochert 1986). A protocol outlined by Pagel (1992) will be used for observations.

Site occupancy classification will require at least one of the following observations:

1) evidence that an egg was laid (incubating birds, eggs, eggshells, young, or a decorated nest),
2) observations of two breeding-age birds that appear to be paired, or
3) observations of one or more birds attending a nest, engaging in reproductive behavior (e.g., copulating), or defending an area (Kochert 1986).

A pair will be considered breeding only if eggs were laid (Steenhof 1986). Occupied nesting territories will be identified based on the behavioral data collected during the survey.

Analyses

Nesting territories will be plotted on 1:24,000 scale USGS maps. All surveyed nest sites will also be reported and plotted. The number of occupied nesting territories will be calculated per kilometer. Productivity will be calculated as the number of young fledged per nesting attempt. Nest success of all nesting pairs will be documented. Number of young produced will be assessed. This information will help determine the status of the peregrine falcon in the Hells Canyon Study Area.

Timetable

Surveys were conducted in 1996. However, because only a small fraction of the total potential nest sites could be surveyed in 1996, field work will continue in 1997 to further assess the distribution and status of nesting peregrine falcons in Hells Canyon. A draft report will be submitted to all participants in August 1997. After revisions are incorporated, a final report will be provided to all participants in November 1998.

Cooperation

Resource agencies with potential interest in studying peregrine falcons in Hells Canyon will be contacted. Currently, this project is being conducted cooperatively with the USFS as a challenge-cost share project.

Statement of Capabilities

IPC has the personnel and equipment necessary to assist in this study. IPC’s principal investigator will be Dr. Toni Holthuijzen. Dr. Holthuijzen will be assisted by Frank Edelmann and at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in wildlife biology and Mr. Edelmann has a Master’s Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho. Mr. Edelmann has seven years of experience conducting wildlife studies in Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by August 1997. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report to be completed in November 1999.

8.2.8.
Title: A Description of State and Federal Sensitive Species in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Fifty-eight species, known or suspected to occur in the study area, were listed by Oregon, Idaho, or federal agencies as *endangered*, *threatened*, *candidate*, or *sensitive* species. All information (e.g., field, literature, and incidental observations) collected on (former) federal *candidate* species and state *sensitive* species will be summarized to assess presence and distribution of these species in Hells Canyon. Upon completion of the study, final results will be presented as a technical report.

Introduction

Fifty-eight species, known or suspected to occur in the study area are classified as *endangered*, *threatened*, *candidate*, or *sensitive* species. Avian species was the largest taxon with 39 listed species, including two *endangered* species (bald eagle and peregrine falcon). Seventeen mammal species, one amphibian, and one reptile potentially occurring in Hells Canyon have also been listed (CDC 1994, ONHP 1995). Therefore, the primary objective of this study is to determine the presence of federal *candidate* and state *sensitive* species in areas that can reasonably be expected to be impacted by project operations in Hells Canyon.

State of Knowledge

The USFWS currently is revising the list of taxa that are candidates for listing as *endangered* or *threatened* species (Federal Register, Vol. 61(40), February 1996). Presently, the terms *species at risk* or *species of concern* are informally being used by the USFWS when referring to species formerly classified as *Category 2* species. These terms are considered “terms of art” that describe the entire realm of taxa where conservation may be of concern to the USFWS, but neither term has official status. Two species are listed as *candidate* species that may occur in the study area; Great Basin population of spotted frog (*Rana pretiosa*), and the northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) (Federal Register, Vol. 61(40), February 1996). For most federal *candidate* species and state *sensitive* species specific information on status and distribution of these species is not available for the study area. Whatever data were available from the literature are summarized in the following.

Amphibians and Reptiles

Eleven species, formerly classified as *candidate* species, or state *species of special concern/sensitive* species potentially occur within the study area. The study area potentially contains most of the amphibians and reptiles that are *species of special concern* in Idaho and eastern Oregon. These include one USFWS *Category 1* species (the Great Basin “population” - Oregon side of the Snake River) of spotted frogs, three former USFWS *Category 2* species (tailed frog (*Aescaphus truei*), the “main” population on the Idaho side of the Snake River) of spotted frogs (*Rana pretiosa*), and the sagebrush lizard (*Isceloporus graciosus*)]. The study area also may contain the following *sensitive* species or *species of special concern*: tiger salamanders (*Ambystoma tigrimum*), western toads (*Bufo boreas*), northern leopard frogs (*Rana pipiens*), Mojave black-collared lizards (*Crotaphytus bicinctores*), ringneck snakes (*Diadophis punctatus*), longnose snakes (*Rhinocheilus lecontei*), and ground snakes (*Sonora semiannulata*).

The spotted frog ranges from extreme southeastern Alaska through western Alberta, western Montana and northwestern Wyoming to northern Utah and central Nevada and west to the Pacific coast in Oregon and Washington. The spotted frog prefers marshy ponds and lake edges. In the southern part of its range, it is presented primarily by isolated populations, which may occur up to 3300 m (10,825 feet) in elevation. Populations of spotted frogs have greatly decreased as a result from interspecific competition with northern leopard frogs, introduced bullfrogs (*Rana catesbeiana*), and loss of riparian habitat (Spahr *et al.* 1991, Marshall *et al.* 1996). The species formerly occurred at scattered localities throughout Oregon, but is now extirpated from western Oregon. The yellow variety still occurs at scattered locales in eastern Oregon (Marshall *et al.* 1996). The spotted frog appears secure in northeastern Oregon (Marshall 1986).

The northern leopard frog ranges in North America as far north as the Great Salt Lake and as far south as Arizona and New Mexico. The species occurs in north-central Oregon along the Columbia and in the Snake River drainage of northern Malheur and south Baker counties. The species prefers marshes and meadows from which they may range into hay fields and grassy woodlands. The current status of the species in unknown in Oregon

(Marshall *et al.* 1996). Likewise, little information is available on the species in the study area vicinity in Idaho.

The tailed frog ranges in the Rocky Mountains from southeast British Columbia to northern Idaho and southeast Washington to northeast Oregon. The species is found in cold fast-flowing permanent streams in forested areas. In Oregon, the species occurs on the west slopes of the Cascade Range, Coast Range and Wallowa Mountains. In Idaho, tailed frogs have been found in tributaries to the Snake River in the Hells Canyon reach (IPC, *unpubl. data*).The status of the species is unknown, but there is evidence for a decline (Marshall *et al.* 1996).

The western toad ranges from southeast Alaska south to northern California and western Montana. The species prefers forested and brushy areas from sea level to high mountains. The species is widely distributed in Oregon, but absent in the valleys of the Great Basin (Marshall *et al.* 1996). The status of the species in Idaho and Oregon is unknown, but populations are declining.

The woodhouse's toad (*Bufo woodhousii*) ranges from the eastern seaboard of the United States west as far as Montana and the southeast corner of California. The species prefers riparian habitats, sagebrush flats and fields. Disjunct populations occur in the Snake River in Idaho and Oregon. The status of the species is unknown other than its presence as isolated populations within limited areas (Marshall et al 1996).

Diurnal Birds of Prey

Ferruginous hawks (*Buteo regalis*) have historically inhabited much of western North America. The species breeds in arid, semi-arid, and grassland regions. The species' breeding range is the most restricted of all North American buteos. Ferruginous hawks prey on a variety of small mammals, birds, and insects. The species is reported to be in decline throughout much of their range. This decline has been attributed to the conversion of grasslands for agricultural purposes, loss of resting sites, control of natural fires, declines in prey populations, and human disturbances (Harlow and Bloom 1987, Marshall *et al.* 1996). The ferruginous hawk appears to be currently restricted to northcentral and southeastern portions of Oregon (Bechard *et al.* 1986, Harlow and Bloom 1987). In Idaho, ferruginous hawks were always limited to the southern portion of the state (Bechard *et al.* 1986). Ferruginous hawks nest in the Wallowa-Whitman National Forest, but specific information is not available (USDA 1990).

The Swainson's hawk (*Buteo swainsoni*) has a similar distribution as the ferruginous hawk. In the early 1900s the species was one of the most common nesting raptor species across eastern and central portions of Oregon (Bechard *et al.* 1986). Swainson's hawks were formerly considered quite common in arid and semi-arid habitats, but their populations have recently declined dramatically (Harlow and Bloom 1987). The population in Oregon is estimated at 400 to 800 pairs (James 1987, Harlow and Bloom 1987). In historic times, Swainson's hawks appear to have been common nesters in northern Idaho counties. The population appears to have declined, but its current status is unknown (Bechard *et al.* 1986).

The northern goshawk (*Accipiter gentilis*) is holarctic in distribution. The species occurs throughout the western United States. Northern goshawks are residents in northeastern Oregon and north and northcentral Idaho (Reynolds 1987). Preferred habitat during the breeding season is older tall forest, either deciduous, coniferous, or mixed (Hayward and Escano 1989). In high mountain areas, some wintering individuals descend to lower elevations and can be found in more open shrubland and woodlands. Northern goshawks nest at elevations of 580 m (1900 feet) to 1860 m (6100 feet) in Oregon. The species nests in large coniferous or deciduous trees in older stands. Nest trees are frequently the largest tree in a stand, often adjacent to small breaks in the canopy. Densities of northern goshawk nest range from a high of 11.0 pairs/100 km^2 in Arizona to 2.4 pairs/100 km^2 in Alaska. Densities for the study area vicinity are not available but are likely to fall somewhere in the middle range of nesting densities. Levine and Erickson (1990) recorded three occupied northern goshawk territories in a raptor survey of the Snake River corridor in the HCNRA. The northern goshawk is an indicator species for mature and old-growth forests on the Wallowa-Whitman National Forest.

Owls

The great gray owl (*Strix nebulosa*) resides in forested areas across North America. In Idaho, resident great gray owls are found in north, north-central, and southeastern Idaho (Munts and Powers 1991). The species nests in central and northeastern Oregon. The great gray owl is an uncommon local resident (Marshall *et al.* 1996). Quantitative data on population trends are not available (Forsman and Bull 1987).

The burrowing owl (*Athene cunicularia*) occurs throughout the western U.S., although very little population data is available. The species breeds and forages in open grasslands, deserts, agricultural lands, and urban areas (Marti and Marks 1987). The status of the species in Oregon is unclear (Marshall *et al.* 1996). The Idaho population is stable (Marti and Marks 1987). Burrowing owls are highly dependent upon burrowing rodents in most parts of the west for nesting. They appear to do well in disturbed habitats and may be one of the raptors least affected by man-made environmental changes. However, large-scale conversion of sagebrush-steppe habitat creates highly unfavorable conditions for the species.

The regional status of the four small forest owls, the boreal owl (*Aegolius funereus*), northern saw-whet owl (*Aegolius acadicus*), flammulated owl (*Otus flammeolus*), and northern pygmy owl (*Glaucidium gnoma*), is poorly known because of their small sizes, low population densities, and with the exception of the northern pygmy owl, nocturnal habits (Reynolds *et al.* 1989). The boreal owl is circumpolar in distribution. It is found in boreal, mainly coniferous forests. In the lower 48 states it nests in the mountains of Washington, Idaho, Montana, Wyoming, and Colorado (Reynolds *et al.* 1989). In Idaho, boreal owls nest in north and northcentral parts of the state. In Oregon, the species occurs as geographically isolated meta-populations because of spotty habitat (Hayward 1994). The boreal owl has mainly been found in higher elevation conifers, primarily spruce (*Picea* spp.) and fir (*Abies* spp.), but also in lodgepole pine and Douglas fir habitat, immediately adjacent to the spruce-fir zone. Data for North American populations are very limited and are not available for the study area and vicinity. Studies in the northern Rocky Mountains suggest that the number of breeding pairs vary widely between years (Reynolds *et al.* 1989). The species exists in small, isolated populations, posing threats to local extirpations.

The flammulated owl occurs in montane forests in western north America from Central America to British Columbia. In Idaho, flammulated owls nest in northern and west-central portions of the State. In Oregon, the species is restricted to the Cascade Mountains and the northeastern section of the state (Reynolds *et al.* 1989, Marshall et al 1996). It is the only forest owl species classified as a neotropical migrant. Flammulated owl nesting habitat consists of mature to old forest stands, with open, multiple canopy layers, and low tree densities (Moore and Frederick 1991). Roosting areas, however, have higher tree densities and canopy cover than nesting sites. In a study in west-central Idaho, singing male densities varied from 0.09 to 0.84 males/40 km line transect (Moore and Frederick 1991). In eastern Oregon, densities of 0.72 males/40 km line transect were reported (Goggans 1986). The species was once thought to be rare, but is now known to occur at least uncommonly and even commonly in prime habitat (Marshall *et al.* 1996).

The northern pygmy owl resides in woodlands and forests in foothills to high mountains from southeastern Alaska, south through British Columbia and most of the western mountains to Mexico and Guatemala. In Idaho, the species nests throughout the state except in the deserts in the southern and southwestern portions of the state. In Oregon, the northern pygmy owl nest in the western and northeastern parts of the state (Reynolds *et al.*

1989). Population status and nesting habitat are little known because few nests have been found. This owl is active during the day and feeds on small birds, mammals, reptiles, and insects. Nests were found in Douglas fir forest, grand fir, and quaking aspen (*Populus tremuloides*). Almost nothing is known of the territories and ranging behavior of this owl. Territories apparently are large, separating pairs by more than 1.6 km (1 mile) (Reynolds *et al.* 1989).

Gallinaceous Birds

The sage grouse (*Centrocercus urophasianus*), which is dependent upon sagebrush-dominated rangelands, was historically widespread in southern Idaho and southeastern Oregon. Currently, the status of sage grouse is of concern to wildlife managers because of general population declines across its range. In response to declines, the western sage grouse subspecies, which occurs in Oregon, was listed as a candidate for *threatened* or *endangered* listing (*C2*) in 1985 by the USFWS (Drut 1994). Because sage grouse were historically abundant in the shrub-steppe habitats of the western United States, efforts have recently been undertaken to understand causes for population declines (Willis *et al.* 1993, Marshall *et al.* 1996). Declines are associated with habitat loss due to cultivation, sagebrush control, wildfire, and livestock grazing (USDI 1987, Marshall *et al.* 1996). Populations have been documented to occur in areas adjacent to the southern reaches of Hells Canyon in both Oregon and Idaho (USDI 1987, Smith 1990, Willis *et al.* 1993). However, few formalized surveys for sage grouse have been conducted in Hells Canyon. Marshall *et al.* (1996) identified that improved inventory procedures, lek counts, and basic inventories in summer and winter areas are needed. Thus, little information is available on the current status of sage grouse abundance and distribution within Hells Canyon.

Similarly, Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) were classified as a federal *C2* species (CDC 1994), because of distribution-wide declines. Columbian sharp-tailed grouse historically occupied much of the Pacific Northwest including Hells Canyon (Marks and Marks 1987, USDI 1987). Currently, sharptails are considered to be extinct in Oregon, and in west-central Idaho are known to exist only as isolated populations (Miller and Graul 1980, USDI 1987, Hemker 1994). The decline of this species is associated with habitat loss due to overgrazing and conversion of rangelands to agriculture (USDI 1987). The status of sharp-tailed grouse specifically in Hells Canyon is unknown. Only one sharptail dancing ground is known to exist in Hells Canyon (USDI 1987). However, few organized surveys for sharptails have been conducted in Hells Canyon; distributional information is restricted to anecdotal sightings.

Mountain quail (*Oreortyx pictus*) are distributed from Vancouver Island, British Columbia south along the mountains of the Pacific coast to the northern Baja Peninsula (AOU 1983, Spahr *et al.* 1991). The status of mountain quail populations has become a focus of concern throughout the intermountain region of the western United States. Because of population declines in this region, the mountain quail was classified as a *species of special concern* by the IDFG and as a *sensitive* species by the USDI Bureau of Land Management (BLM) and Regions 1 and 4, USFS. In 1991, the USFWS listed mountain quail as a *Category 2* (*C2*) *candidate* species. Mountain quail were listed as *C2* because detailed data on distribution, abundance, life history, habitat use patterns, and population ecology is limited. Little research has been conducted because of the bird's secretive behavior, low population densities, and use of dense vegetation in difficult terrain (Heekin and Reese 1995).

Specifically in Hells Canyon, however, Ormiston (1966) investigated mountain quail food habits, habitat use, and movement. More recently, Vogel (1994) assessed habitat suitability in selected tributaries of Brownlee Reservoir. Although mountain quail are now absent from this area, habitat appeared suitable for reintroduction efforts (Vogel 1994). Reese and Smasne (1996) also searched for mountain quail in areas studied by Ormiston (1966) in the HCNRA, but reported locating no quail. Although Reese and Smasne found no mountain quail, isolated populations are believed to exist elsewhere in the HCNRA (Stephen and Sturts 1991).

The distribution of the spruce grouse is generally congruent with that of the boreal coniferous forest. Spruce grouse in Oregon, which are categorized as a *sensitive* species, are mostly restricted to the Wallowa Mountains (Marshall *et al.* 1996). However, individuals in Oregon may move through Hells Canyon to link with populations in Idaho. The species reaches its southernmost extent of its range in Idaho. Spruce grouse are sparsely distributed throughout their ranges in Idaho and Oregon. Information on population sizes are not available for Oregon or Idaho (IDFG 1990). Spruce grouse are considered *sensitive* in Oregon because of limited numbers and distribution potentially due to wildfire and logging (Marshall *et al.* 1996).

Waterfowl

Harlequin ducks (*Histrionicus histrionicus*) breed in western North America from western Alaska south to Vancouver Island, eastern Oregon, and western Wyoming. In Idaho, the species has been found along swiftly flowing mountain streams (Cassirer *et al.* 1991). Population densities on streams reaches used by harlequin ducks averaged 0.15 pairs/km of suitable stream (Cassirer *et al.* 1991). Harlequin ducks were observed at elevations from 600 m (1970 feet) to 1200 m (3937 feet). In eastern Oregon, on the Wallowa-Whitman National Forest, harlequin duck habitat exists and the species has been sighted (USDA 1990). In Oregon, the species winters at selected sites on the coast, especially along rocky shores. It nests along streams, mainly on the west slopes of the Cascade Range. A 1930s breeding record is available for the Wallowa Mountains (Wallowa River near Frazier Lake and Imnaha River; Gabrielson and Jewett 1940). Surveys have not been conducted in Oregon (Cassirer and Groves 1991).

Shorebirds

The long-billed curlew (*Numenius americanus*) historically was abundant over much of the prairie regions of North America. Extensive market hunting and loss of habitat exterminated the species from eastern North America in the latter part of the last century. Numbers continued to decline through the early part of this century until the 1930s (Bent 1929). Then numbers stabilized, apparently as a result of reduced hunting and grazing pressure. Also, long-billed curlew started to exploit newly created habitat, such as annual grasslands and irrigated lands (Cochran and Anderson 1987). The population of long-billed curlews in the Columbia and northern Great Basin was estimated at 8,000 to 13,000 nesting pairs in 1980 (Pampush 1980). An estimated 2,500 to 3,500 nesting pairs are found in the central Snake River Basin. Most of these birds nest in Idaho (Pampush 1980). An important breeding area is southeast of the study area in the Cascade Resource Area, BLM-Boise District. This area supports an estimated 1,200 nesting pairs (USDI 1987). Habitat exists at the Wallowa Whitman National Forest and scattered sightings of the species have been reported (USDA 1990). The long-billed curlew is considered an uncommon breeding bird in the Blue Mountains Province in Oregon (Marshall 1986).

The upland sandpiper (*Bartramia longicauda*) breeds locally from north-central Alaska, to central Maine, northeastern Oregon, central Colorado and across the plains to north-central Texas. The species was abundant in historical times but greatly reduced in the past due to market hunting and agricultural practices. Stephens and Sturts (1991) reported the species as nesting near the study area. The upland sandpiper is a rare breeding bird in the Blue Mountains Province in Oregon. The largest population of upland sandpipers in the Rocky Mountains was found in the Blue Mountains, distributed in small, disjunct populations (Marshall 1986). Extensive surveys in 1984 and subsequent observations accounted for fewer than 100 upland sandpipers in Oregon (Herman *et al.* 1985). Populations in Idaho are even smaller. Habitat is available on Wallowa-Whitman National Forest and the species has been reported (USDA 1990).

Perching Birds

Loggerhead shrikes (*Lanius ludivicianus*) are widely distributed in North America. They range from southern Canada to Mexico and from coast to coast. Southern populations are largely residents while northern populations are at least partially migratory (Miller 1931, Bent 1965). Concern was expressed during the 1980s that loggerhead shrike populations were declining (Davis and Morrison 1987). Mild to precipitous declines have been observed in most parts of the U.S. (Davis and Morrison 1987). The Pacific coast and the southwest, however, seem to have stable to slightly declining populations (Davis and Morrison 1987). In shrub-steppe habitats of southeast Oregon, no decline is evident for the past 15 years (Keister and Ivey 1994). The species mainly is found in sagebrush and juniper steppe in eastern Oregon (Marshall *et al.* 1996). The species is considered an uncommon breeding bird in the Blue Mountains Province in Oregon (Marshall 1986). Stephens and Sturts (1991) recorded loggerhead shrikes as transient in east-central Idaho. There are no long-term data available on population trends of loggerhead shrikes in east-central Idaho.

The rosy finch (*Leucosticte arctoa*) breeds above timberline from Alaska to southwestern Alberta and south through the Cascades, Sierra Nevada, and the Rocky Mountains to east-central California and north-central New Mexico. A subspecies of the rosy finch, the Wallowa rosy finch (*L. arcotoa wallowa*), occurs in summer around snow fields in the Eagle Cap Wilderness Area in the Wallowa-Whitman National Forest (Marshall 1986). The status of black rosy finches in the Wallowa Mountains is unclear, particularly because of their confusing taxonomic status (Marshall *et al.* 1996). Populations of the black rosy finch (*L. arctoa atrita*), another subspecies of the rosy finch, have not yet been identified (USDA 1990).

The bank swallow (*Riparia riparia*) ranges from western and central Alaska to southern California and southern Texas. In Oregon, the species occurs as a summer resident mainly east of the Cascade Range (Marshall *et al.* 1996). The bank swallow breeds throughout Idaho, except at high elevations (Stephens and Sturts 1991). A joint Idaho/Oregon Snake River state wildlife survey in 1991 found three colonies totaling 650 burrows along the river east of Nyssa, Malheur County. The status of the bank swallow in Oregon and Idaho is unclear (Marshall *et al.* 1996, Stephens and Sturts 1991).

The yellow-billed cuckoo (*Coccyrus americanus*) breeds over much of the U.S. and northern Mexico. However, the species has declined in the western U.S. since the 1930s. The species was formerly an abundant common breeding species along the Columbia River west of the Cascades. The species prefers large riparian forests, especially those with cottonwood overstories and willow understories. The yellow-billed cuckoo breeds in southern Idaho, at least in historical times (Stephens and Sturts 1991). No current nest sites are known in Oregon (Marshall *et al.* 1991). Information is not available for Idaho.

The black-throated sparrow (*Amphispiza bilineata*) can be found in the Great Basin, Mojave, and Colorado deserts. In Oregon, the species is found in the southeast corner of the state (Marshall *et al.* 1996). Black-throated sparrows nest throughout the southern part of Idaho (Stephens and Sturts 1991). The species typically occurs in a narrow zone between valley or playa floors and steep rocky areas, mountain ranges, or escarpments (Bent 1965). The species was historically very rare in Oregon. Currently, the black-throated sparrow is a rare to uncommon summer resident and vagrant (Marshall *et al.* 1996). Information on the status of the species is not available for Idaho.

The grasshopper sparrow (*Ammodramus savannarum*) has a spotty breeding range from British Columbia to the southeast. The range in Oregon of the species is disjunct with locations which change periodically. Site locations are clustered in northeastern Oregon (Marshall *et al.* 1996). Grasshopper sparrows nest throughout southern Idaho (Stephens and Sturts 1991). Specific information on population status, however, is not available.

Woodpeckers

The pileated woodpecker (*Dryocopus pileatus*) is a widely dispersed breeding bird in North America. The species is generally limited to mature coniferous, deciduous, and mixed forests, with large, dead trees. The pileated woodpecker is uncommon in coniferous forests of northeastern Oregon (Bull 1987). The species is an important primary excavator of nest cavities that are used by secondary cavity users. The density of pileated woodpeckers in a study area in the Wallowa-Whitman National Forest was estimated at one pair/220 hectares (Bull 1987). The species is reported breeding in the study vicinity in Idaho (Stephens and Sturts 1991). Specific information on the status of this species on the Idaho side of the study area is not available.

The white-headed woodpecker (*Picoides albolarvatus*) ranges from southern British Columbia south through Washington and Idaho to southern California and Western Nevada (AOU 1983). The species uses open-canopied stands of mature and older ponderosa pine (*Pinus ponderosa*), and less frequently, mixed ponderosa pine and Douglas fir (Frederick and Moore 1991). White-headed woodpeckers were reported in a survey in the HCNRA (Frederick and Moore 1991). The information collected in this survey was insufficient to provide density estimates for the species. White-headed woodpeckers used a wider range of habitats during the breeding season than has been suggested by previous studies in its northern range (Frederick and Moore 1991). The species is considered an uncommon breeding bird in the Blue Mountains Province in Oregon (Marshall 1986). The bird is considered rare to uncommon, having a patchy distribution even within ponderosa pine zones in Oregon (Marshall *et al.* 1996).

Three-toed woodpeckers (*Picoides tridactylus*) range across North America from tree line south to southern Oregon and through Idaho and Utah to New Mexico and Arizona. The species is found in northern coniferous and mixed forest types up to elevations of 3000 m (9840 feet). Forests containing spruce, grand fir, ponderosa pine, tamarack (*Larix laricina*), and lodgepole pine are used (Spahr *et al.* 1991). Nests may be found in spruce (*Picea spp*.), tamarack, pine, western red cedar (*Thuja plicata*), and aspen. The woodpeckers forage on a wide variety of tree species, depending on location. In the northeastern United States, densities were estimated at approximately 5 pairs/100 hectares (40 acres) (Spahr *et al.* 1991), although densities may increase during beetle outbreaks. The species stay on their territories year-round, though insect outbreaks may cause irregular movements. Specific information on the status of this species is not available for the study area.

The black-headed woodpecker (*Picoides arcticus*) ranges from Alaska and Canada where there are coniferous forests south into Oregon, in high-elevation forests, along the Cascade Range and the Blue Mountains in northeast Oregon. Likewise in Idaho, the species can be found in coniferous forests throughout the state (Stephens and Sturts 1991). The species is found in spruce, jack and lodgepole pine (*Pinus banksiana* and *P. contorta*), but also is associated in Oregon with ponderosa pine or mixed forests (Marshall *et al.* 1996). The species is locally common in Oregon with a spotty distribution. The black-headed woodpecker breeds throughout Idaho in suitable habitat (Stephens and Sturts 1991). However, specific information on population size is not available.

The Lewis' woodpecker (*Melanerpes lewis*) ranges from British Columbia to southern New Mexico and eastern Colorado. The species is found in open country with scattered trees rather than dense forest. Open or park-like ponderosa pine forests are probably the major breeding habitat. Also found along edges of pine and juniper trees stands and in deciduous forests, especially riparian cottonwoods (DeGraaf *et al.* 1991). The species was originally a summer resident in every part of Oregon (Gabrielson and Jewett 1940), but has declined in numbers and restricted in distribution since the late 1940s. Now the species is found breeding only in the oak (*Queraus spp*.)-ponderosa pine belt and in northeast Oregon river valleys. Apparently, the decline is continuing in Oregon. In Idaho, the species breeds throughout the state. Specific information on population status is not available for Idaho (Burleigh 1972, Stephens and Sturts 1991).

Bats

The range of the spotted bat (*Euderma maculatum*) is restricted to western North America and northern Mexico (Hall 1981). The species ranges as far north as British Columbia. Little is known about the status of the spotted bat. The species appears to be widespread but rarely abundant (Fenton *et al.* 1987). It seems to prefer arid areas with canyons and cliffs where it can roost (Poché and Bailie 1974, Poché and Ruffner 1975, Woodsworth *et al.* 1981, Leonard and Fenton 1983). The critical factor appears to be the presence of cracks and crevices ranging from 2.0 cm (0.78 inches) to 5.5 cm (2.14 inches) in width at the opening (Poché 1981). In Utah, Poché (1981) found numerous spotted bats in cracks and small crevices. They were not found in caves or trees. Poché (1981) suggested that the spotted bat may select a narrow range of roosting parameters. These include the absence of forests or trees, availability of cliffs, little annual rainfall, and mild winters with a few nights where temperatures drop below 0°C. Spotted bats appear to feed mainly on moths (Poché 1981, Woodsworth *et al.* 1981, Fullard *et al.* 1983, Leonard and Fenton 1984, Wai-Ping and Fenton 1989). No records are available on spotted bats in Oregon, and only a single record exists for southwestern Idaho (Hall 1981).

The western big-eared bat (*Plecotus townsendii*) occurs throughout western North America from British Columbia to southern Mexico, and east to South Dakota and western Texas and Oklahoma. The species is widely distributed throughout the intermountain region. Western big-eared bats use juniper/pine forests, shrub-steppe habitats, deciduous forests, and mixed coniferous forests at elevations from sea level to 3300 m (10,825 feet). The species does not migrate, but remains at hibernacula from October through February. Low reproductive rates, limited roost sites, and vulnerability to human disturbance makes the species vulnerable (Spahr *et al.* 1991). It was estimated that approximately 2,800 western big-eared bats occur in Oregon, with 1,600 east of the Cascades. Population numbers are not available for Idaho.

The long-eared myotis (*Myotis evatis*) ranges from central British Columbia south to new Mexico and Arizona. In Oregon, the species is found state-wide in forested and riparian habitats. Likewise, the species occurs throughout Idaho (Groves and Marks 1985). Information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The long-legged myotis (*Myotis volans*) ranges from southeast Alaska to central Mexico. The species inhabits coniferous forests, but is also found in riparian and desert habitats (Warner and Czaplewski 1984). The bat is likely to occur throughout the states of Oregon and Idaho. Information on the status of the species in both Oregon and Idaho is not available (Marshall *et al.* 1996).

The pallid bat (*Anrtozous pallidus*) ranges from southern British Columbia south through Arizona and New Mexico. The bat inhabits arid regions, especially rocky areas near water. In Oregon, the species is usually associated with canyons. Rocky crevices and human structures are used for day roosts. Night roosts are located in shallow caves, cliff overhangs, and human structures (Hermanson and O'Shea 1983). The species is uncommon is Oregon and populations are local. Specific information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The silver-haired bat (*Lasionycteris noctivagans*) occurs throughout much of North America ranging from southeast Alaska to northern Mexico. The species is most abundant in forested areas and prefers old-growth Douglas fir/western hemlock (*Tsuga heterophylla*) (Marshall *et al.* 1996). The bat species occurs throughout Oregon and Idaho (Groves and Marks 1985, Marshall *et al.* 1996). Information on the status of the species in Oregon or Idaho is not available (Marshall *et al.* 1996).

The western small-footed myotis (*Myotis cilolabrum*) ranges from extreme southern British Columbia to the northern edge of Mexico. In Oregon, the species is found in valleys and ponderosa pine forests east of the Cascade Range. Population numbers are unknown. The bat is confined to habitat that is not modified on a large scale. Its status as a *sensitive* species in Oregon needs to be re-evaluated (Marshall *et al.* 1996).

The Yuma myotis (*Myotis yumanensis*) ranges from southwest British Columbia to southern Colorado, Arizona, and northwestern New Mexico. The species is likely to occur throughout Oregon. In Idaho, the species appears to be restricted to arid areas, caves and human structures (Groves and Marks 1985). Information on the status of the species in both Oregon and Idaho is not available (Marshall *et al.* 1996).

Lagomorphs

Pygmy rabbits (*Brachy logus idahoensis*) are found in seven western states. In Oregon and Idaho, the species appears to occur in only isolated pockets (Weiss and Verts 1984). The geographic range of the species includes most of the Great Basin and some adjacent intermountain areas of the western United States (Green and Flinders 1980a). Pygmy rabbits are closely associated with dense or clumped stands of big sagebrush growing in deep, loose soils (Green and Flinders 1980a,b; Weiss and Verts 1984). Pygmy rabbits are unique because they dig shallow burrows. Greasewood (*Sarcobates vermiculata*) (*Artemisia tridentata tridentata*) stands are also occupied (Davis 1939). The pygmy rabbit is dependent on big sagebrush for cover and, to a large extent, for food (Wilde 1978; Green and Flinders 1980a,b; White *et al.* 1982a,b). This dependency may pose a threat to the species. Fragmentation of sagebrush communities will ultimately affect existing populations. Pygmy rabbit populations do not seem to be cyclic as other leporids. Their reproductive patterns do not seem to respond quickly to favorable environmental conditions (Wilde 1978, Green and Flinders 1980a). Populations of pygmy rabbits appear to be susceptible to rapid declines and local extirpation (Weiss and Verts 1984). Population densities apparently vary in several orders of magnitude from less than 1 to 45 rabbits/hectare (Green and Flinders 1980a). Asherin and Claar (1976) did not record pygmy rabbits in the study area in their surveys. The species was suspected to occur in the shrub-steppe habitat at the upper end of Brownlee Reservoir.

Insectivores

The distribution of the Preble's shrew (*Sorex preblei*) is unclear. Records suggest that the species may occur throughout the Columbia Plateau and Snake River Plain, and extend throughout the northern Rocky Mountains (Hoffman and Fisher 1978). All established records of the shrew, however, are from elevations ranging from 1400 m (4593 feet) to 2700 m (8858 feet) (Hoffmann *et al.* 1969, Hoffmann and Fisher 1978, Tomasi and Hoffmann 1984, Williams 1984). Habitat descriptions where Prebles's shrews were caught were generally described as (montane) sagebrush communities (Williams 1984), arid to semi-arid shrub-grass associations, or openings in montane coniferous forests dominated by sagebrush (Tomasi and Hoffmann 1981). Preble's shrews apparently have been collected in the Wallowa-Whitman National Forest (USDA 1990). Specific information on population status is not available.

Rodents

The Idaho ground squirrel (*Spermophilus brunneus*) is limited to a few isolated colonies in five counties in western Idaho (Adams, Valley, Gem, Payette and Washington counties) (Yensen 1991). The northern population is restricted to Adams and Valley counties with the main concentration between the Seven Devils Mountains and the Cuddy Mountains in Adams County. The southern population occurs in Gem, Payette, and Washington counties north of the Payette River. The northern populations occur in meadows surrounded by ponderosa pine and Douglas fir forests between elevations of 1150 m (3773 feet) to 1550 m (5085 feet). Vegetation in these drier meadows often is dominated by stiff sage (*Artemisia rigida*) or mountain big sage (*Artemisia tridentata vaseyana*) (Yensen 1991).

Populations are small (fewer than 200 individuals). Seventeen populations have been identified. Southern populations occur at elevations of 670 m (2198 feet) to 975 m (3199 feet) in the low rolling hills and valleys north of the Payette River. The distributional range is bounded south by the Payette River, west by the Snake River, and on the northeast by unsuitable habitat (Yensen 1991). The species has been collected from 24 sites in the southern range. The limited ranges and small breeding populations make the species vulnerable to a variety of threats.

Carnivores

The marten (*Martes americana*) inhabits boreal forests of North America. In the western U.S., marten ranges include Oregon, Idaho, Washington, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, and California (Strickland *et al.* 1982). In northeastern Oregon, martin are relatively common in the Blue and Wallowa Mountains (Marshall *et al.* 1996). In Oregon, marten are classified as Sensitive-State Vulnerable (ONHP 1995), but are a harvested furbearer in Idaho (Will 1995). Sensitive status was assigned in Oregon because of declining habitat quantity and quality due to harvest of mature and old-growth timber.

No habitat studies have been conducted in Oregon. However, martens elsewhere (including Idaho) generally inhabit mature and old-growth mesic forests that contain large quantities of standing and downed, coarse woody debris (Koehler *et al.* 1975, Koehler and Hornocker 1977, Marshall *et al.* 1996). Hence, habitat fragmentation due to logging may be isolating populations and affecting long-term viability. National forests in Oregon often use marten as an indicator species for old-growth forests, although provisions in the national forest planning process may be inadequate (Marshall *et al.* 1996). Martens have been documented to occur at upper elevations adjacent to Hells Canyon in Oregon (USDA 1992, 1993, Schommer 1994). It is anticipated that martens also occur adjacent to Hells Canyon in the Seven Devils Mountains of Idaho. Adequate information is not currently available to assess population status nor distribution in and adjacent to Hells Canyon.

The wolverine (*Gulo gulo*) has a circumboreal distribution. In North America, the species occurs in Alaska and across the boreal forests of Canada south into the northwestern U.S. Wolverine numbers declined steadily in the contiguous U.S., after the late 1800s. Today, they are uncommon. In the continental U.S., the presence of wolverines has been confirmed in Wyoming, Washington, Oregon, Idaho, and Montana. Only Idaho and Montana are known to support reproducing populations of wolverines (Hornocker and Hash 1981, Copeland 1996). The species' status is unknown in these other states. Wolverines are a naturally low-density species throughout their range. Densities are low, even in the best habitats, and closely tied to the diversity and availability of food. The distribution and status and of wolverines in and adjacent to Hells Canyon is currently unknown. Marshall *et al.* (1996) reported that research is needed to better define wolverine habitat needs and status.

The present-day distribution of the wolverine in Idaho is probably in the mountainous portions of the state from the South Fork of the Boise River north to the Canadian border (Groves 1988). In Oregon, wolverine occurs statewide in mountainous regions (Marshall *et al.* 1996). The species inhabits tundra and coniferous forest zones, generally at higher altitudes during summer and mid-to-lower elevations during winter. Low elevation riparian areas may be important winter habitat. They are solitary except during the breeding season and while females are rearing young (Spahr *et al.* 1991).

Information about wolverine populations is usually limited because of the species' secretive habits and generally low densities. Most information available has been collected incidentally to fur harvest. However, within the continental U.S., wolverine are legally harvested only in Montana. Therefore, basic information about wolverine distribution and relative abundance is limited in most areas potentially occupied south of the Canadian/U.S. border. In the absence of harvest data, distributional surveys may be the only means of establishing the extent of the wolverines' range. Establishing this species' presence in an area is the first piece of information necessary for understanding habitat requirements, movement patterns, and demography. Hence, this baseline information is essential for understanding the effects of human disturbance and natural resource development in areas occupied by wolverines (Zielinski and Kucrea 1995, Marshall *et al.* 1996).

The fisher (*Martes pennanti*) occurs in North America from British Columbia to Nova Scotia south to the northeastern U.S. They also occur in Montana, central Idaho, northwestern Wyoming, Oregon, and California. Fishers potentially occur adjacent to Hells Canyon in the Wallowa Mountains of Oregon and Seven Devils Mountains of Idaho (Spahr *et al.* 1991, Marshall *et al.* 1996). Fisher movements and habitat use are generally determined by the availability of food, dens, and suitable weather conditions. Food is probably the most important factor (Strickland *et al.* 1982). No studies of fisher habitat have been conducted in Oregon (Marshall *et al.* 1996). However, research elsewhere has found that fishers prefer forests dominated by conifers with extensive and continuous canopies (e.g., 70 to 80 percent). Dense lowland forests and mature to old-growth forests with high canopy closure often satisfy the habitat requirements of the fisher (Spahr *et al.* 1991).

Fishers are classified as a *species of concern* by the USFWS and of *critical* status by the ODFW (ONHP 1995). The IDFG also classifies the fisher as a *species of special concern*, and the BLM and USFS classify the species as *sensitive* (CDC 1994). Fishers are *sensitive* in Oregon and Idaho because of their general rarity and their questionable status as a viable species. Over-trapping and habitat destruction, mainly due to logging, wildfire, and settlement, have constricted the fisher's range. Forest fragmentation, which reduces and isolates suitable habitat, is the current threat to fisher populations. Accordingly, timber harvest has been associated with fisher declines (Spahr *et al.* 1991, Marshall *et al.* 1996). Because fishers are a secretive, low-density species, most population information is available only from trapping records. Because they are no longer trapped in Idaho or Oregon, little is known about fisher populations in these states (Spahr *et al.* 1991). Currently, no information is available on the status and distribution of fishers specifically in Hells Canyon.

The lynx (*Lynx canadensis*) is holarctic in distribution, ranging across the boreal region of Canada and Alaska, down to the northern tier of the U.S. (McCord and Cardoza 1982). In the western U.S., they are found as isolated populations in spruce, fir, and lodgepole pine forests of Washington, Idaho, Montana, Wyoming, Colorado, and Utah. A peripheral record also exists for the Wallowa Mountains of northeastern Oregon (Coggins 1969). Lynx are at the southern extremity of their range in Idaho and Oregon, and probably occur at low densities in these states (McCord and Cardoza 1982).

The species is generally abundant and widespread in northern portions of its range. However, lynx have declined in much of their former range in the U.S., excluding Alaska (McCord and Cardoza 1982). Declines have been attributed to hunting, trapping, predator control, and loss of wilderness forests (Spahr *et al.* 1991). Forest fragmentation due to timber harvest, road building, and development is of primary concern for loss of habitat and travel corridors (Spahr *et al.* 1991). Because of range contraction and population declines in Oregon and Idaho, lynx is currently classified as a *species of concern* (formerly *Category 2*) by the USFWS (Spahr *et al.* 1991, CDC 1994, ONHP 1995).

The most recent surveys for lynx in the Hells Canyon area were conducted in the Wallowa Mountains of Oregon and adjacent to Hells Canyon. The USFS conducted winter track surveys from 1991 to 1994. Only two incidental sightings of lynx were reported in the Wallowa Valley, Eagle Cap, and HCNRA combined (USDA 1992, 1993; Schomer 1994). Specific information on lynx densities in Hells Canyon and the surrounding vicinity is currently not available.

The kit fox (*Vulpes velox*) is a narrowly specialized fox that is adapted to desert and semi-arid habitats of western North America (Egoscue 1962, Samuel and Nelson 1982). Currently, five subspecies of kit fox are identified. The Nevada kit fox (*V. velox nevadensis*) occurs farther north than other subspecies and is largely identified with the Great Basin and adjacent cold desert habitats (O'Neal *et al.* 1987). The range of this subspecies is reported to extend into extreme southeastern Oregon and southwestern Idaho (Samuel and Nelson 1982, Marshall *et al.* 1996). Kit fox is classified as a *species of special concern* by the IDFG, state *threatened* by the ODFW, and *sensitive* by the BLM (CDC 1994, ONHP 1995). Kit fox was originally listed as state *threatened* in Oregon due to a scarcity of records combined with susceptibility to habitat alteration, predator control programs, trapping, and incidental shootings. Mining, residential development, and other human-caused habitat alterations are currently considered as potentially detrimental to the kit fox in Oregon (Marshall *et al.* 1996). It is doubtful that kit foxes are present in Hells Canyon or the immediate vicinity, based on the currently known distribution of the species (Samuel and Nelson 1982).

Methods

Study Design and Field Methods

Amphibians and Reptiles

Information on herptiles in the Hells Canyon Study Area is sparse. Therefore, data on species distributions and numbers are very limited. Surveys for spotted frogs will be part of general surveys of the herpetofauna community in the study area. A variety of survey techniques will be employed to determine the species composition of the herpetofauna community. These will include:

1) time-constrained searches (Crump and Scott 1994),
2) night driving,
3) breeding call surveys,
4) drift fence trapping, and
5) incidental observations (see also Heyer *et al.* 1994).

Diurnal Birds of Prey

Special surveys will not be conducted for state *sensitive* raptors. However, information on these species will be gathered using data collected during general raptor surveys, and incidental observations during field activities. If specific survey data are required for these species, information currently available in the literature will be used to determine habitat requirements of each of the four species. Using a cover type map of the study area and GIS, habitat suitability maps will be developed for each of the species. Based on this, a sampling design will be developed. However, habitat for these species appears to be very limited along the Snake River in Hells Canyon and there may be little reason to conduct surveys in addition to the raptor surveys and incidental observations.

Owls

Surveys of the three small forest owls, the most likely *candidate*s to be present in the Hells Canyon Study Area, could be conducted as follows. First, habitat associations of these three owl species are known sufficiently well to target specific habitats for surveying. The cover type map for the study area will be used to develop a suitability map employing GIS. Based on these suitability maps, a sampling design will then be developed, ensuring adequate geographical coverage of the study area. Surveying at the selected sites will be conducted using data loggers. Passive data loggers, that sample at specific intervals during optimal calling times for these owls, may be used.

Gallinaceous Birds

Gallinaceous birds *species of special concern* that are likely to occur in the study area are sage grouse, sharp-tailed grouse, spruce grouse, and mountain quail. The spruce grouse is a high-elevation species and is unlikely to occur in the Snake River corridor. Specialized surveys for these other three upland game birds will be conducted individually in areas with high probabilities of occurrence.

Waterfowl

Harlequin duck have been found to nest along swiftly flowing mountain streams in Idaho (Cassirer *et al.* 1991). However, tributaries to the Snake River in the study area do not appear to be suitable to harlequin ducks, because many are too small and do not provide the vegetation cover required by nesting harlequin ducks. However, harlequin ducks have been observed at Brownlee Reservoir in the winter. Specific surveys are not proposed for harlequin ducks. Any data collected on harlequin ducks will be compiled during the general surveys of wintering waterfowl. In addition, incidental observations will be reported.

Shorebirds

Two shorebird *species of special concern*, the long-billed curlew and upland sandpiper, are likely to occur in the Hells Canyon Study Area. The upland sandpiper occurs in high elevation marshes and is unlikely to be encountered along the Snake River corridor. Specific surveys are not proposed for the long-billed curlew. However, data collected on this species will be compiled from general upland surveys and incidental observations.

Perching Birds

Two perching bird *species of special concern*, the loggerhead shrike and rosy finch, may be present in Hells Canyon. A subspecies of the rosy finch (*Leucosticte arctoa wallowa*) occurs in summer around snow fields in the Eagle Cap Wilderness. This species is unlikely to be encountered along the Snake River corridor. Specific surveys are not proposed for either the loggerhead shrike or the rosy finch. Any data collected on these species will be compiled during general avian surveys and from incidental observations.

Woodpeckers

Four woodpecker *species of special concern*, the pileated woodpecker, white-headed woodpecker, three-toed woodpecker, and Lewis' woodpecker, are likely to occur in Hells Canyon. Specific surveys are not proposed for these woodpeckers. However, data collected on these species will be compiled during general avian surveys and from incidental observations.

Bats

Six bat *species of special concern* are likely to occur in the Hells Canyon Study Area. Special surveys will be conducted for these and other bat species as a cooperative effort with the USFS.

Lagomorphs

Specific surveys are not proposed for the pygmy rabbit. Any data collected on this species will be compiled during general upland game or small mammal surveys and from incidental observations.

Insectivores

Specific surveys are not proposed for the Preble's shrew. Any data collected on this species will be compiled during small mammal surveys. Specific sampling will be conducted for shrews during small mammal surveys using pit-traps. All collected shrews will be immediately labeled and preserved. All shrews will be submitted to a recognized expert for identification.

Rodents

The presence of Idaho ground squirrel colonies in the study area will be determined using aerial surveys. Dr. E. Yensen of Albertson College, who found many of the currently known Idaho ground squirrel colonies, is interested in the distribution of this species. Therefore, Dr. Yensen will be solicited to design and conduct these surveys.

Carnivores

Specific surveys are not proposed here for carnivores. Any data collected on these species will be compiled from general carnivore and furbearer surveys or incidental observations.

Analyses

All information collected on state *sensitive* species and former federal *candidate* species and will be summarized to assess presence and distribution of these species, if possible.

Timetable

General wildlife surveys and those specifically directed towards state *sensitive* species were implemented in 1995. Field work will continue through 2000. A report, summarizing information on all *sensitive* species, will be completed in 2001.

Cooperation

Resource agencies with potential interest in studying state *sensitive* species in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigators will be Dr. Toni Holthuijzen and Frank Edelmann. They will be assisted by at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in wildlife biology and Mr. Edelmann has a Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho. Mr. Edelmann has conducted wildlife research on game animals for the past seven years in Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by December 1998. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.9.
Title: Mule Deer Population Survey in Hells Canyon

This is a descriptive study that will be conducted by the IDFG, with assistance from IPC. IPC was invited to participate in this cooperative study because important big game wintering areas occur within IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information to be collected during this study could assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. Other potential cooperators may include the BLM and the ODFW. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

Winter range is recognized as a major component of the annual habitat requirements of mule deer, and a central issue surrounding this big game resource in Hells Canyon. Probably the most serious issue for mule deer in Hells Canyon is winter habitat loss through development. Objectives of this study are to: estimate minimum population levels, determine age composition, track population trends, and obtain information on late winter/early spring distribution, with emphasis on habitat use near hydropower projects. A helicopter survey will be conducted during mid to late March when mule deer that have wintered near the Hells Canyon reservoirs become concentrated in areas with rapidly greening vegetation. Data collected will consist of spatial distribution, relative abundance, and adult:fawn ratios. Final results will be presented as a technical report.

Introduction

Mule deer (*Odocoileus hemionus*) were probably not abundant prior to settlement of Idaho and Oregon, because habitat conditions were less suitable for browsing ungulates. However, in the late 1800s, ranges were altered from perennial grasslands to shrublands that were more conducive to mule deer diets. Changes in range conditions coupled with reductions in livestock grazing, predator control, and regulated hunting are believed to have contributed to large population increases observed during the 1950s and 1960s. After these increases, habitat conditions again declined with depletion of winter ranges by the deer themselves. This, coupled with harsh winters, caused drastic declines during the 1970s and 1980s. Currently, most populations have generally recovered but may never reach the record levels previously observed. Nevertheless, winter range is still recognized as a major component of the annual habitat requirements of mule deer, and a central issue surrounding this big game resource in Hells Canyon (ODFW 1990, Scott 1991).

The goals of this project are to monitor population trends and obtain preliminary information on the spatial distribution of mule deer during late winter relative to hydropower projects in Hells Canyon. Specific objectives are to:

1) estimate minimum population levels,
2) determine age composition,
3) track population trends, and
4) obtain information on late winter/early spring distribution, with emphasis on habitat use near hydropower projects.

State of Knowledge

Currently, surveys monitoring the abundance of mule deer in Hells Canyon are conducted by the IDFG (Scott 1991) and the ODFW. The IDFG has been monitoring mule deer numbers during late winter/early spring since 1962 at an average interval of 2.4 years. However, since 1991, the survey has been conducted annually to more closely track the decline of mule deer numbers that began in the Hells Canyon population during the winter of 1988 to 1989. Maintaining the completeness of this record of mule deer population trend will be useful for addressing issues surrounding population fluctuations relative to hydropower development in Hells Canyon.

Methods

Survey Design and Field Methods

The helicopter survey will be conducted during mid to late March 1997, when mule deer that have wintered near the Hells Canyon reservoirs become concentrated in areas with rapidly greening vegetation. The survey will involve flying at a fixed contour elevation approximating that of the level of spring green-up and counting and classifying all deer observed. Data collected will consist of spatial distribution, relative abundance, and adult:fawn ratio of the mule deer population that occurs adjacent to the Hells Canyon reservoirs during late winter/early spring.

Analyses

Summary statistics for spatial (based on survey strata) and population data (i.e., abundance and adult:fawn ratios) will be calculated for mule deer populations in Hells

Canyon. Population trends over time will be evaluated graphically. Qualitative, graphical trend analyses will also be used to evaluate the relative use of areas influenced by hydropower projects. Graphical analyses will consist of plotting proportions of counts/search unit, and then evaluating proportional changes in the population distributions relative to latitude and areas influenced by hydropower projects. A baseline, qualitative description of population distribution during spring will follow from these graphical analyses.

Timetable

The proposed timing for initiation of this survey is January 1997. At that time, resource agencies that may be interested in conducting cooperative big game surveys in Hells Canyon will be contacted. Then consulting meetings will be arranged with representatives of those interested agencies. Helicopter surveys will be conducted during mid to late March. Approximately six days will be required to conduct the survey. Although this survey is designed as a one-year study, it may be extended for a second year if first-year results support this recommendation. Completion of the technical/progress report is desired by December so that preparations can be made for a subsequent 1998 survey, if recommended.

Cooperation

Initially, resource agencies with potential interests in monitoring mule deer populations in Hells Canyon will be contacted. Interest for participating in this study will be evaluated and opportunities for cooperation will be solicited. Study efforts will then be coordinated among participants. Previously, the IDFG has conducted annual spring mule deer surveys in Hells Canyon (Kuck 1994). It is anticipated that the IDFG will participate in this survey. The ODFW will also be contacted for opportunities to conduct a similar cooperative survey on the Oregon side of the reservoirs.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator for IPC will be Frank Edelmann, assisted by at least one wildlife technician. Mr. Edelmann has a Master’s Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Results of the proposed deer survey in Hells Canyon will be presented as a technical report. Prior to publications of the technical report, progress reports will be prepared and distributed to participating organizations at logical intervals during the course of the study.

8.2.10.
Title: Distribution and Abundance of Mountain Goats in Hells Canyon

This was a descriptive study conducted by the IDFG, with assistance from IPC. IPC was invited to participate in this cooperative study because this important big game population winters within IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information collected will assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

Historically, mountain goats occupied the Seven Devils Mountains in Idaho, but were apparently absent from this area by 1936 (Bailey 1936). Mountain goats were restored to the Seven Devils with reintroductions by 1964. Currently, however, relationships between habitat management and population responses in Hells Canyon are poorly understood. Objectives of this survey, which is now underway, are to determine: minimum population level, herd composition, track long-term population trends, and to obtain information on seasonal distribution of mountain goats in Hells Canyon. To gather this information, helicopter surveys were conducted in 1996 following IDFG methodologies.

Introduction

Mountain goats (*Oreamnos americanus*) have adapted strategies to persist in relatively harsh, unproductive habitats. One strategy focuses on diverting energy resources towards survival as opposed to reproduction. Thus, the reproductive potential for mountain goat populations is relatively low compared to other North American ungulates. The lack of quality winter forage has often been hypothesized as the primary source of mountain goat mortality. However, it has also been suggested that goats rely on conserving energy during winter as opposed to maximizing forage intake. Supporting the latter claims, research has indicated that physical, rather than vegetative, characteristics best describe winter habitat. Consequently, strategies for providing winter habitat include protecting inaccessible areas with cliffs and alpine ridges. Vegetative manipulation is believed to be of little importance for managing mountain goat habitat. However, relationships between habitat management and responses by goat populations in Hells Canyon are poorly understood. As a result, these issues have been identified as research priorities and may be of central importance for mountain goat viability in Hells Canyon.

The objectives of this survey are to determine:

1) minimum population level,
2) herd composition, and
3) long-term population trends, and obtain information on seasonal distribution relative to hydropower projects for mountain goats in Hells Canyon.

Goals are to gather information for describing important wildlife resources associated with the Hells Canyon Project.

State of Knowledge

Mountain goats are native to Idaho (Rideout 1978) but their historic status in Oregon is not clear (Bailey 1936). Historically, they occupied the Seven Devils Mountains in Idaho but were apparently absent from this area by 1936 (Bailey 1936). Mountain goats were restored to the Seven Devils after two reintroductions in 1962 and 1964 (Oldenburg 1994). According to recent surveys, this population appears to be stable to increasing and has been designated as a source population for other translocation efforts (Hayden 1990, Oldenburg 1994). These goats appear to confine movements mostly within the Seven Devils, but are also observed along the Snake River. Management goals of the IDFG are to maintain the Seven Devils population at 90 goats (1990 observed number) (Hayden 1990), and to monitor the health of this population with surveys every five years. Also, the IDFG has placed priorities on identifying factors that affect population density and over-winter survival, and developing better methods for monitoring herd health (Hayden 1990).

Methods

Aerial survey techniques were used to determine seasonal distribution, abundance, and population composition of mountain goats. Reliable population estimation techniques have not been developed for these species, therefore surveys were treated as censuses. Also, because it was difficult to assume that all animals were observed, counts were considered as minimum population size. To maximize the opportunity to observe individuals when they will most likely be near areas influenced by hydropower projects, the survey was conducted in late winter/early spring. During this period, mountain goats were likely to be at lower elevations on wintering areas and possibly on project lands.

Helicopter surveys were conducted primarily following IDFG methodologies. Emphasis was placed on areas of known previous occupancy. Surveys began at Deep Creek near Hells Canyon Dam and ended near Pittsburgh Landing, Idaho. Flights also began at the river and extended to elevations of approximately 8000 feet to ensure that most mountain goats were encountered. Data recorded for each individual observed included:

1) age,
2) group size,
3) UTM location, and
4) a general description of habitat.

Locations were plotted on USGS topographic maps.

Timetable

The project began with the information-gathering period (including a literature review and consultation with appropriate resource experts) in January 1996. Identification of survey areas were conducted in early March 1996 and relied heavily on previous work conducted by wildlife agencies. The survey was conducted during late winter/early spring in 1996. Data analysis began in May 1996. The draft technical report was prepared around June 1996, and completion of the final technical report will be contingent on draft reviews.

Cooperation

This was a cooperative project between IPC and IDFG. The actual survey required one IPC employee and three IDFG employees for three work days.

Statement of Capabilities

IPC had the personnel and equipment necessary to conduct this study. The principal investigator for IPC was Frank Edelmann, who has a Master's Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Findings of this project will be presented as a technical report.

8.2.11.
Title: *Literature and Status Review of Big Game Species in Hells Canyon*

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Big game species comprise an important component of the biodiversity in Hells Canyon. Therefore, IPC is conducting a literature review to obtain background information to assist in relicensing its Hells Canyon hydroelectric facilities. The information gained from this investigation will help IPC focus its relicensing efforts on addressing the historic and current status, and influences of resource development, including current and ongoing hydroelectric operations, on big game populations in Hells Canyon.

Introduction

Big game species comprise an important component of the biodiversity in Hells Canyon. Six species classified as big game commonly occur in Hells Canyon. These are:

1) Rocky Mountain mule deer (*Odocoileus hemionus*),
2) Rocky Mountain elk (*Cervus elaphus*),
3) mountain goat (*Oreamnos americanus*),
4) Rocky Mountain bighorn (*Ovis canadensis*),

5) black bear (*Ursus americana*), and
6) mountain lion (*Felis concolor*).

Three others also occur, but generally in small populations or as transients. These are:

1) white-tailed deer (O. virginianus),
2) shiras moose (Alces alces), and
3) pronghorn (Antilocapra americana) (Asherin and Claar 1976).

During spring of 1996, IPC solicited proposals to conduct a literature and population status review of big game species in Hells Canyon, including an assessment of ecological, public, and political issues associated with these species. The purpose of this literature review is to provide IPC with background information to assist in relicensing its Hells Canyon hydroelectric facilities.

State of Knowledge

This literature and status review of big game populations will:

1) elucidate ecological, public, and political issues surrounding these populations,
2) assimilate and interpret existing information, and
3) identify important information gaps.

The review will be restricted to the first six species listed. However, if significant issues about the remaining three species are uncovered while researching the others, the review may be expanded. Mule deer are the most common and widely distributed big game species in Hells Canyon. However, Rocky Mountain elk are probably the most important economically and recreationally for hunting. Black bear and mountain lion are also important game species and are ecologically the remnants of the large predator community historically found in Hells Canyon. Rocky Mountain bighorn and mountain goat are high-profile species and are probably most important recreationally for viewing. Occasionally, pronghorn and moose may also enter Hells Canyon as transients.

Methods

The literature review will be conducted by contract through the University of Idaho's Department of Fish and Wildlife Resources. The review will be exhaustive and utilize published literature (e.g., peer and non-peer reviewed and agency publications) and unpublished literature (e.g., internal agency documents, progress reports, and written wildlife observations). Personal interviews with individuals considered to be experts in big game ecology in Hells Canyon may also be appropriate to augment literary information.

The literature and status review will be conducted individually for each species and focus on:

1) interpreting available information,
2) summarizing conceptual information on individual topics, and
3) illustrating concepts with specific examples for each species reviewed.

Reporting results of the review will follow a similar pattern, with summaries of concepts illustrated with specific examples. An absence of information on specific topics should be reported. Primary emphasis should be to identify those issues that potentially affect the current and future viability in Hells Canyon of each big game species to be addressed. Finally, the reviewer should provide an interpretation as to the relative magnitude of issues that may affect these species and discuss potential management and mitigative measures suitable for Hells Canyon.

Timetable

This project originated with the distribution of an RFP in April 1996. Proposals were received in July 1996. A contractor was selected to conduct the review in July 1996. Work began in late August 1996 and will continue until November 1997. Phase I will address mountain goat, bighorn sheep, black bear, and mountain lion. Phase II will address mule deer and elk. The project will be conducted in two phases because of the large volume of work. Milestone dates are:

1) December 2, 1996, a letter describing progress to date;
2) June 30, 1997, the final report for Phase I; and
3) November 30, 1997, the final report for Phase II.

Cooperation

This project will be conducted by IPC, however, resource agencies will be contacted for information related to big game species. This assimilation of information will aid those agencies responsible for managing big game populations in Hells Canyon.

Statement of Capabilities

Dr. John Ratti at the University of Idaho has been contracted to conduct this review. He has conducted numerous literature reviews during his professional career, several of which have been published in peer-reviewed literature. In addition, he is thoroughly familiar with Pro-Cite.

Deliverables

Deliverables required for this study are:

1) A final report for services to be completed during Phase I.

2) A final report for services to be completed during Phase II.
3) An electronic database of all literature in Pro-Cite7 format, version 2.0 will be due with the final report for Phase II November 30, 1997.

8.2.12.
Title: Spring Distribution, Habitat Use, and Relative Abundance, of Upland Game Birds in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Currently, only one formal upland game bird survey, a late-summer survey for chukars, is conducted in Hells Canyon (Hemker 1994). No early spring surveys are conducted, although this is a critical period for upland game bird reproduction. Surveying during this period could provide information on relative abundance and distribution of upland game bird species in Hells Canyon. The goal of this study is to provide baseline information describing relative abundances and distribution of upland game bird species during spring in Hells Canyon.

Introduction

Most upland game birds currently in Hells Canyon are the result of translocations to establish huntable populations of exotic species (Smith 1990). Introduced exotic species include:

1) california quail (Callipepla californicus),
2) chukar partridge (Alectoris chukar),
3) gray partridge (Perdix perdix),
4) Merriam’s wild turkey (Meleagris gallopavo merriami), and
5) ring-necked pheasant (Phasianus colchicus).

Native upland game birds, either currently or historically occurring in Hells Canyon, are primarily grouse species. These are:

1) blue grouse (Dendragapus obscuras),
2) ruffed grouse (Bonasa umbellus),
3) sage grouse (Centrocercus urophasianus),
4) sharp-tailed grouse (Tympanuchus phasianellus), and
5) spruce grouse (Dendragapus canadensis).

The occurrence of sage and sharp-tailed grouse in the Hells Canyon area is currently unknown.

Mountain quail (*Oreortyx pictus*), previously a game species, also occurs in restricted areas of Hells Canyon (Smith 1990). The most common native migratory upland game bird, occurring in the study area (primarily during spring and summer) is the mourning dove (*Zenaida macroura*) (Smith 1990).

The goal of this study is to provide baseline information focusing on relative abundance and distribution of upland game bird species during spring in Hells Canyon. This information will aid in preliminary descriptions of the upland game bird resources currently in Hells Canyon. Objectives of the study are to:

1) identify distributions of game birds during the early reproductive period,
2) determine areas used during this period, and
3) estimate relative abundances of species among different areas in Hells Canyon.

State of Knowledge

Currently, only one formal upland game bird survey, which is in late summer for chukar population trend, is conducted in Hells Canyon (Hemker 1994). No early spring surveys are conducted, although this is a critical period for upland game bird reproduction. Because upland game birds are very detectable in spring, as males advertise for mates, surveying upland game birds during this period could provide information on relative abundance and distribution. Specifically, descriptions of relative trends in breeding populations, population centers, and general habitat use may be obtained.

Methods

Study Design and Field Methods

Surveys were conducted during early spring 1996 when males of many upland game bird species typically advertise audibly for mates (Davis 1982). Counts made along walking transects, systematically located across the study area, were used to index abundance of upland game birds. Sampling units with suitable access for surveying were identified from topographic and orthophoto maps. Sampling units were confined to within 3 air miles of the three reservoirs' shores. Also, sampling was restricted to the area between Hells Canyon Dam and (approximately) Weiser, Idaho. Attempts were made to establish sampling units uniformly across the study area.

A transect of known distance was established in each sampling unit. Because it was anticipated that upland game bird populations are at relatively low densities, widely distributed, and occupy a diverse array of habitats, transects were established so as to survey as much area as possible.

Surveys were conducted twice (once each during March and April, 1996). Two counts were intended to help offset poor detectability due to variation in reproductive chronology between species. To minimize variation within a sampling period, however, the survey effort was standardized; all surveys began at sunrise and continued until the entire transect was covered or until four hours after sunrise. Also, surveys were conducted under generally similar weather conditions. Both visual and audible observations were recorded by species. If several individuals we observed together, group size was recorded.

Analyses

Game bird densities will not be estimated with data collected because of the difficulties of meeting assumptions of statistical estimators. Therefore, frequency indices will be calculated for each species. Frequency indices will allow comparisons of relative abundance by species, area, and cover type (assuming detectability is constant across time, cover type, and species). Counts will be standardized by survey effort (e.g., time, distance, and area) to make indices comparable. Summary statistics for each parameter indexed will then be calculated.

Timetable

The study was initiated in January 1996 with the literature review and final development of a survey design. Sampling units were reconnoitered in February 1996 and transects were established in units that were determined to be suitable (based primarily on access and efficiency). Transects were surveyed twice during the spring breeding season. Surveys were conducted in mid-March and late April 1996. Each survey period required approximately two weeks. Data analyses will begin in May 1997. Analyses, including data entry, may require as long as two months, with completion expected in July 1997. Proposed completion of the first draft of the final report will be October 1997. Completion of the final report will depend on draft reviews.

Cooperation

Study design, data collection, and report preparation were conducted by IPC. However, resource agencies cooperated by facilitating access to administered lands during the survey.

Statement of Capabilities

IPC had the personnel and equipment necessary to conduct this study. The principal investigator was Frank Edelmann, who was assisted by a wildlife technician and five field technicians. Mr. Edelmann has a Master’s Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Preliminary results of surveys will be presented as a progress report. Final results and conclusions will be presented as a technical report.

8.2.13.
Title: Distribution and Abundance of Sage and Sharp-tailed Grouse in Hells Canyon

This was a descriptive study conducted by the Oregon Department of Fish and Wildlife, BLM-Baker Resource Area, and IDFG, with assistance from IPC. IPC was invited to participate in this cooperative study because potentially important sage and sharp-tailed grouse habitat occurs within IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information collected during the study could assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

The status of sage grouse is currently of concern to wildlife managers because of general population declines across their range. The Columbian sharp-tailed grouse formerly ranged over most of the intermountain region from central British Columbia south to California and Colorado. The species is extinct in Oregon and reduced to disjunct populations in western and southeastern Idaho. The goal of this study is to determine if sage and/or sharp-tailed grouse currently occupy Hells Canyon. This information will aid in general descriptions of the upland game bird resources potentially occurring in Hells Canyon.

Introduction

The sage grouse (*Centrocercus urophasianus*) was historically widespread in southern Idaho and southeastern Oregon. Currently, this species' distribution has become increasingly restricted due to agricultural development (Morse 1980). Sage grouse do occur in the vicinity of Hells Canyon in Adams and Washington counties. The Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) formerly ranged over most of the intermountain region from central British Columbia south to California and Colorado. However, this species is currently extinct in Oregon and reduced to disjunct populations in western Idaho (Marks and Marks 1987). Small populations currently exist near Hells Canyon in Adams and Washington counties.

The goal of this study was to provide baseline information about abundance and distribution of these two upland game bird species. Specifically, the question, "Do sage and/or sharp-tailed grouse currently occupy Hells Canyon, and if so in what abundance?" was addressed. This information will aid in general descriptions of the game bird resources potentially occurring in Hells Canyon.

State of Knowledge

The status of sage grouse is currently of concern to wildlife managers because of general population declines across their range. In response to declines, the western sage grouse subspecies, which occurs in Oregon, was listed as a candidate for *threatened* or *endangered* listing (*C2*) in 1985 by the USFWS (Drut 1994). Because sage grouse were historically abundant in the shrub-steppe habitats of the western U.S., efforts have been undertaken to understand causes for population declines (Willis *et al.* 1993). Populations have been documented to occur adjacent to the southern reaches of Hells Canyon in both Oregon and Idaho (Smith 1990, Willis *et al.* 1993).

However, no formalized surveys for sage grouse have previously been conducted specifically in Hells Canyon.

Similarly, the Columbian sharp-tailed grouse was classified as a federal *C2* species (CDC 1994) because of distribution-wide declines. Columbian sharp-tailed grouse historically occupied much of the Pacific Northwest including Hells Canyon (Marks and Marks 1987, USDI 1987). Currently, sharptails are considered to be extinct in Oregon, and in west-central Idaho are known to exist only as isolated populations (Miller and Graul 1980, Hemker 1994). The status of sharp-tailed grouse in Hells Canyon is unknown. Similar to sage grouse, no organized surveys for sharptails have previously been conducted in Hells Canyon; distributional information is restricted to anecdotal sightings.

Methods

To focus survey efforts, habitats that were deemed at least of minimal suitability for sage and sharp-tailed grouse were identified from aerial photos and orthophoto maps. Aerial/helicopter surveys were then conducted in an effort to visually locate grouse occupying breeding leks. To maximize a single survey effort for both sage and sharp-tailed grouse, timing of lek searches was set at a compromise between the expected peak attendance for each species. Surveys were conducted in a systematic fashion such that all suitable lekking habitat was searched at least once. Disproportionate search effort will be afforded areas of anecdotal sightings.

Timetable

The study was initiated in January 1996. Initial work was to:

1) delineate survey areas,
2) schedule survey timing, and
3) assimilate necessary resources.

The survey was conducted between March and April 1996 at times that maximized detectability for both species. Following surveys and data collection, data analyses and preparation of a draft technical report were completed by October 1996. Completion of the final technical report will be contingent upon draft reviews.

Cooperation

This project was cooperatively funded and conducted by the ODFW Baker Wildlife District, BLM, Baker Resource Area, IDFG, and IPC. In addition to funding, cooperators provided personnel time and housing accommodations during surveys.

Statement of Capabilities

IPC had the personnel and equipment necessary to conduct this study. The principal investigator was Frank Edelmann, who has a Master's Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Findings of this project will be presented as a technical report.

8.2.14.
Title: Summer Survey of Waterfowl Broods in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Data on waterfowl are limited for the Hells Canyon Study Area. Such data are desirable to evaluate the potential impacts of hydropower generation on nesting and brooding waterfowl. The objective of this study is to determine species composition, distribution, and numbers of waterfowl in Hells Canyon during the brood-rearing period. Baseline waterfowl survey data collected by IPC will be of use to state and federal resource agencies in their efforts to describe, understand, and manage nesting waterfowl rearing broods in Hells Canyon.

Introduction

Data on waterfowl are limited for the Hells Canyon Study Area. Such data are desirable to describe this resource and evaluate the potential impacts of hydropower generation on nesting and brooding waterfowl. For example, waterfowl habitat may decrease in quality and quantity due to accelerated erosion of banks and changes in riparian vegetation. Deterioration of riparian habitat, likewise, may have a negative influence on available habitat. Such impacts have been reported by several authors (Lewke and Buss 1977, Tabor *et al.* 1980, Books 1985, Monda and Reichel 1989).

This study is proposed to develop baseline data to support the FERC relicensing application. The objectives of this study are to determine the species, distribution, and numbers of waterfowl rearing broods in the Hells Canyon Reservoirs.

State of Knowledge

Asherin and Claar (1976) reported 29 species of waterfowl along the middle Snake River. Six species were known or suspected to nest in the study area, including:

1) Canada geese (Branta canadensis),
2) mallard (Anas platyrhynchos),
3) common merganser (Mergus merganser),
4) northern pintail (Anas acuta),
5) American wigeon (Anas americana), and
6) green-winged teal (Anas crecca).

Canada geese commonly nested on islands above Brownlee Reservoir, with fewer nesting attempts occurring below Brownlee Reservoir. According to Asherin and Claar (1976), mallard nesting was confined to upper Brownlee while common mergansers were noted in all three reservoirs and below Hells Canyon Dam. No waterfowl brood surveys have been published for the Hells Canyon area since 1976.

General methods to survey waterfowl populations are reviewed by Eng (1986) and Call (1982). The three most commonly used census techniques were air, boat, and ground transportation. Stancill and Leslie (1990) compared results of waterfowl surveys by these means, and suggested that aerial and boat surveys provided comparable estimates of waterfowl trends for the most abundant waterfowl species.

Methods

Study Design and Field Methods

The unimpounded reach of the Hells Canyon Study Area contains few nesting waterfowl species (Asherin and Claar 1976). This swift-flowing reach harbors little habitat suitable for nesting waterfowl, with the exception of species adapted to fast-flowing water, such as mergansers (Asherin and Claar 1976). Therefore, surveys of waterfowl broods will be restricted to the impounded sections of the study area.

Boating surveys will be conducted in the reservoir section of the study area. A stratified-random sampling design will be used to select sections of the shoreline to be surveyed. Habitat will be *a priori* stratified by low and high quality. High-quality habitat is considered to be any islands occurring in the reservoirs and the mouths of tributaries. The remaining habitat is considered to be low quality. A pilot study was conducted in 1995 to determine the minimum required sample size to provide accurate population estimates of waterfowl broods (with a 15-percent coefficient of variation). According to weights determined during the pilot study, the number of sample transects will be allocated to each stratum. All broods encountered will be identified to species, counted, and plotted on topographic maps.

Analyses

Survey data will be standardized per linear length of shore surveyed. Data will be compiled per species and stratum. Population estimates and 95-percent confidence intervals will be calculated for both adult waterfowl and young using standard methodologies (Schaeffer *et al.* 1990).

Timetable

In 1995, the pilot survey was begun. In 1996, the main study was implemented. The study will be conducted for four more consecutive years, through 2000). Data analyses will begin in 2000 after completion of the final survey in August 2000. Preparation of the draft technical report will begin October 2000, with completion expected in January 2001. However, actual completion of the final report will be contingent upon draft reviews.

Cooperation

Study design, data collection, and report preparation is currently being conducted entirely by IPC. This is not expected to change during the study.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Frank Edelmann, who will be assisted by at least one wildlife technician. Mr. Edelmann has a Master’s Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Final results of waterfowl brood surveys will be presented as a technical report. Preliminary findings will be prepared as annual progress reports following surveys.

8.2.15.
Title: Use of Hells Canyon by Wintering Waterfowl

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Asherin and Claar (1976) reported low numbers of wintering waterfowl during January of 1974 and 1975 from upper Brownlee Reservoir to the confluence of the Salmon River. No information on wintering waterfowl has been published since that study. Therefore, objectives are to identify key concentration areas for wintering waterfowl, and determine relative numbers and distribution of waterfowl species in Hells Canyon. This study is proposed to develop baseline data in support of the FERC relicensing application. Aerial surveys will be used to count wintering waterfowl. Spatial distribution and concentration areas of waterfowl will be described.

Introduction

The BLM formulated waterfowl management guidelines at state, district, and resource area levels (USDI 1989*a*,*b*). The BLM's overall goal was to help perpetuate a diversity and abundance of waterfowl by managing wetlands and other habitats that are important to the maintenance of this international resource. An objective was to identify and rank important key waterfowl areas on public lands at each planning resolution. Likewise, at the district level, identification of key waterfowl habitat areas was listed as an important goal. Therefore, waterfowl survey data collected by IPC will be of use to state and federal resource agencies attempting to meet this objective.

The general objective of this study is to describe waterfowl resources in Hells Canyon. The specific objectives are to identify key waterfowl concentration areas, and determine relative numbers and distribution of waterfowl species.

State of Knowledge

Asherin and Claar (1976) reported low numbers of wintering waterfowl during January of 1974 and 1975 (1,405 and 1,429 individuals, respectively) from upper Brownlee Reservoir to the confluence of the Salmon River. Brownlee Reservoir contained the majority of ducks and geese with similar numbers of Canada geese (*Branta canadensis*), mallard (*Anas platyrhynchos*), goldeneyes (*Bucephala clangula, B. islandica*), and common merganser (*Mergus merganser*). Below Brownlee Dam, the most abundant species were common merganser and goldeneyes, while Canada geese and mallard were observed in smaller numbers. No information on wintering waterfowl specifically for this area has been published since 1976.

A variety of techniques are used by wildlife agencies to monitor waterfowl populations (IDFG 1990). The Midwinter Waterfowl Count, conducted cooperatively with the USFWS and state agencies, is considered to provide the best estimate of the total number of wintering waterfowl nationwide and probably also in Idaho. General methods to survey waterfowl populations are reviewed by Eng (1986) and Call (1982). The three most commonly used were air, boat, and ground surveys. Stancill and Leslie (1990) compared results of waterfowl surveys by each of these means, and suggested that aerial and boat surveys provided comparable estimates of waterfowl trends for the most abundant waterfowl species.

Methods

Study Design and Field Methods

This study is proposed to consist of two phases:

1) a pilot study, and
2) study implementation.

Aerial surveys will be conducted because this method appears to be the most efficient technique to survey Hells Canyon for waterfowl. The pilot study consisted of one field season (winter of 1994 to 1995) during which two aerial surveys were conducted. The objectives of this pilot study were to:

1) determine the effort (time) required to survey the study area using a helicopter,
2) identify potential difficulties for counting waterfowl during aerial surveys, and
3) evaluate alternatives to aerial surveys.

One of the aerial surveys coincided with the USFWS Annual Midwinter Waterfowl Count.

The wintering waterfowl study will be implemented during winters of 1995 to 2000, based on results of the pilot study. For waterfowl observed, species, number, and location (river mile, plotted on 1:24,000 USGS maps) will be recorded. To minimize variation in surveys, a strict adherence will be placed on using the same sampling routes and survey protocol. A number of factors may potentially affect the survey (e.g., weather conditions, icing of the river, and hunting seasons). These factors are anticipated to be included in the data analysis when data collection has been completed.

Analyses

Species of waterfowl will be classified into foraging guilds as dabblers, divers, and surface dippers (Ehrlich *et al.* 1988). Numbers of waterfowl will be standardized by river mile to enable comparisons among river sections. Spatial distribution and concentration areas of waterfowl (i.e., by river mile) will be analyzed with categorical data analysis techniques and the GIS. Numbers of waterfowl will be standardized per river mile to allow comparisons among river sections. Analysis of variance will be used to determine differences in the number of waterfowl per river mile among river reaches. Species diversity will be calculated using the Shannon index of diversity to compare species diversity among survey areas.

The USFWS, in cooperation with IDFG, conducts annual Midwinter Waterfowl Counts for each of the continental flyways. The objective of these counts is to determine the distribution and relative numbers of waterfowl on the continent, organized by flyway. Historic data collected in the study area will be used as a comparison data base.

Timetable

This study was originated with a pilot field season (winter of 1994 through 1995), during which the first aerial survey was conducted. The study was implemented in 1996 with the first full (non-pilot) survey. The study will be conducted through 2000. Data analyses will begin in 2001 after completion of the final survey. Analyses are expected to required approximately eight months. Preparation of the draft technical report will begin in 2001 with completion expected in October 2001. However, actual completion of the final report will be contingent upon draft reviews.

Cooperation

Resource agencies with potential interest in studying waterfowl in Hells Canyon will be contacted. Opportunities for cooperation will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Frank Edelmann, who will be assisted by at least one wildlife technician. Mr. Edelmann has a Master’s Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Final results of waterfowl winter surveys will be presented as a technical report. Preliminary findings will be prepared as annual progress reports.

8.2.16.
Title: Distribution and Relative Abundance of Mammalian Carnivores and Furbearers in Hells Canyon

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

Mammalian carnivores comprise important components of the biological diversity in most terrestrial ecosystems. However, because of surveying difficulties and financial limitations, state game agencies currently do not conduct formal carnivore/furbearer surveys in Hells Canyon. As a result, the information necessary for baseline descriptions of this wildlife community is currently absent. In order to begin filling these information gaps, a study of the carnivore/furbearer community was conducted in 1995. This study was designed to gather preliminary data on presence, relative abundance, and spatial distributions of these species.

Introduction

Generally, all survey methods previously employed for investigating carnivore/furbearer populations attempt to index population attributes (e.g., presence, relative abundance, population change over time). Estimating absolute densities is almost impossible, or so time-intensive and expensive to be impractical for most management agencies (Spowart and Samson 1986). Because of these difficulties, state game agencies currently do not conduct formal carnivore/furbearer surveys in Hells Canyon. Hence, the information necessary for baseline descriptions and informed management decisions concerning these species is absent. In order to begin filling these information gaps, a study of the carnivore/furbearer community was conducted in 1995. This study was designed to gather preliminary data on presence, relative abundance, and distributions of these species in Hells Canyon.

Because there is little documented information about the carnivore/furbearer community in Hells Canyon, the goal of this proposed study is to gather baseline population data that will aid in forming general descriptions of these resources. The primary objectives are to:

1) determine the species composition of the predator/furbearer community,
2) estimate their relative abundance, and
3) determine spatial distributions in Hells Canyon.

State of Knowledge

Mammalian carnivores (Order Carnivora) comprise important components of the biological diversity in most terrestrial ecosystems. This is because species within this diverse group are capable of occupying almost every habitat in North America (Spowart and Samson 1986). The variety of ways in which carnivores can affect the dynamics of wildlife communities is another characteristic of this group’s diverse functioning in ecosystem processes. Despite specific functions and their magnitude for affecting community processes, carnivores hold ecological value as both individual species and as a taxonomic group by contributing to the overall biological diversity of ecosystems (Risser 1995, Walker 1995).

In addition to biological and ecological value, carnivores have anthropomorphic values aesthetically and economically. Current views of predators range from that of livestock threat to trapping/hunting resource to symbol of America's diminishing wildlands. Aesthetic values stem from the belief that because carnivores/furbearers are an integral part of the natural environment they should be protected (ODFW 1993*a*, 1993*b*). Economic values generally coincide with harvest and fur products, and recreation is associated with hunting and viewing. In addition to being important natural resources, predators are valued aesthetically with people simply finding satisfaction in the knowledge that these species are important parts of the native fauna still functioning in biological systems (Will 1989; Harris 1991; Beecham and Zager 1992; ODFW 1993*a*, 1993*b*).

Fifteen species of the Order Carnivora are believed to occur in the Hells Canyon area (Larrison and Johnson 1981, Chapman and Feldhamer 1982). Additionally, lynx (*Felis lynx*) and wolverine (*Gulo gulo*) have been sighted in the Wallowa Mountains to the east (Schommer 1994). The kit fox (*Vulpes macrotis*) may also be an extremely rare transient in the southernmost portions of Hells Canyon (Larrison 1981, Samuel and Nelson 1982). Historically, wolf (*Canis lupus*) and grizzly bear (*Ursus arctos*) occupied the area, but are currently considered to be extinct in Hells Canyon (Craighead and Mitchell 1982, Paradiso and Nowak 1982). Other furbearers of the Order Rodentia that were considered in this study include:

1) beaver (Castor canadensis),
2) muskrat (Ondatra zibethicus), and
3) nutria (Myocastor coypus).

The species to be considered in this study are often legally classified to groups other than taxonomically. In Idaho, marten (*Martes americana*), fisher (*Martes pennanti*), mink (*Mustela vison*), river otter (*Lutra canadensis*), beaver, muskrat, bobcat (*Felis rufus*), lynx, red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and badger (*Taxidea taxus*) are considered furbearing animals. However, there is no harvest season for fisher or otter. Western spotted skunk (*Spilogale gracilis*), striped skunk, long-tailed weasel (*Mustela frenata*), short-tailed weasel (*Mustela erminea*), and coyote are classified as predatory wildlife. The wolverine and kit fox are protected nongame species and may not be harvested. Grizzly bear and wolf are currently classified as *threatened* and *endangered* (IDFG 1994). In both Idaho and Oregon, black bears and mountain lions are classified as big game animals (Harris 1991; Beecham and Zager 1992; ODFW 1993*a,b*).

Currently, the only monitoring of carnivores and furbearers in Hells Canyon is through harvest. This includes big game harvest of black bears and lions, and trapping of furbearers. The harvest of all black bears, mountain lions, bobcats, and lynx is recorded in a mandatory check and report (IDFG 1994, 1995; ODFW 1995). In Idaho, trappers are also required to report their harvest each year (IDFG 1994). Although legal harvest is monitored relatively closely, this information is not always reflective of true population parameters or dynamics (Harris 1991, Beecham and Zager 1992). Therefore, directly surveying populations in conjunction with harvest data will provide better population information about these species. Population and behavioral characteristics (e.g., low densities, nonrandom distributions, large home ranges, and high mobility), however, often create problems for sampling and monitoring. As a result, no single or best technique has been developed for surveying all carnivore populations (Spowart and Samson 1986).

Methods

Study Design and Field Methods

A scent-station survey was used to elicit visitations from carnivores/furbearers in an effort to index the:

1) presence,
2) relative abundance, and
3) relative distribution of these species in Hells Canyon (Linhart and Knowlton 1975, Conner *et al.* 1983, Spowart and Samson 1986, Nottingham *et al.* 1989).

Additionally, incidental observations were used to document presence of rare species. Scent-station surveys are often employed for monitoring carnivores, because stations are relatively inexpensive, easy to implement, and can be applied in large numbers over relatively large areas (Linhart and Knowlton 1975).

The carnivore/furbearer survey area was restricted to the reservoir reach of the Hells Canyon study area. Areas with motorized access within this area were delineated on 1:24,000 topographic maps and considered available for sampling. From the areas available, a subset was selected systematically so that the study area was sampled as uniformly and efficiently as possible. This area was further subdivided into three reservoir sections with boundaries established at the dams. Survey routes were established within the areas available so that sampling was proportional to reservoir length. This systematic/stratified allocation of survey routes was to increase sampling efficiency so that large areas could be surveyed.

Stations remained operational for one to three consecutive 24-hour periods with monitoring occurring daily. Information recorded when monitoring an active station included:

1) station number,
2) date,
3) time, and
4) species observed.

A visit by a species was defined as the presence of at least one track at the station (Nottingham *et al*. 1989). Tracks were identified to species according to Murie (1974). Because it was impossible to identify tracks of individuals, multiple visits by a species were not discernible.

Analyses

Analyses consisted primarily of calculating summary statistics on species presence and visitation rates according to the spatial and habitat categories in which scent stations were established. Scent stations were considered replicates.

Timetable

Field work began on October 2, 1995 with initial establishment of scent stations. Actual surveys began approximately on October 3, with activation of the stations. Stations were monitored once daily during three consecutive 24-hour sampling periods. This weekly routine continued for three consecutive weeks (to October 20). Following surveys and data collection, data analyses and preparation of a progress report was completed by January 1996. Completion of the final technical report will be contingent upon preliminary findings.

Cooperation

Resource agencies with potential interest in studying carnivores in Hells Canyon were contacted. As a result, the study was conducted cooperatively among the USFS, IDFG, and IPC.

Statement of Capabilities

IPC had the personnel and equipment necessary to conduct this study. The principal investigator was Frank Edelmann, who has a Master's Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho. Mr. Edelmann was assisted by a wildlife technician and five field assistants during the project.

Deliverables

Initial results were prepared as a progress report completed in January 1996. Final results will be presented as a technical report.

8.2.17.
Title: Survey of Wolverine Dens in the Seven Devils Mountains of Hells Canyon

This is a descriptive study that will be conducted by the IDFG, Oregon Department of Fish and Wildlife, and the USFS Wallowa-Whitman National Forest, with assistance from IPC. IPC was invited to participate in this cooperative study because potentially important wolverine habitat occurs immediately adjacent to IPC's study area for relicensing the Hells Canyon Project. IPC chose to participate because the information to be collected could assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will provide descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

Wolverine numbers declined steadily in the contiguous United States after the late 1800s. Today, these animals are uncommon in the lower 48 states, with Idaho and Montana having the only known reproducing populations (Hornocker and Hash 1981, Copeland 1996). The goal of this study is to determine if wolverines occur in Hells Canyon. If wolverines are found to occur in Hells Canyon, the probability of wolverine/hydroproject interactions will be assessed graphically and qualitatively from distributional data.

Introduction

The wolverine (*Gulo gulo*) has a circumboreal distribution. In North America, the species occurs in Alaska and across the boreal forests of Canada south into Washington, Oregon, Idaho, Montana, and Wyoming. Wolverine numbers declined steadily in the contiguous United States after the late 1800s; today, they are uncommon in the lower 48 states. The present-day distribution of the wolverine in Idaho is probably in the mountainous portions of the state from the South Fork of the Boise River north to the Canadian border (Groves 1988). Comparable information is not available for Oregon. The species inhabits tundra and coniferous forest zones, generally at higher altitudes during summer and mid-to-lower elevations during winter. Low elevation riparian areas may be important winter habitat (Spahr *et al.* 1991).

The goal of this study is to determine if wolverines occur in Hells Canyon. Specific objectives will be to:

1) map potential wolverine winter denning habitat with GIS technology,
2) identify areas with high probability of wolverine occupancy if potential wolverine winter denning habitat is identified in areas that can reasonably be expected to be impacted by project operations,
3) conduct winter helicopter surveys in high probability areas, and
4) locate denning sites based on snow tracking.

If wolverines are found to occur in Hells Canyon, the probability of wolverine/hydroproject interactions will be assessed graphically and qualitatively from distributional data.

State of Knowledge

In the continental U.S., the presence of wolverines has been confirmed in Wyoming, Washington, Oregon, Idaho, and Montana. Only Idaho and Montana are known to support reproducing populations of wolverines (Hornocker and Hash 1981, Copeland 1996). The species' status is unknown in these other states. Information about wolverine populations is usually limited because of the species' secretive habits and generally low densities. Most information available has been collected incidentally to fur harvest. However, within the continental U.S., wolverine are legally harvested only in Montana. Therefore, basic information about wolverine distribution and relative abundance is limited in most areas potentially occupied south of the Canadian/U.S. boarder.

In the absence of harvest data, distributional surveys may be the only means of establishing the extent of the wolverines' range. Establishing this species' presence in an area is the first piece of information necessary for understanding habitat requirements, movement patterns, and demography. Hence, this baseline information is essential for understanding the effects of human disturbance and natural resource development (e.g., hydropower, timber, mining, and recreational activities) in areas occupied by wolverines (Zielinski and Kucrea 1995).

Methods

Study Design and Field Methods

Recent data on wolverine behavior and habitat use suggest that winter aerial surveys may provide an alternative to ground methods (Copeland 1996). Female wolverines in Idaho predictably place their reproductive dens on north-facing talus slopes in isolated, high-elevation subalpine cirques. Natal dens are established during February and March. These areas generally lack forested cover, therefore, snow trails resulting from foraging movements soon after a snowfall can be easily observed during helicopter surveys. Properly timed over-flights of subalpine habitats may reveal the presence of denning, resident, or dispersing female wolverines.

Aerial survey methodology is aimed at searching only areas with the highest probability of wolverine presence that can reasonably,potentially be expected to be impacted by project operations. Delineation of high-probability areas will be based on four criteria associated with denning habitat and easily mapped with GIS techniques. The survey will be restricted to Hells Canyon down-river of Hells Canyon Dam. It is anticipated that most high probability areas will occur in the Seven Devils Mountains of Idaho and Wallowa Mountains of Oregon. Because wolverines have large home ranges and are capable of long-distance daily foraging movements, the greater Hells Canyon area (i.e., approximately the area between the Oregon and Idaho canyon rims from Hells Canyon Dam to the confluence of the Snake and Salmon Rivers) will be considered for surveying. A contour-following helicopter survey plan will be developed. Aerial surveys will be conducted during March, which is the peak of natal denning.

Analyses

Analyses will consist primarily of mapping observations and developing graphical presentations. Observations will be presented on GIS-generated maps with overlays of landscape features (e.g., water, topography, roads, trails, resource extraction developments and sites, and other human developments). If a wolverine population is detected in Hells Canyon, the potential for hydroprojects to impact the population will be evaluated based on the spatial distribution of observations.

Timetable

The project will begin in January 1997 with the construction of GIS maps depicting areas with high probability for wolverine presence. Aerial surveys will be conducted if necessary during March, 1997. Weather conditions will dictate actual flight timing. Surveys will be conducted during optimal snow tracking conditions (i.e., three to five days following substantial snow fall). This is a one-year study to be completed during 1997. Following aerial surveys, all observations will be entered into the study's GIS coverage. This information will then be incorporated into a final report to be due December 1997.

Cooperation

Opportunities for sharing study costs for the 1997 wolverine survey with resource agency cooperators will be solicited. Specifically, the IDFG, ODFW, and the Wallowa-Whitman National Forest were contacted.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator for IPC will be Frank Edelmann, who will be assisted by at least one wildlife technician. Mr. Edelmann has a Master's Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho.

Deliverables

Findings of this project will be presented as a technical report. Most information will be portrayed graphically. Recommendations for conducting future wolverine studies in Hells Canyon will follow from this graphical analysis and presentation of information collected.

8.2.18.
Title: Nongame Wildlife Habitat Measurements

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe wildlife resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

A major goal in describing wildlife habitat is to develop an understanding of the factors that determine the patterns of occurrence, distribution, and abundance of wildlife species (Verner *et al.* 1986). Hence, the objective of this study is understand habitat relationships for small mammal, bird, and herptile communities in Hells Canyon, by comparing characteristics of cover types in both upland and riparian vegetation with distributions of these wildlife communities. Species-habitat relationships will be explored.

Introduction

A major goal in describing wildlife habitat is to develop an understanding of the factors that determine the patterns of occurrence, distribution, and abundance of wildlife species (Verner *et al.* 1986). It is important for wildlife managers to understand the relationships underlying the observed distributional patterns of wildlife species in relation to habitat features. Alternatively, insights into the distributional patterns of wildlife species may provide insight into possible environmental impacts of human activities, such as hydroelectric facilities.

Wildlife-habitat relationships have been researched extensively. Avian and small mammal research have particularly long histories focusing on habitat relationships (Brown 1991). However, similar investigations are sparse for herptiles (Manly *et al.* 1993). Standard techniques to measure habitat has received considerable attention (Cooperrider *et al.* 1986, Morrison *et al.* 1992, Heyer *et al.* 1994). The objective of this study is to characterize small mammal, bird, and herptile habitat within specific cover types in both upland and riparian vegetation communities that are sampled. Species-habitat relationships will then be explored and reported.

State of Knowledge

Research on nongame wildlife habitat relationships that could be used for this study has not been conducted in Hells Canyon. Extensive botanical surveys have been conducted by Johnson and Simon (1987), but descriptions of various plant associations are restricted to identification of dominant plant species and their cover values. Information on structure, cover, and density of plant species has not been collected. The latter information is of particular importance to wildlife species and for evaluation of habitat suitability of particular cover types or plant associations.

Methods

Study Design and Field Methods

Sampling designs differ between riparian and upland vegetation. Riparian habitat sampling will be conducted in circular plots. Upland habitat will be sampled using both circular plots and transect lines. Habitat will be sampled at all circular plots. Along line transects in upland vegetation, a random point will be selected within each 100-m (330-foot) section. At each sample point, the horizontal structure, vertical structure, and floristics of the vegetation will be determined as described in the following.

Riparian Habitat

Herbaceous Composition and Cover

Vegetation at circular plots will be measured at sample points placed along two lines. Each line will be placed in a randomly selected quadrant of the circular plot. Along a transect line, sample points used for placement of Daubenmire frames will be randomly selected in 5-m (16.4-foot) intervals. At each random sample point, two Daubenmire frames will be placed at the side of the line with their long axes paralleling the angle of the transect line. The percent cover of the two dominant species of forbs and grasses will be estimated using the Daubenmire cover scale (Daubenmire 1959). The percent cover of all remaining forbs and grasses will be estimated as an overall estimate. Likewise, the cover of litter, bare soil, moss, and rock will be estimated. At the center of the circular plot, slope, aspect, soil texture, and grazing impact will be noted. Litter depth will be measured by placing a hole through the litter and creating a vertical cut that will be measured using a ruler.

Canopy Cover of Woody Plants

The line intercept method (Müller-Dombois and Ellenberg 1974) will be used to determine percent canopy cover for each individual in the shrub and tree layers.

The two randomly located transect lines will be used for this purpose. These lines will have a maximum length of 15 m (49 feet). Tree and shrub canopies, identified to species, will be projected vertically to the tape and the length of the line segments covered by each woody plant individual noted (Hays *et al.* 1981). Plant species forming clumps that cannot be distinguished as separate individuals will be measured in clumps that form a natural unit.

Shrub and Tree Density and Composition

The density and composition of shrubs and trees at circular plots will be estimated using belt transects. Two belt transects will be centered on the two randomly placed transect lines along which the Daubenmire frames are placed. The belts will have a maximum length of 15 m (49 feet) and will be 2 m (6.6 feet) wide (i.e., a 1-m (3.3-foot) wide strip at each side of the transect line). Species of woody plants, whether individuals are dead or alive, height (cm) of both shrubs and trees, and diameter at breast height (cm) will be measured.

Vegetation Structure

Vertical structure of the vegetation will be measured at each random sample point along the two randomly placed transect lines. A graduated pole with an attached 0.20 x 0.50 m^2 frame will be used. The vertical distribution of the vegetation will be determined by counting the number of contacts where the vegetation breaks the 0.20 x 0.50 m^2 plane at 0.10-m (0.3-inch) height, 0.20-m (0.6-foot) and every

20 cm (7.8 inches) up to 2.0 m (6.6 feet), and at 1.0-m (3.3-foot) intervals thereafter until no vegetation is present. Herbaceous plants will be identified as either grasses or forbs, but any woody plants will be identified to species.

Upland Habitat

Herbaceous Composition and Cover

The vegetation along a transect will be measured at randomly selected locations at 100-m (328-foot) intervals. At each sample point, two Daubenmire frames (0.20 x 0.50 m) (Daubenmire 1959) will be used to measure species composition, plant cover, and frequency. The percent cover of the two dominant species of both forbs and grasses will be estimated using the Daubenmire cover scale (Daubenmire 1959, 1968). Subsequently, the percent cover of the remaining forbs and grasses will be estimated as an overall estimate. Likewise, the cover of litter, bare soil, moss and rock will be estimated. At each random sample point, slope, aspect, soil texture, and grazing impact will be recorded. Litter depth will be measured by probing a hole through the litter and creating a vertical cut that will be measured using a ruler.

Canopy Cover of Woody Plants

The line intercept method (Müller-Dombois and Ellenberg 1974) will be used to determine canopy cover per species for the shrub and tree layers. At each sample point, a 10-m (3.3-foot) line length centered on the point will be sampled. Plant canopies identified to species will be projected vertically to the tape and the length of the line segments covered by the plant canopy reported (Hays *et al.* 1981). Plant species forming clumps that cannot be distinguished as separate individuals will be measured in clumps that form a natural unit.

Shrub Density and Composition

The density and composition of shrubs at transect lines will be recorded using a belt transect. The belt transect will be centered on the line intercept and will be 2 m (16.6 feet) wide (i.e., a strip 1 m (3.3 feet) wide on each side of the transect line). Species of woody plants, whether the individuals are dead or alive, and height (cm) of shrubs will be measured.

Vegetation Structure

At each random sample point along the line transect, the vertical structure of the vegetation will be measured. A graduated pole will be used with a 0.20 x 0.50 m^2 frame attached. The vertical distribution of the vegetation will be measured by counting the number of contacts where the vegetation breaks the 0.20 x 0.50 m^2 plane at 0.10 m (0.3 inch) and every 20 cm (7.8 inches) up to 2.0 m (6.6 foot), and at 1.0-m (3.3-foot) intervals thereafter until vegetation is absent. Herbaceous plants will be identified as either grasses or forbs, but any woody plants will be identified to species.

Analyses

Calculated habitat parameters fall into four categories:

1) cover,
2) density,
3) diversity, and
4) structural measures.

Cover

The percentage of cover in each of the three physiognomic strata will be calculated for each sample point. Data based on the Daubenmire frames will be used to estimate the percentage of cover for the herb stratum. The line intercept data will be used to estimate cover percentages for the shrub and tree strata.

Density

The density of tree and shrub species per hectare (2.47 acres) will be calculated using the circular plot data. These data also will be used to calculate the percentages of living shrubs and trees.

Diversity

Species diversity will be calculated for each physiognomic stratum using the Shannon diversity index (HU) (Shannon and Weaver 1949). Data based on the Daubenmire frames will be used to calculate HU for herbaceous plants, while belt transect data will serve to calculate HU for the shrub and tree strata.

Structure

For each transect and sample point, the number of hits for each physiognomic class and height will be calculated. Likewise, the percentage of hits with dead vegetation in each physiognomic class will be determined. These calculations form the basis for two heterogeneity measures, the vertical and horizontal diversity indices. These two measures of structure determine the regularity of vegetation distribution in vertical and horizontal planes (Anderson and Ohmart 1986, Ohmart *et al.* 1988). Vertical foliage height diversity (FHD) will be calculated for each transect according to information theory as $FHD = \sum p_i(\ln p_i)$, whereby p_i is the proportion of the total foliage density (i.e., hits) contributed by the density at level *I*. Horizontal foliage diversity, or patchiness, will be calculated as the variance associated with the mean total foliage density (i.e., mean total hits) $HDI = \sum\{(K_i)^2 - ((\sum K_i)^2/n)\}/(n-1)$, whereby K_i = foliage density at the ith trap site; n = sample size. This variance will be calculated for each vertical layer. Total horizontal diversity is the sum of the variances over all vertical layers (Ohmart *et al.* 1988). High variation in the horizontal plane is equivalent with high patchiness.

Timetable

The study was implemented in 1995. Two years of habitat data have been collected above Hells Canyon Dam and only limited data below Hells Canyon Dam. Vegetation sampling will be completed in September 1998. Following surveys and data collection, data analyses and preparation of a progress report will be completed by November 1999. Completion of the final report will be contingent upon preliminary findings.

Cooperation

Resource agencies with potential interest in studying wildlife-habitat relationships in Hells Canyon will be contacted. Opportunities for cooperation and cost-sharing will then be evaluated and solicited.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct this study. The principal investigator will be Dr. Toni Holthuijzen, who will be assisted by Frank Edelmann and at least one wildlife technician. Dr. Holthuijzen holds a Ph.D. in wildlife biology and Mr. Edelmann has a Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho.

Deliverables

Initial results will be prepared as a progress report to be completed by November 1999. Preliminary findings will be evaluated to direct the project in following years. Upon completion of the project, final results will be presented as a technical report.

8.2.19.
Title: *Review of Wildlife Information and Data Collected in Hells Canyon by the Oregon Department of Fish and Wildlife Department*

This was a descriptive study/literature review conducted jointly by the Oregon Department of Fish and Wildlife and IPC. IPC participated in this review because the information synthesized will assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will assist in providing descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

The ODFW possesses much of the currently available information about wildlife resources in Hells Canyon. This information is useful for describing the wildlife resources in the area, and for identifying and conducting future wildlife investigations in conjunction with relicensing the Hells Canyon Project. The goal of this proposed project was to gather available information on wildlife resources possessed by the ODFW. This information will be used to assess information needs and then prepare environmental studies of terrestrial species in and around Hells Canyon.

Introduction

The ODFW possesses much of the currently available information about wildlife resources in Hells Canyon. This information is useful for describing the wildlife resources in the area, and for identifying and conducting future wildlife investigations in conjunction with relicensing the Hells Canyon Hydropower Complex. However, this information had not been summarized specifically for the Hells Canyon area. Therefore, in 1996, IPC and the ODFW entered a cost-sharing project to review the available information. The area of interest for this request was the Oregon side of the Snake River, from the mouth of the Salmon River upriver to approximately Weiser, Idaho, and from approximately the canyon rim to the Idaho bank of the Snake River.

The goal of this project was to gather available information on wildlife resources in response to IPC's request for information possessed by the ODFW. This information will be used to assess information needs and then prepare environmental studies of terrestrial species in and around Hells Canyon.

State of Knowledge

It was IPC's goal to gain an understanding of the extent and applicability of existing data concerning wildlife and other natural resources in the State of Oregon that may be influenced by this project. The ODFW manages many natural resources in Hells Canyon. Therefore, this agency has wildlife inventories and other records that may contain information relative to gaining an understanding of wildlife resources in the vicinity of Hells Canyon. IPC and the ODFW share a common interest in compiling this data into a form useable by both parties.

Methods

The primary emphasis of the data search was on files kept at ODFW offices, including the Wallowa and Baker districts of the Northeast Region, and Ontario District of the Southeast Region. Also, ODFW personnel at these offices were contacted to learn what additional information is available and its location. Annual and monthly reports were reviewed and copies of reports were obtained. Preliminary data gathering, which involved developing lists of publications, reports, surveys, and observations, was conducted through an ODFW-IPC cost-sharing agreement in 1996. Lists include dates, sources, and locations of each information source.

The following were sources of information:

1) Unreported file data (e.g., *threatened* and *endangered* sightings, nongame or raptor nest observations, results of miscellaneous surveys).
2) Reported unanalyzed data (e.g., monthly and annual reports, information on translocations, wildlife surveys, harvest records).
3) Reported site-specific data which has been analyzed (e.g., Pitman-Robertson reports, graduate theses).
4) Syntheses of site-specific data from multiple locations (e.g., publications, survey summary reports).

Timetable

This project began in July 1996. Draft reports and databases were prepared in November 1996.

Cooperation

This was a cooperative effort between IPC and the ODFW. The synthesis of this information will benefit both organizations.

Statement of Capabilities

IPC had the personnel and equipment necessary to conduct this study. The principal investigator for IPC was Frank Edelmann. Mr. Edelmann has a Master's Degree in Wildlife Resources and five years experience designing and implementing wildlife studies in Idaho. Actual work was conducted by a contractor mutually selected by ODFW and IPC.

Deliverables

A private consultant was hired to review wildlife inventories and records maintained by the ODFW. The consultant developed a list of this and other pertinent wildlife information available in Oregon Department of Fish and Wildlife files. A bibliography was provided to both IPC and the Oregon Department of Fish and Wildlife.

8.2.20.
Title: Habits of Bald Eagles Wintering in Northeastern Oregon and Adjacent Areas of Washington and Idaho (From Isaacs et al. 1992)

This is a descriptive study that will be conducted jointly by the USFS, BLM, ODFW, USFWS, Washington Department of Wildlife, and Oregon State University, with assistance from IPC. IPC was invited to participate in this cooperative study because important bald eagle wintering areas occur within IPC's study area for the Hells Canyon Project. IPC chose to participate because the information collected will assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will assist in providing descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

The ecology of bald eagles (*Haliaeetus leucocephalus*) in northeastern Oregon and adjacent areas of Washington and Idaho was investigated from November to April, 1988 through 1991. Objectives were to document eagle abundance, locate foraging areas, describe food habits, and locate and document use of night roosts. The estimated number of eagles on the study area peaked at 218 during early January 1989, 283 during mid-February 1990, and 291 during early February 1991. There apparently has been a substantial increase in bald eagle use of the area in recent years. Primary foraging areas were Brownlee (27 percent) and Oxbow (16 percent) reservoirs, the lower Wallowa and Grande Ronde rivers (23 percent), and the Wallowa Valley (15 percent); human activities could have substantial impacts on bald eagle use of those areas. Fish and large mammal carrion were the most obvious foods utilized; ground squirrels and waterfowl were also important.

Forty-six night roosts were located and twelve more were suspected; many more roosts probably exist in inaccessible areas. Management of habitat for bald eagles should focus on maintaining or enhancing the prey base, providing perches where necessary in foraging areas, protecting roosts from timber harvest or other habitat degradation, and controlling human activities in areas where they conflict with bald eagle use.

Introduction

Bald eagles occur throughout most of North America and are primarily associated with coastal waters, inland lakes, and rivers. Migrating and wintering eagles are found in most states, but large breeding populations in the contiguous 48 states are restricted to the Great Lakes states, Florida, the Pacific Northwest, Chesapeake Bay, and Maine. Bald eagles that nest in harsh climates (e.g., northern Canada) migrate to areas with milder winters (wintering areas) during the nonbreeding season. Wintering areas have been identified in many of the contiguous 48 states (Spencer 1976). In Oregon, detailed studies of the habits of wintering bald eagles have been conducted in the Klamath Basin (Keister and Anthony 1983, Keister *et al.* 1987), Harney Basin (Isaacs and Anthony 1987), along the lower Columbia River (Garrett *et al.* 1987), in the Willamette Valley (DellaSala *et al.* 1989), and along the Crooked River (Isaacs *et al.* In Press). In all of these areas, abundant food attracted bald eagles and they congregated at foraging areas and night roosts that were used consistently within and in successive winters.

The purpose of this study was to investigate the habits of bald eagles wintering in Northeast Oregon and adjacent areas of Washington and Idaho. The objectives were to:

1) Document the number of bald eagles wintering in Northeast Oregon.
2) Identify and determine the pattern of use of foraging areas.
3) Document food habits.
4) Locate and document the magnitude and pattern of use of night roosts.

State of Knowledge

Historic and present distributions of the bald eagle are essentially the same. However, numbers of eagles in the continental United States decreased until the late 1970s. In response to that decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous states and *threatened* in Oregon, Washington, Michigan, Minnesota, and Wisconsin (USDI 1978). Major reasons for the decline included:

1) shooting,
2) poisoning,
3) pesticide contamination resulting in death and reduced productivity, and
4) human activities resulting in habitat alterations and possible disturbance to nesting and wintering birds (USDI 1986).

The reasons for communal roosting are poorly understood (Anthony *et al.* 1982, Keister *et al.* 1985). Communal roosts may improve survival by acting as centers for communicating locations of food (Ward and Zahavi 1973). The Pacific States Bald Eagle Recovery Team recognized the importance of communal roosts and recommended that roosting areas be identified and secured (USDI 1986). Late fall, winter, and early spring observations of bald eagles in Wallowa, Union, and Baker Counties of northeast Oregon indicated that there were substantial numbers of bald eagles present from January through March and that communal roosting areas existed (Isaacs *et al.*

1992). Consequently, there was concern about the potential impacts of habitat alteration and other human activities on the species, so there was a need to identify important winter habitats.

Methods

Study Design and Field Methods

The study was conducted during late fall, winter, and early spring, 1988 through 1991. Bald eagles in foraging areas were counted from ground vehicles, helicopters, and boats. Age, location, activity (ground and boat surveys only), and time were recorded for each eagle observed. All eagle locations were mapped using monthly color codes. Surveys were used to locate principal feeding areas and document food habits. Counts derived from surveys were used to estimate the number of bald eagles on the study area.

Night roosts were places used by at least one bald eagle for roosting for at least one night. A communal night roost was defined as a roost used by two or more eagles for at least two nights. Searches for roosts began by observing and mapping flights of eagles leaving feeding areas during late afternoon. If a consistent pattern of flights to a particular area was observed, that area was searched for a night roost. Once a roost was located, roost counts were conducted as frequently as possible. Eagles were counted leaving roosts at dawn or arriving at roosts at dusk. Time, age, flight direction, and altitude were recorded when possible for each bald eagle observed.

Food habits and the effects of human activities on eagles were recorded opportunistically. Foods utilized and potential prey observed at foraging areas were recorded to evaluate food habits. Age (adult or subadult) and reaction (flushed or stayed perched) was also recorded for each perched eagle approached or passed.

Analyses

Estimates of bald eagle populations in three general habitats and four major drainages (Snake, Grande Ronde, Wallowa, and Powder river valleys) were used to evaluate bald eagle distribution. General habitats recognized were:

1) reservoirs and lakes (Brownlee, Oxbow, Hells Canyon, Phillips, and Unity reservoirs, and Wallowa Lake),
2) rivers (Snake, upper Grande Ronde, and lower Grande Ronde and Wallowa), and
3) agricultural areas (Baker, Keating, Wallowa, Imnaha, Burnt and upper Powder river valleys).

The relationship between the number of bald eagles observed during simultaneous counts was analyzed using simple linear regression. The relationship was considered significant if the level of significance was less than 0.05.

Timetable

Ground survey routes were driven weekly from December 1988 through mid-April 1989, and bi-weekly from mid November 1989 to mid April 1990 and from mid November to late March 1991. Helicopter surveys were conducted monthly along inaccessible portions of the Grande Ronde River. Surveys by powerboat were conducted on Brownlee Reservoir, the Snake River, and once on Hells Canyon Reservoir. Brownlee Reservoir was surveyed once in January and March 1989, and bi-weekly from mid November to mid March in years 1989 through 1991. The Snake River was surveyed three times in 1989 and 1990 and five times in 1990 and 1991. The study was completed in 1992.

Cooperation

This was completed as a cooperative effort among the USFS, BLM, ODFW, USFWS, Washington Department of Wildlife, Oregon State University, and IPC.

Statement of Capabilities

During the study, F.B. Isaacs was a research associate at Oregon State University, S.L. Reed and E.R. Reed were biologists with the USFS, and R.G. Anthony was a professor at Oregon State University.

Deliverables

This project was completed in 1992 with the preparation of a final report. The report was entitled "Habits of Bald Eagles Wintering in Northeastern Oregon and Adjacent Areas of Washington and Idaho" (Isaacs *et al.* 1992).

8.2.21.
Title: Validation of a Mountain Quail Survey Technique (From Heekin and Reese 1995)

This is a descriptive study that will be conducted jointly by the BLM, ODFW, and University of Idaho, with assistance from IPC. IPC was invited to participate in this cooperative study because mountain quail occur within IPC's study area for the Hells Canyon Project. IPC chose to participate because developing survey techniques for *species of special concern*, such as mountain quail, would be useful for future studies designed to describe important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC's participation in cooperative studies that will assist in providing descriptions of important wildlife resources as required by FERC's relicensing process.

Abstract

For the past several decades, mountain quail populations throughout the intermountain region of the United States have been declining. As a consequence, managers have become concerned about the possibility of extirpation of remnant populations. However, because so few studies have been done on the species, information that will enable managers to develop effective management plans is unavailable. As a first step toward collecting more information on the species, managers have expressed a need for an economical and efficient means for surveying mountain quail. During May 1994, a calling survey was conducted in five areas in the Little Salmon River Canyon, in west-central Idaho. Calling surveys were found to be useful for detecting the presence of mountain quail in targeted areas, and this type of survey is the most efficient method available in terms of time and labor cost.

Introduction

Mountain quail (*Oreortyx pictus*) have recently become a focus of concern throughout the intermountain region of the western United States due to population declines. As a result of this decline, the mountain quail has been classified as a *species of special concern* by the IDFG and as a *sensitive* species by the BLM and Regions 1 and 4 of the USFS. In 1991, USFWS listed mountain quail as a *Category 2* (*C2*) *candidate* species. Currently, mountain quail are considered a *species of concern* by the USFWS (CDC 1994, ONHP 1995).

Detailed data on the distribution, abundance, life history, habitat use patterns, and population ecology of mountain quail is limited due to the bird's secretive nature, low densities, and use of difficult terrain. These characteristics in conjunction with their use of thick vegetation makes it difficult to detect mountain quail. These factors have limited the study of this species. However, without better information on distribution, population dynamics, and limiting factors, wildlife and land managers lack the information necessary for effective management plans. Without such knowledge, strategies for restoration of mountain quail habitat and populations may not succeed.

Considering the lack of feasibility of intensive searches for mountain quail, calling surveys may be the most efficient method for gathering information on species distribution. Detection of calls can provide information on regional distribution by providing data on minimum numbers and population trends over time. Furthermore, using imitated vocalizations may increase the probability of detecting individuals by eliciting responses (Stirling and Bendell 1966, Levy *et al.* 1966, Fuller and Mosher 1981). While several authors (Robbins 1981, Bibby *et al.* 1992, Ralph *et al.* 1993) advocate completing surveys within an optimum time frame, or caution against conducting surveys in poor weather, little information exists as to the optimum methodology, number and timing of visits, or weather parameters, for a mountain quail calling survey.

Therefore, objectives of this study were to:

1) Determine locations and movements of radio-collared mountain quail during the breeding season.
2) Collect weather and cover type information for mountain quail locations.
3) Determine the efficacy of calling surveys for determining the presence of mountain quail.

State of Knowledge

Mountain quail are a *species of special concern*. In Idaho, this native quail historically occurred along the Boise, Snake, Salmon, Little Salmon, and Clearwater river systems (Murry 1938; Ormiston 1966; Brennan 1989; Robertson 1989, 1990). However, the species' distribution in Idaho has significantly declined since the late 1930s. Brennan (1984, 1990) offered several causes for the decline of mountain quail in Idaho, including deterioration and loss of habitat due to intensive agriculture, cattle grazing, and water impoundments along the Snake River.

Methods

Twenty-four mountain quail were radio-collared in 1994. Because radio telemetry allowed accurate locating of these collared quail, a calling survey used to detect the presence of mountain quail could be evaluated. The study was also designed to collect information on differential success of detection under various seasonal and weather conditions. After the quail had moved to breeding range and males had commenced more intense yelping, survey routes were selected. Surveys were conducted throughout May and each survey area was occupied over the course of the study period by at least one radio-collared mountain quail.

Potential sources of bias affecting the detection of calling by mountain quail include:

1) selection of the target habitat,
2) characteristics of the observer,
3) characteristics of the bird, and
4) timing of survey period.

In addition, weather conditions, such as precipitation and wind, may negatively affect bird activity and the observer's ability to detect the birds (Bibby *et al.* 1992, Ralph *et al.* 1993). If the poor weather conditions made detection of quail impossible, surveys were discontinued.

To determine if success in eliciting a response was related to time of day, survey time frames were varied among four starting times: sunrise, 10:00 A.M., 3:00 P.M., and no earlier than two hours before official sunset. Length of the survey route depended on location of the radio-collared quail, landowner permission, topography, and interfering sounds at lower elevations. Survey stations were approximately 200 meters (656 feet) apart and were upslope, out of the bottom of the drainage, to eliminated the interfering sounds of running water. Three different broadcast presentation methods were used in an attempt to elicit yelping responses. To determine if there were differences in effectiveness between the three presentation methods, these were varied over the course of the route and on each visit. The presentation method at each station consisted of a two-minute listening period, followed by a two-minute broadcast presentation, followed by another two-minute listening period. The initial listening interval at the starting point of each route was analyzed separately. Broadcast presentations then varied between a taped yelp, a yelp produced using a hand-held call, or an assembly call produced using the hand-held call.

Timetable

Field work was conducted during spring 1994, and the project was completed with a final report in winter 1995.

Cooperation

This project was cooperatively conducted by the BLM, the IDFG, the University of Idaho, and IPC.

Statement of Capabilities

P.E. Heekin is a research associate at the University of Idaho and has been investigating mountain quail ecology for over three years. Dr. K.P. Reese is a professor of wildlife resources at the University of Idaho. He has been investigating upland game bird ecology for over 15 years.

Deliverables

This project was completed in 1995 with the preparation of a final report. The report was titled "Validation of a Mountain Quail Survey Technique" (Heekin and Reese 1995).

8.2.22.
Title: Movements, Habitat Use, and Population Characteristics of Mountain Quail in West-central Idaho: Big Canyon Creek (from Reese and Smasne 1996)

This is a descriptive study that will be conducted jointly by the USFS, Wallow-Whitman National Forest, BLM, IDFG, and University of Idaho, with assistance from IPC. IPC was invited to participate in this cooperative study because potentially important mountain quail habitat occurs within IPC’s study area for relicensing the Hells Canyon Project. IPC chose to participate because the information collected will assist in describing important wildlife resources in the Hells Canyon Study Area and vicinity. This study was not specifically developed as part of the Collaborative Process. However, the Collaborative Team has been informed of IPC’s participation in cooperative studies that will assist in providing descriptions of important wildlife resources as required by FERC’s relicensing process.

Abstract

Mountain quail (*Oreortyx pictus*) in the intermountain region of the western U.S. have declined significantly during the past decades. This decline has been attributed to factors including:

1) the loss of winter habitat resulting from water impoundments on the Snake River;
2) a general loss of habitat due to increased agriculture along the Snake River corridor; and
3) an overall deterioration in habitat quality as a result of cattle grazing.

As a precursor to a comprehensive study of population declines in Hells Canyon, a pilot study was conducted to provide preliminary information about mountain quail distribution and abundance in Big Canyon Creek, Idaho. Winter flushing surveys began in early March. Survey methods included walking riparian habitats and attempting to flush or otherwise visually observe quail. No mountain

quail were observed during this survey. Apparently, mountain quail no longer occupy this portion of Hells Canyon.

Introduction

Mountain quail numbers in the intermountain region have been declining over the past several decades. As a result, the species has been classified as a *species of special concern* by the IDFG, and the BLM and Regions 1 and 4 of the USFS have designated the mountain quail as a *sensitive* species (Moseley and Groves 1990). The mountain quail has also been included on the list of *species of concern* in Idaho by the Boise Area Office of the USFWS (Boccard 1980). Consequently, land and wildlife management agencies have identified the need to gather information on the ecology and habitat requirements of mountain quail in Idaho for the development of management strategies that will prevent further declines and lead to restoration of populations.

As a precursor to a comprehensive ecological study of mountain quail, a pilot study was proposed to provide preliminary information about the distribution and abundance of the mountain quail population in Big Canyon Creek, Idaho. Specifically, information about seasonal (i.e., late winter and early spring) distributions and relative abundances within this area will be important for assessing trapping areas, availability of study individuals, and subsequent sample sizes. Conducting surveys during the pilot phase will also provide insight into logistical restraints associated with access, travel, and efficiency of data collection. Benefits will include:

1) location of late winter use/concentration areas,
2) potential trap sites, and

3) a qualitative assessment of population abundance in the Big Canyon Creek area.

The cumulative benefit of gathering this information during a pilot study will be the ability to objectively assess the feasibility of conducting a comprehensive investigation of the mountain quail ecology in the remote setting of the Big Canyon Creek drainage.

Objectives of the proposed pilot study of mountain quail ecology in the Big Canyon Creek study area focused on gathering preliminary information about distribution and abundance of the resident population. Assessment of logistical constraints due to the remoteness of the area is also of interest. The goal of the proposed pilot study was to provide information that will be useful in assessing the feasibility of conducting a comprehensive mountain quail project in the Big Canyon Creek area.

Specifically, objectives were to:

1. Locate late-winter concentration areas for mountain quail in the Big Canyon Creek study area.
2. Determine minimum numbers and relative abundances of mountain quail in areas used during winter.
3. Identify potential trapping sites for mountain quail.
4. Identify logistical constraints and limitations for travel, and access during data collection efforts.
5. Qualitatively assess the overall feasibility of conducting a comprehensive investigation of mountain quail ecology in the remote setting of the Big Canyon Creek area.

State of Knowledge

In Idaho, mountain quail occur on the extreme eastern fringes of the species' distribution. Historically, they occurred in the Boise, Snake, Salmon, Little Salmon, and Clearwater river systems, inhabiting the narrow brushy draws associated with the lower elevations of these drainages. The species' range in Idaho has diminished over the past several decades, concurrent with declines in numbers (Murray 1938; Ormiston 1966; Brennan 1989; Robertson 1989, 1990). Brennan (1990) attributed habitat loss and the subsequent decline in numbers of mountain quail to several factors:

1) the loss of winter habitat resulting from water impoundments on the Snake River;
2) a general loss of habitat due to increased agriculture along the Snake River corridor; and
3) an overall deterioration in habitat quality as a result of cattle grazing.

Other authors reported that direct and indirect anthropogenic causes of mortality include hunting, overgrazing by livestock, nest trampling by livestock, logging, and river impoundments (McLean 1930, Enderlin 1947, Gutierrez 1975).

The mountain quail, because of its secretive nature (Bent 1963, Johnsgard 1973), low population densities, and use of dense vegetation and rugged terrain, is probably the least studied of all the upland game birds in the United States (Gutierrez 1975; Brennan 1989, 1990). Although mountain quail are mentioned in several publications over the past several decades, there have been only a few natural history descriptions or reviews (Grinnell *et al.* 1918, McLean 1930, Rahm 1938, Edminster 1954, Miller and Stebbins 1964, Johnsgard 1973, Gutierrez 1975). Also, only a few comprehensive ecological studies have been completed on mountain quail (Ormiston 1966; Gutierrez 1977, 1980; Brennan 1984; Brennan *et al.* 1987). Other than surveys by Brennan (1989) and Robertson (1989, 1990), Ormiston's work (1966) is currently the only published study of mountain quail in the intermountain region.

Because of these drastic declines in distribution and population sizes, an ongoing study was initiated in 1991 in west-central Idaho, designed to identify spring and summer movement, habitat use, and population characteristics (Heekin *et al.* 1992, 1993, 1994). This study, began in 1992, is in the Little Salmon River Canyon, south of Riggins, Idaho. It continued through February of 1996. This was, at that time, the most comprehensive research of mountain quail ecology conducted in Idaho.

Methods

In late February or early March of 1996, the principal investigator and field technician visited the Big Canyon Creek area to complete a preliminary reconnaissance of the study area. Access limitations, vehicle requirements (i.e., 4X4, ATV, horses), availability of field quarters, and survey areas were addressed. Technician training also occurred during this initial visit. Following the field orientation, the technician assumed all responsibility for field work.

Winter flushing surveys began in early March with a visual survey of the study area and subsequent delineation of potentially suitable wintering habitat. These areas (consisting of shrub-dominated, low-elevation draws) were mapped on 1:24,000 topographic maps and then systematically surveyed for mountain quail presence and abundance. Survey methods included walking the draws and attempting to flush or otherwise visually observe quail. All observations of quail sign (e.g., tracks, droppings, and feathers) were to be recorded. Hunting dogs were used to increase searching efficiency when available.

Information collected for all mountain quail sightings were to include minimum group size, date, time, UTM location (Grubb and Eakle 1988), and a qualitative assessment of access to the area. Locations were also to be mapped on topographic maps. This information was then to be used to qualitatively assess wintering population size, relative abundance in the area, and potential winter concentration sites. Recommendations for potential trapping sites were to follow from this information.

Timetable

In late February of 1996, the study was initiated with a preliminary reconnaissance of the study area. Winter flushing surveys begin in early March and finished by May 1996. A summary report of the pilot study was submitted in April 1996. The final report was provided to cooperators on June 7, 1996.

Cooperation

This was a cooperative project funded jointly by the BLM, IDFG, USFS Wallowa-Whitman National Forest, University of Idaho, and IPC.

Statement of Capabilities

Dr. Kerry P. Reese is a professor in Wildlife Resources at the University of Idaho. Dr. Reese has extensive experience with upland game birds, and habitat analysis of radiotelemetry-derived data, and has conducted much of the current work with mountain quail in Idaho.

Deliverables

A summary report of the pilot study was submitted in April 1996 to all cooperators for review. Following incorporation of reviewer comments, the final report was provided to cooperators on June 7, 1996. The report was titled "Results of a Pilot Study: Survey of Mountain Quail in Big Canyon Creek, Idaho" (Reese and Smasne 1996). The report contained summary statistics of all quantitative data collected, discussions of qualitative data, and maps identifying areas surveyed. Finally, the report made recommendations on the feasibility of conducting a comprehensive investigation of mountain quail ecology in the Big Canyon Creek area.

8.2.23.
Title: Effects of Water Level Fluctuations on Wildlife Habitat

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize this project's operational impacts on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories.

T4. Effects of flow changes below dams.

T5. Impacts to *threatened*, *endangered*, and *sensitive* species from flow changes and flooding of original habitat from construction.

T7. Terrestrial species habitat impacts in units/acres by habitat type (both sides of the river, all known species).

T8. Direct species impacts due to reservoir operational changes during the winter.

T9. Operational effects on both reservoir and downstream areas.

T10. Post-construction loss of habitat.

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T14. Study design and quality? How do we know what we know?

T17. Impact identification.

T18. Mitigation plans.

T23. Current impacts of project operations on wildlife habitat (reservoir and free-flowing reaches).

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free flowing reaches).

T27. Wildlife habitat fragmentation caused by project construction and operation.

T31. Flooding/dewatering of terrestrial species - microhabitat.

T33. IPC land management practices' effects on terrestrial resources.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

T44. Water level fluctuations versus migrations, home ranges, territories, etc.

T45. Water level fluctuations per mile of shoreline riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What are the riparian habitats from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hell Canyon Dam to the confluence of the Salmon River?

3) What are the effects to riparian habitats including microhabitat from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by the Hells Canyon Project operations?
4) What are the riparian resources in reservoir reaches in the study area?
5) What are the water level fluctuations in the reservoir reaches?
6) What are the effects to riparian habitat, including microhabitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
7) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The overall goal is to minimize negative impacts of the Hells Canyon Project's operations and maintenance activities on wildlife resources in the Hells Canyon Study Area. This goal results from the FERC requirement that hydropower license applications describe wildlife resources, identify operational impacts to these resources that may result, and provide measures for resource protection, mitigation, and enhancement (FERC 1990).

Abstract

The purpose of this study is to evaluate the impact of water level fluctuations on wildlife habitat. This study is proposed to determine existing and future wildlife habitat conditions based on various potential flow scenarios and resource values in Hells Canyon. Information on river hydrology, vegetation, and wildlife species in the study area will be used to describe baseline habitat conditions. This information will then be used to model vegetation changes through time under various flow scenarios representing potential project operations and flow management activities. Quantity and quality of wildlife habitat will be evaluated under current and alternative flow scenarios. Potential scenarios will be developed in cooperation with resource agencies and other

interested parties. Analyses will lead to recommendations for operation of hydroelectric production project facilities, and appropriate mitigation, protection and enhancement measures to help attain desired future resource goals.

Introduction

Quantitative evaluation of habitat for wildlife has emerged as an important component of resource assessment (Hobbs and Hanley 1990), because natural resource managers are increasingly expected to predict the consequences of management activities on wildlife species (Verner *et al.* 1986). Central to habitat evaluation are models defining the functional relationships between species and their habitats (Krohn and Salwasser 1982, Hobbs and Hanley 1990). Species-habitat relationship models have been developed to assess changes in habitat quality and quantity that may occur as a result of resource development or habitat management actions.

Biologists have traditionally used knowledge of animal life history attributes to model animal ecology. A common approach is to model animal habitat by linking known habitat use patterns with maps of existing vegetation, thereby identifying the spatial extent of important habitat features for use in conservation and management. These kinds of models transcend a variety of different scales and purposes, from species-specific Habitat Suitability Index (HSI) models, multiple-species wildlife-habitat matrices, to spatially explicit descriptions of animal distributions for conservation planning (Edwards *et al.* 1995). Kinds and use of different modeling approaches are outlined in texts by Verner *et al.* (1986), Morrison *et al.* (1992), and Anderson and Gutzwiller (1994).

Evaluating habitat has several advantages over conducting detailed population analyses that are often required for impact analyses. First, habitat is stationary and therefore relatively easy to quantify. Second, although many factors affect survival and reproduction of individuals in a population, all wildlife populations are ultimately dependent on habitat for existence. Finally, empirical data can be augmented with fundamental principles of wildlife ecology (e.g., foraging theory, intra-specific competition, habitat selection, and predator avoidance) to allow formulation of functional relationships that exist between a species' habitat and population parameters (Morrison *et al.* 1992). Hence, these models can be used to quantify species-specific habitat conditions as they may change through time, or predicted to change through time, based on natural and unnatural processes or perturbations, including combinations of these.

Impacts of ongoing operations of the Hells Canyon Project to wildlife resources are difficult to assess due to the large number of wildlife species involved, their widely varying habitat requirements, and the magnitude of the study area. Directly assessing the influences of project operations on population dynamics of these wildlife resources is difficult because studies cannot be conducted under controlled conditions, which limits the inferences that can be drawn. Rather than focusing on wildlife populations and their dynamics, habitat conditions can be evaluated to indirectly assess influences of project operations on wildlife resources.

Species-habitat relationship models can also be used in combination with vegetation models (e.g., succession models) to evaluate habitat conditions in some predicted landscape at points through time. Vegetation succession models can be constructed to predict future vegetation/habitat patterns based on various scenarios of management actions or perturbations in a landscape. Actions can include various dam operations associated with managing river flows for hydropower production, flood control, navigation, and anadromous fish flushes.

Integrating species-habitat relationship models with predictive vegetation models provides an opportunity to evaluate potential habitat conditions under various river management scenarios and contributions of individual components (i.e., hydropower, flood control, etc.) to those scenarios and the resulting landscape. This approach could allow:

1) quantitative evaluation of competing strategies for managing operations of the Hells Canyon Projects,
2) identification of influences of operation strategies and individual flow management activities on wildlife resources,
3) determination of the best balanced landscape to reach desired future goals for the numerous resources to be considered, and
4) development of a management plan (including project operations, protection, mitigation, and enhancement measures) that may achieve the desired resource goals for Hells Canyon.

Therefore, this study is proposed to identify flow management options and protection, mitigation, and enhancement measures needed to achieve the desired wildlife habitat goals (e.g., protecting goose nesting islands on upper Brownlee Reservoir, maintaining interconnected riparian habitats, and increasing the quality of low-elevation big game habitat), based on a balancing of resource values, for Hells Canyon. Specific objectives will be to:

1) describe the wildlife resources occurring in Hells Canyon;
2) characterize the spatial and temporal variation in water level and flow fluctuations and sources of fluctuations (e.g., hydropower, flood control, fish flush, navigation, runoff) within the study area;
3) describe project facilities, and operation and maintenance influences on resulting hydrology;
4) determine desired future wildlife, habitat, and landscape goals for the Hells Canyon Study Area;
5) select wildlife evaluation species;

6) determine habitat values for current baseline conditions;
7) determine and model future operation and flow scenarios;
8) determine habitat values for predicted future conditions and estimate changes in values;
9) identify the scenario that is most likely to meet desired future resource goals;
10) assess influences of project operations on wildlife resources and the desired future resource goals; and
11) develop suggestions for future project operations and protection, enhancement, and mitigation measures that will most likely lead to the desired future resource conditions and goals.

A primary and overriding objective of this study is to determine the efficacy and feasibility of this proposed approach to habitat evaluation.

State of Knowledge

The Hells Canyon Project consists of three dams and associated reservoirs. These reservoirs constitute the reservoir reach of the project and consist of:

1) Brownlee Dam and storage reservoir,
2) Oxbow Dam and run-of-river reservoir, and
3) Hells Canyon Dam and run-of-river reservoir.

Also, water conditions of the unimpounded section of the Snake River below Hells Canyon Dam, termed the river reach, are directly affected by operations of the complex. Currently, information on water level fluctuations for the Hells Canyon Complex is being compiled by IPC. Data on fluctuations are collected on a daily basis. Data can therefore, be compiled at any desired time-interval to provide descriptions of current flows and project operations.

A vegetation cover type map for the study area is also being developed by IPC. This map will be used as the baseline data describing the current availability and distribution of vegetation habitat types in the study area. Further, structural and community characteristics of cover types are being characterized by IPC. Therefore, habitat parameters required for analyses of species-habitat relationships are likely to be available.

Game Species

Game species (i.e., big game, upland game, and waterfowl) comprise an important component of the biodiversity in Hells Canyon. Six species classified as big game commonly occur in Hells Canyon. These are:

1) Rocky Mountain mule deer (*Odocoileus hemionus*),
2) Rocky Mountain elk (*Cervus elaphus*),
3) mountain goat (*Oreamnos americanus*),
4) Rocky Mountain bighorn (*Ovis canadensis*),
5) black bear (*Ursus americana*), and
6) mountain lion (*Felis concolor*).

Three others also occur, but generally in small, populations or as transients. These are:

1) white-tailed deer (*O. virginianus*),
2) shiras moose (*Alces alces*), and
3) pronghorn (*Antilocapra americana*).

Most upland game birds currently in Hells Canyon are the result of translocation by state wildlife agencies to establish huntable populations of exotic species suited to various habitats in and adjacent to the canyon (Smith 1990). Introduced exotic species include California quail (*Callipepla californicus*), chukar partridge (*Alectoris chukar*), gray partridge (*Perdix perdix*), Merriam's wild turkey (*Meleagris gallopavo merriami*), and ring-necked pheasant (*Phasianus colchicus*). Pheasants are primarily restricted to the southernmost portion of the study area.

Native upland game birds, either currently or historically occurring in Hells Canyon, are primarily grouse species. These are:

1) blue grouse (Dendragapus obscurus),
2) ruffed grouse (Bonasa umbellus),
3) sage grouse (Centrocercus urophasianus),
4) sharp-tailed grouse (Tympanuchus phasianellus), and
5) spruce grouse (Dendragapus canadensis).

The occurrence of sage and sharp-tailed grouse in Hells Canyon is currently unknown. Mountain quail (*Oreortyx pictus*), previously classified as a game species, also occur in restricted areas of Hells Canyon (Smith 1990).

The most common native migratory upland game bird occurring in the study area primarily during spring, summer, and fall is the mourning dove (*Zenaida macroura*) (Smith 1990). Common snipe (*Gallinago gallinago*), also often classified as a migratory upland game bird, may occur to a limited degree in higher-elevation wet meadows, or in the restricted reservoir and riparian wetlands.

Asherin and Claar (1976) reported 29 species of waterfowl along the middle Snake River. Six species were known or suspected to nest in the project area including:

1) Canada geese (Branta canadensis),

2) mallard (Anas platyrhynchos),
3) common merganser (Mergus merganser),
4) northern pintail (Anas acuta),
5) American wigeon (Anas americana), and
6) green-winged teal (Anas crecca).

Canada geese commonly nested on islands above Brownlee Reservoir with fewer nesting attempts occurring below Brownlee Reservoir. In 1990, 910 breeding pairs of Canada geese were counted between Walters Ferry and Farewell Bend (IDFG 1990). According to Asherin and Claar (1976), mallard nesting was confined to upper Brownlee while common mergansers were noted in all three reservoirs and below Hells Canyon Dam. No waterfowl brood surveys have been published for the Hells Canyon Projects since 1976.

Asherin and Claar (1976) reported low numbers of wintering waterfowl during January of 1974 and 1975 (1,405 and 1,429 individuals, respectively) from upper Brownlee Reservoir to the confluence of the Salmon River. Brownlee Reservoir contained the majority of ducks and geese with similar numbers of Canada geese, mallards, goldeneyes (*Bucephala clangula, B. islandica*), and common mergansers. Below Brownlee Dam, the most abundant species were common merganser and goldeneyes, while Canada geese and mallard were observed in smaller numbers. No information on waterfowl wintering in Hells Canyon has been published since 1976.

Mammalian carnivores and furbearers (Orders Carnivora and Rodentia) are also important components of the biological diversity in most terrestrial ecosystems, including Hells Canyon. From the Order Carnivora, 15 species are present, including:

1) black bear (Ursus americanus),
2) marten (Martes americana),
3) fisher (Martes pennanti),
4) mink (Mustela vison),
5) long-tailed weasel (Mustela frenata),
6) short-tailed weasel (Mustela erminea),
7) river otter (Lutra canadensis),
8) mountain lion (Felis concolor),
9) bobcat (Felis rufus),
10) red fox (Vulpes vulpes),
11) coyote (Canis latrans),
12) raccoon (Procyon lotor),
13) badger (Taxidea taxus),
14) western spotted skunk (Spilogale gracilis), and
15) striped skunk (Mephitis mephitis).

Five additional species of Order Carnivora may inhabit portions of Hells Canyon during winters or in the future. These include the federally protected grizzly bear (*Ursus horribilis*) and grey wolf (*Canis lupus*). Wolverine (*Gulo gulo*) and kit fox (*Vulpes macrotis*), which are protected nongame species in the state of Idaho, may also be present. In addition, the lynx (*Lynx canadensis*) may reach the northern extent of the Hells Canyon Project. From the Order Rodentia, two species, the beaver (*Castor canadensis*) and muskrat (*Ondatra zibethica*), are included as furbearers.

Nongame Species

The nongame community of the Hells Canyon Study Area is rich and diverse (Asherin and Claar 1976, Marshall 1986). At least 126 avian species occur in the study area. Riparian vegetation and forested uplands were of particular importance, judging by the high number of species utilizing these cover types. Eleven were open-water bird species or shorebirds. The most common ones were great blue heron (*Ardea herodias*), killdeer (*Charadrius vociferus*), spotted sandpiper (*Actitis macularia*), American avocet (*Recurvirostra americana*), ring-billed gull (*Larus delawarensis*), and California gull (*Larus californicus*). Goatsucker (*Caprimulgidae*), swift (*Apodidae*), hummingbird (*Trochilidae*), kingfisher (*Ceryle alcyon*), and woodpecker (*Picidae*) species were also recorded. Seventy-six passerine species were associated with riparian areas and adjacent uplands. Many of these are dependent on the riparian areas for food, cover, and nesting. Most bird species that nest in riparian habitats are neotropical migrants. These comprise between 60 percent and 85 percent of the landbirds (Knopf 1985, Dobkin and Wilcox 1986, Saab and Groves 1992).

Taylor (1989) reported 108 bird species sighted along the Snake River where it runs through Hells Canyon. Seventeen diurnal and twelve nocturnal raptor species have been reported (Marshall 1986). Eleven diurnal raptors were found nesting in the study area, namely,

1) peregrine falcon (*Falco peregrinus*),
2) northern goshawk (*Accipiter gentilis*),
3) Cooper's hawk (*A. cooperii*),
4) sharp-shinned hawk (*A. striatus*),
5) northern harrier (C*ircus cyaneus*),

6) red-tailed hawk (*Buteo jamaicensis*),
7) Swainson's hawk (*B. swainsoni*),
8) golden eagle (*Aquila chrysaetos*),
9) prairie falcon (*Falco mexicanus*),
10) American kestrel (*F. sparverious*), and
11) turkey vulture (*Cathartes aura*).

Four owls, common barn owl (*Tyto alba*), burrowing owl (*Athene cuniculaera*), great horned owl (*Bubo virginianus*), and short-eared owl (*Asio flammeus*) were also found nesting (Asherin and Claar 1976).

In the Blue Mountains Province in Oregon, 29 small mammal species, 7 medium-sized mammal species, and 13 bat species were reported (Marshall 1986). Asherin and Claar (1976) trapped 10 species of small mammals, namely,

1) vagrant shrew (Sorex vagrans),
2) montane vole (Microtus montanus),
3) house mouse (Mus musculus),
4) Great Basin pocket mouse (Perognathus parvus),
5) deer mouse (Peromyscus maniculatus),
6) western harvest mouse (Reithrodontomys megalotis),
7) Ord's kangaroo rat (Dipodimys ordii),
8) golden-mantled ground squirrel (Spermophilus lateralis),
9) Townsend's ground squirrel (Spermophilus townsendii), and
10) northern pocket gopher (Thomomys talpoides).

Asherin and Claar (1976) collected seven species of bats. These were, ranked in frequency of collection:

1) big brown bat (*Eptesicus fuscus*) (30 percent),

2) yuma myotis (*Myotis yumanensis*) (27 percent),
3) western pipistrel (*Pipistrellus hesperus*) (18 percent),
4) little brown myotis (*Myotis licifugus*) (13 percent),
5) small-footed myotis (*Myotis leibii*) (7 percent),
6) silver-haired bat (*Lasionycteris noctivagans*) (4 percent), and
7) pallid bat (*Antrozous pallidus*) (1 percent).

Methods

Study Area

The Hells Canyon study area extends along the Snake River from approximately Weiser, Idaho, to the confluence of the Snake and Salmon Rivers. This section of river consists of the three reservoir reaches and the unimpounded river reach. The lateral extent of the study area will include the reservoir reaches to a height 50 m (164 feet) above full pool level. The lateral extent of the study area downstream of Hells Canyon Dam will encompass all lands inundated by a 150,000-cfs flood event.

Study Design

An extensive review of available information and relevant literature will be conducted prior to the final study design and implementation of methods. This review will allow refinement of the study design and methods, facilitate identification of gaps in the current information base, and help modify specific study objectives to increase efficiency in filling information gaps. Also, as part of the information review, subject experts and resources agency representatives will be contacted and consulted as necessary. Therefore, final development of the design, objectives, and methodologies will be completed as part of this study. Generally, however, information on project operations and maintenance, hydrology, vegetation, and wildlife species in the study area will be described to establish baseline conditions. This information will then be used to model vegetation changes through time under various flow scenarios representing potential project operations. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Quantity and quality of wildlife habitat will be evaluated under current conditions and alternative scenarios.

Field Methods

Field work will be required for characterizing the baseline vegetation, and is currently being conducted by IPC as part of another relicensing study. The study area will be mapped by cover type, based on the 26 vegetation, natural feature, and land use cover types used in IPC's earlier relicensing studies. The map will be developed through standard photo-interpretation techniques using July/August 1993, 1:15,000-scale color infrared aerial photos.

The objective of field sampling will be to collect data on the existing conditions of each vegetation cover type. The approach will be similar to the "subjective without preconceived bias" concept of Müller-Dombois and Ellenberg (1974). That is, placement of sample sites within cover types will be done without any assumption of eventual classification or apparent condition, but rather for the representation of homogeneous vegetation. Obvious ecotones, microsites, exceptionally dense clumps or openings, or areas of recent severe disturbance will be avoided. Sample locations will be selected using a stratified-random method wherein the study area is stratified into 5-mile segments and by left and right bank, and polygons of each vegetation cover type are randomly selected in each segment throughout the length of the study area. Detailed data on species composition, cover, woody species density and height, and vegetation structure will be collected using standard sampling techniques.

Field work for collecting vegetation data is ongoing and expected to be completed in 1998. However, additional field work may be required to gather site-specific hydrologic and geomorphologic information necessary for constructing and parameterizing the vegetation simulation models.

Analyses

Consultation

A team of private consultants will be solicited and selected to conduct data analyses. Therefore, a detailed study plan describing analyses will be generated by the selected contractor. However, a guidance and evaluation team, comprising representatives from interested resource agencies, non-governmental organizations, and IPC's personnel, will be involved in all phases of this study.

Water Level Fluctuations

The IPC Water Management Department will compile information on operations of the complex based on historic information. This will include hydrologic information on: daily, monthly and annual river and reservoir water level fluctuations; and water level changes related to non-power production water releases (i.e., flood control, fish flushes). Specifically, historic information summarized will include: minimum and maximum headwater elevations recorded on a daily, monthly, and annual basis; and mean, median, 90 and 98 percent of maximum elevations on a daily, monthly, and annual basis over the period of record or a representative time period (10 to 15 years). Also, these data will be collected by the IPC Water Management Department during the course of this study. Information on water surface elevation fluctuations using the DWOPER model will be calculated at each of the locations where habitat data are collected.

Vegetation Description

The cover types and plant communities occurring in the study area will be quantified and described. The cover type map will be analyzed to describe the extent, representation, and distribution of cover types in the study area. Species composition, cover, woody species density and height, and vegetation structure will be summarized to describe the different cover types and plant communities occurring in each cover type.

Vegetation Modeling

The existing conditions will be used as a basis of comparison with future water flow scenarios. Future conditions will be based on expected changes in vegetation condition simulated over a period of years. The time frame for simulations will be based on the expected duration of the project license plus the period between the present and the date of license expiration. A period of 30 to 50 years probably will be reasonable. Future vegetation conditions will be determined using vegetation models (Simons and Associates 1990) constructed with botanical and hydrologic information currently being collected by IPC. Using these models, changes in vegetation cover types over time can be evaluated at various time intervals (e.g., short-term perturbations and long-term changes). Output from the vegetation models will be spatially explicit and displayed as "scenario cover type maps" (Hutchinson 1989) with a GIS.

Wildlife Habitat Modeling

Once the baseline vegetation description has been established and future vegetation conditions have been simulated through the vegetation modeling procedures, influences on wildlife species will be evaluated indirectly using appropriate species-habitat relationship models. Evaluation species and habitat models used will be restricted to those currently available. The focus of this analysis will be on habitat conditions rather than on any single evaluation species. Evaluation species' variables will be used as a tool to measure habitat condition and value. Current and future habitat values will be calculated for each selected evaluation species and each future flow scenario.

Link to Protection, Mitigation, and Enhancement Measures

Analyses of current and predicted future conditions will lead to recommendations for operations of the Hells Canyon Project. Also, options for appropriate mitigation for ongoing impacts, if identified, and opportunities for resource protection and enhancement will be developed.

Timetable

The study will be initiated in early 1998 and require two years for completion. Field work for developing the vegetation simulation models will be completed during 1998. A draft report will be prepared by November 1999, with the final report submitted in 2000.

Cooperation

Vegetative, geologic, hydrologic, and landscape field data may be collected jointly during this study with other wildlife studies, and during several botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Geologic and hydrologic data will be collected in conjunction with all related wildlife and botanical flow fluctuation studies. Accordingly, flow fluctuation modeling will also be coordinated among related studies.

Cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFWS, and USFS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation among IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Deliverables

A draft report will be prepared by November 1999 and the final report in 2000.

8.2.24.
Title: Effects of Water Level Fluctuations and Road and Transmission Line Corridors on Riparian Habitat Fragmentation

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize this hydroproject's operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T9. Operational effects on both reservoir and downstream areas.

T13. Changes in quality of upland and riparian habitat on land currently or formerly under IPC control.

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T23. Current impacts of project operations on wildlife habitat—altered migration routes.

T26. Effects of operations on the quantity and quality of riparian habitat (reservoir and free-flowing reaches).

T27. Wildlife habitat fragmentation caused by project construction and operation.

T31. Flooding/dewatering of terrestrial species - microhabitat.

T33. IPC land management practice's effects on terrestrial resources.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

T40. Livestock grazing impacts in relation to current management plans.

T44. Water level fluctuation versus migrations, home ranges, territories, etc.

T45. Water level fluctuations per mile of shoreline riparian conditions.

T46. Flooding/dewatering impacts on microhabitats of certain small mammals and amphibians.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What are the riparian habitats from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hell Canyon Dam to the confluence of the Salmon River?
3) What are the effects to riparian habitats including microhabitat from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by the Hells Canyon Project operations?
4) What are the riparian resources in reservoir reaches in the study area?
5) What are the water level fluctuations in the reservoir reaches?
6) What are the effects to riparian habitat, including micro-habitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
7) What habitats are fragmented by transmission line corridors, reservoirs, or other project facilities?
8) What are the effects of habitat fragmentation caused by transmission line corridors, reservoirs, altered river flows, roads, or other project facilities on wildlife migration or movement patterns?

9) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The overall goal of this study is to minimize the negative impacts of the Hells Canyon Project's operations and maintenance activities on wildlife resources in the Hells Canyon Study Area. This goal results from the FERC requirement that hydropower license applications describe wildlife resources, identify operational impacts to these resources that may result, and provide measures for resource protection, mitigation, and enhancement (FERC 1990).

Abstract

Species vulnerability (i.e., demography) is strongly related to landscape heterogeneity and variability (i.e., composition, area, geometrical configuration, connectivity, and availability of suitable habitat). Resource development can influence landscape heterogeneity by fragmenting particular habitats into fewer, smaller, and increasingly isolated patches. Conserving a significant proportion of the biodiversity in the western United States hinges on conserving blocks of interconnected riparian habitats and their ecological functions. This study is proposed to evaluate the current spatial structure of riparian habitats in Hells Canyon and evaluate the likelihood that flow fluctuations due to hydropower operations are fragmenting riparian habitats. For corridors, landscape structure will be compared among varying resolutions to identify the scale of influences that corridors exert on the structure of the surrounding landscape. Appropriate mitigation for ongoing impacts and opportunities for resource protection and enhancement will be developed based on results of this study.

Introduction

Scientists generally agree that biological diversity is rapidly being lost (Myers 1979, Wilson 1988, Soulé 1991, Hansen *et al.* 1993), with habitat fragmentation being a primary contributing factor (Harris 1984, Saunders *et al.* 1991). Species vulnerability (i.e., demography) is strongly related to landscape heterogeneity and variability (i.e., composition, area, geometrical configuration, connectivity, and availability of suitable habitat; Fahrig and Paloheimo 1988, Palmer 1992, Hansen *et al.* 1993, McGarigal and Marks 1995). Resource development can influence landscape heterogeneity by fragmenting particular habitats into fewer, smaller, and increasingly isolated patches. This fragmentation can in turn influence wildlife population and community dynamics within a landscape. However, habitat fragmentation affects populations according to individual species' life histories, including resource requirements and the scale at which the environment is perceived (Forman and Godron 1986, Hansen *et al.* 1993). Hence, consequences (i.e., species persistence) of habitat fragmentation due to human activities are species-specific and scale-dependent (McGarigal and Marks 1995). For example, habitat patchiness can enhance regional persistence for some species through metapopulation dynamics (Fahrig and Poloheimo 1988, Gilpin and Hanski 1991), or increase vulnerability due to decreased habitat suitability and resource availability (Yahner *et al.* 1993, Yahner 1996). Net consequences for regional biodiversity will be the sum of individual species effects.

Generally, however, habitat fragmentation is believed to be detrimental to many species and may contribute substantially to the loss of regional and global biodiversity (Harris 1984, Saunders *et al.* 1991). This can be compounded when fragmentation affects habitats that contribute disproportionately to a region's biodiversity. In the western United States, riparian ecosystems comprise approximately 0.5 percent of the landscape (Ohmart and Anderson 1996), however, more wildlife species use riparian areas than any other vegetation type (Thomas 1979, Brinson *et al.* 1981, Knopf *et al.* 1988, Saab *et al.* 1995). Riparian habitats support a diversity and abundance of wildlife because of high physical complexity and trophic production (Hawkins 1994). Wildlife concentrate in these habitats because of the relative abundance and diversity of resources (e.g., water, forage, cover, and travel corridors) necessary to meet complex and varied life histories (Thomas 1979). Therefore, impacts to riparian habitats due to fragmentation may be expected to disproportionately affect wildlife communities and thus regional biodiversity. Effects of fragmentation are further heightened in riparian habitats, because this ecosystem has been reduced by greater than 70 percent since presettlement (Brinson *et al.* 1981, Dahl 1990, Noss *et al.* 1995).

Conserving a significant proportion of the biodiversity in the western United States hinges on conserving blocks of an interconnected riparian ecosystem and its ecological functions (Noss 1983, 1992; Hawkins 1994; Noss *et al.* 1995). Riparian ecosystem conservation can be advantageous over individual species conservation for protecting biodiversity. Ecosystem conservation directly addresses habitat alteration, which is the primary cause of many species declines, and can provide a more cost-efficient approach for simultaneously conserving groups of species (LaRoe 1993, Noss *et al.* 1995). Developing a regional multiple-use management approach for conserving riparian ecosystems in Hells Canyon will require:

1) an understanding of the processes driving the vegetation dynamics of riparian vegetation communities,
2) a knowledge of the effects of land and water use practices on riparian vegetation dynamics,
3) an inventory of the distribution and abundance of areas currently and potentially capable of supporting riparian habitat and uses these areas sustain, and

4) a means to predict results of alternative management actions designed to maintain and enhance riparian habitats (Hansen *et al.* 1993, Hawkins 1994).

This study is proposed to:

1) describe the current landscape structure of habitats in Hells Canyon,
2) evaluate the likelihood that water level fluctuations due to hydropower operations are fragmenting riparian habitats, and
3) identify the influence of road and transmission line corridors on fragmenting the habitats through which they pass.

Specific objectives related to water level fluctuations will be to:

1) describe the current landscape structure of riparian habitats,
2) determine the trends and variation of the Snake River hydrograph,
3) identify the influence of Hells Canyon hydropower operations and other water use practices on this hydrograph,
4) develop a desired landscape structure of riparian habitats and potential flow management scenarios attempting to reach this desired structure,
5) predict change in the landscape structure over time under the various competing management scenarios, and
6) recommend a preferred management and monitoring strategy for conserving riparian habitats.

Objectives related to road and transmission line corridors will be to:

1) identify the corridors associated with the Hells Canyon Project,
2) digitally map their locations,
3) map boundaries of cover types in the corridors,
4) visually reconnoiter for the presence of wildlife species and habitats that may be of special concern (e.g., nesting raptors, and riparian and wetlands habitats),
5) summarize technical characteristics of the transmission lines and roads,
6) characterize corridor operations and maintenance activities,
7) assess landscape structure in and adjacent to these corridors,
8) identify potential impacts of habitat fragmentation due to IPC’s creation, use, and maintenance of these corridors, and

9) develop appropriate protection, mitigation, and enhancement measures to reach desired resource goals.

Issues of wildlife avoidance of habitat (i.e., behavioral responses) due to the presence of roads and transmission lines, and/or increased vulnerability to mortality factors due to roads will not be addressed in this study. The ultimate goal of this study is to identify means for maintaining, and if possible, enhancing the biodiversity of wildlife communities by conserving important wildlife habitats in the multiple-use landscape of Hell Canyon.

State of Knowledge

Fluctuating water levels that diverge from a natural hydrograph can preclude the establishment of riparian vegetation, or change the structure and composition of riparian vegetation communities. Thus, the establishment of riparian vegetation along reservoirs, or river reaches below dams can be marginal and fragmented (Nilsson and Keddy 1988). This could result in fragmentation of riparian habitats that will otherwise be physically linked. Fragmentation of a landscape produces a series of remnant vegetation patches surrounded by a matrix of different vegetation and/or land uses (Saunders *et al.* 1991). The lack of connectivity among fragments may negatively impact wildlife communities, especially those with riparian obligates. Habitat fragmentation also alters the spatial configuration of habitats patches, which can affect population or meta-population stability or persistence by reducing movements within a population (Gilpin and Hanski 1991).

Road and transmission line corridors can also have a variety of effects on landscapes and thus wildlife populations (Andrews 1990). These include:

1) habitat loss and modification,

2) extension of edge effects into natural areas,
3) barrier effect,
4) disturbance effect,
5) directly killing animals, and
6) providing human access. Hundreds of miles of roads and transmission lines are associated with the Hells Canyon Project License.

The license application will require:

1) a detailed characterization of wildlife resources occurring in these corridors,
2) evaluation of impacts imposed on resources due to project operations, and
3) development of mitigative and enhancement measures for impacts (FERC 1990).

Currently, little is known about the natural resources that are associated with these corridors. Therefore, to conduct future assessments of resources related to corridors, preliminary information on:

1) location of roads and transmission lines in the study area,
2) composition and configuration of habitats in these corridors, and
3) influences of these habitats on wildlife populations is essential.

However, this information has not been collected and/or synthesized.

The resulting effect of altering landscape heterogeneity and variability on wildlife populations can be mixed depending on individual species' life histories. Habitat variation affects ecological processes, and thus vertebrate populations, at many spatial scales (Wiens 1989*a*,*b*). This makes the evaluation of landscape structure and function a difficult task, especially if defining a landscape from an organism-centered perspective (McGarigal and Marks 1995). Currently, information on structure, function, and change of landscape elements (e.g., habitat patches adjacent to the reservoirs and river, and in corridors) in Hells Canyon is not available. Therefore, the overall landscape structure and potential impacts to key wildlife habitat components, such as riparian, cannot currently be evaluated.

A cover type map of plant communities occurring in the study area is being currently being developed by IPC. This map is based on the 26 vegetation, natural feature and land use cover types used in IPC's prior relicensing studies. Cover type patches will be geo-referenced, which will facilitate landscape analyses. This map will be used as the baseline data describing the current availability and distribution of vegetation habitat types in the study area. Further, structural and community characteristics of cover types are being characterized by IPC. This work is ongoing and expected to be completed in 1998.

Also, IPC is compiling information on water level fluctuations and flows in Hells Canyon. Data will be analyzed over several time intervals and point locations to provide a description of the current hydrograph, and the temporal and spatial variation in this hydrograph. Attempts will be made to identify the contributions of water management activities to observed flows. Water management will include activities such as hydropower production, flood control, fish passage, and navigation.

Methods

Study Area

The Hells Canyon study area extends along the Snake River from approximately Weiser, Idaho to the confluence of the Snake and Salmon Rivers. This section of river consists of the three reservoir reaches and the unimpounded river reach. Brownlee Reservoir is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles long (RM 284.6 to 272.2), and Hells Canyon Reservoir is approximately 25 miles in length (RM 272.2 to 247.0). The unimpounded reach extends approximately 59 miles from Hells Canyon Dam (RM 247.0) to the confluence of the Snake and Salmon Rivers (RM 188.2). The lateral extent of the study area will be determined by the coverage of the cover type map.

Also, hundreds of miles of transmission lines are associated with the Hells Canyon Project License, and may extend well beyond Hells Canyon. Roads are defined as areas cleared for vehicles, whether dirt or paved. Only those roads created as part of the operation and maintenance of the Hells Canyon Project will be considered in this study. This includes roads used for the operation and maintenance of transmission lines associated with the Hells Canyon Project License.

Study Design

An extensive review of available information and relevant literature will be conducted prior to the final study design and implementation of methods. This review will allow refinement of study design and methods, facilitate identification of gaps in the current information base, and help modify specific study objectives so as to increase efficiency in filling information gaps. Also, as part of the information review, subject experts and resource agency representatives will be contacted and consulted as necessary. Therefore, final development of the design, objectives, and methodologies will be completed as part of this study. Generally, however, information on current project operations and maintenance (including roads, transmission lines, and power production facilities), hydrology, sources of flow fluctuations, and vegetation, in the study area will be described to establish baseline conditions.

When addressing influences of water level fluctuations, this information will then be used to model vegetation/cover type changes through time under various flow management scenarios representing potential project operations. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Landscape structure (e.g., fragmentation) of riparian cover types, which will represent critical wildlife habitat, will be evaluated under current conditions and alternative flow management scenarios. For corridors, landscape structure will be evaluated at varying resolutions. Comparisons among resolutions will help identify the scale of influences that corridors exert on the structure of the surrounding landscape.

Field Methods

Field work will be required for characterizing the current vegetation conditions. This work is being conducted by IPC to fulfill FERC relicensing requirements. The study area will be mapped by cover type using standard photo-interpretation techniques using July/August 1993 1:15,000-scale color infrared aerial photos. Field sampling will be used to collect data on the existing conditions of each vegetation cover type. The approach will be similar to the “subjective without preconceived bias” concept of Müller-Dombois and Ellenberg (1974). That is, placement of sample sites within cover types will be done without any assumption of eventual classification or apparent condition, but rather for the representation of homogeneous vegetation. Obvious ecotones, microsites, exceptionally dense clumps or openings, or areas of recent severe disturbance will be avoided. Sample locations will be selected using a stratified-random method, wherein the study area is stratified into 5-mile segments and by left and right bank. Polygons of each vegetation cover type are then randomly selected in each segment throughout the length of the study area. Detailed data on species composition, cover, woody species density and height, and vegetation structure will be collected using standard sampling techniques. This information will not, however, be geo-referenced.

Field data may also be needed to describe the locations, vegetation, and cover types of road and transmission line corridors. All transmission lines associated with the Hells Canyon Project that are owned or administered by IPC are patrolled at relatively regular intervals. Patrols are usually conducted by helicopter and focus on monitoring the structural and engineering integrity of the transmission lines (e.g., insulators, cable splices, structures, suspensions, etc.). Any field efforts needed to cover-type map or generally reconnoiter corridors will capitalize on these routine patrols. During these flights, a Global Positioning System (GPS) will be used to digitally map transmission line routes. While mapping the route, visual delineation of cover type boundaries will be recorded referencing GPS positions.

Field work collecting vegetation data is ongoing and expected to be completed in 1997. However, additional field work may be required to gather site-specific hydrologic and geomorphologic information necessary for constructing and parameterizing the vegetation simulation models.

Analyses

Consultation

A team of private consultants will be solicited and selected to conduct data analyses. Thereafter, a detailed study plan describing analyses will be generated by the selected contractor. However, a guidance and evaluation team, comprising representatives from interested resource agencies, non-governmental organizations, and IPC, will be involved in all phases of this study.

Water Level Fluctuations

The IPC Water Management Department will compile information on operations of the Hells Canyon Complex based on historic information. This will include hydrologic information on:

1) daily, monthly, and annual river and reservoir water level fluctuations; and
2) water level changes related to power and non-power production water releases (i.e., flood control, fish flushes).

Specifically, historic information summarized will include:

1) minimum and maximum headwater elevations recorded on a daily, monthly, and annual basis; and

2) mean, median, 90 and 98 percent of maximum elevations on a daily, monthly, and annual basis over the period of record or a representative time period (10 to 5 years).

Also, these data will be collected by the IPC Water Management Department during the course of this study. Information on water surface elevation fluctuations using the DWOPER model will be calculated at each of the locations where habitat data are collected.

Corridor Description

General information about road and transmission line corridors associated with the Hells Canyon Project will be collected and summarized. Analyses will consist of summarizing both existing information and that obtained during any reconnaissance flights. Also, digital data on locations of the transmission lines will be prepared for GIS mapping. Existing information on the transmissions lines and roads will be requested from IPC's Transmission and Distribution, and Right-of-Way Departments. Technical information to be requested and summarized for each line will include:

1) line length,
2) tower/pole construction,
3) voltage,
4) amperage,
5) conductor, and
6) insulator.

Information about transmission line corridors will also include:

1) locations,
2) easements,
3) line ownership,
4) river crossings, and
5) access roads.

Similarly, information summaries about roads will include:

1) locations,
2) easements,
3) road ownership,
4) stream crossings,
5) construction type, and
6) uses.

Many of the roads are associated with transmission lines and are located within the transmission line rights-of-way. Summaries of transmission lines and roads will be useful for determining if and how the operations of these corridors may influence natural resources in Hells Canyon.

Landscape structure will then be evaluated at varying resolutions. The composition and configuration of cover-type patches within corridors will be compared to that of the surrounding landscape. Landscape structure will be compared a several scales (i.e., increasing analysis areas). Comparisons among resolutions will help identify if and at what scale corridors exert an influence the structure of the surrounding landscape.

Vegetation Description

The cover types and plant communities occurring in the study area will be quantified and described. The cover type map (which will be geo-referenced) will be analyzed to describe the extent, representation, and distribution of cover types in the study area. Species composition, cover, woody species density and height, and vegetation structure will be summarized to describe the different cover types and plant communities occurring in each cover type.

Cover Type Modeling

A predictive modeling approach will be developed to best identify the likely influences of alternative flows management scenarios on the landscape structure of cover types in Hells Canyon (Hansen *et al.* 1993). Multiple scenarios will be developed representing potential flow management strategies, and will consider both power and non-power sources of water level fluctuations. Emphasis will be placed on evaluating the landscape structure of riparian cover type elements, because these habitats often contribute disproportionately to an area's biodiversity (Hawkins 1994). The feasibility of developing landscape projection models will be evaluated. If the trajectory of the Hells Canyon landscape can be modeled and predicted through time based on flow fluctuations, the influences of hydroproject operations on riparian habitats will be assessed.

The existing conditions will be used as a basis of comparison with future water flow scenarios. Evaluation of predicted future conditions will be based on expected changes in vegetation conditions and landscape structure as simulated over time periods. The time frame for simulations will be based on the expected duration of the project's renewed license. A period of 30 to 50 years probably will be reasonable. Future vegetation conditions will be determined using vegetation models (Simons and Associates 1990) that will be constructed with botanical and hydrologic information currently being collected by IPC. Output from the vegetation models will be spatially and temporally explicit and displayed as "scenario cover type maps" (Hutchinson 1989) with GIS. Landscape structure will be analyzed for each scenario cover type map (McGarigal and Marks 1995), and changes in the predicted structure will be evaluated at various time intervals (e.g., short-term perturbations and long-term changes).

Link to Protection, Mitigation, and Enhancement Measures

Analyses of current and predicted future conditions under various flow management scenarios will lead to recommendations for operation of the Hells Canyon Project. Options for appropriate mitigation for ongoing impacts, if identified, and opportunities for resource protection and enhancement will be developed.

Timetable

The study will be initiated in early 1998 and require two years for completion. Field work for developing the vegetation simulation models will be completed during 1998. A draft report will be prepared by November 1999, with the final report submitted during 2000.

Cooperation

Vegetative, geologic, hydrologic, and landscape field data may be collected jointly during this study with other wildlife studies, and during several botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Geologic and hydrologic data will be collected in conjunction with all related wildlife and botanical flow fluctuation studies. Accordingly, flow fluctuation modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (BLM, USFWS, and USFS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation among IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,

2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

A consultant with expertise in vegetation ecology, vegetation modeling, sampling techniques, and a strong background in quantitative analysis and GIS applications will be contracted to conduct this study. A single consultant will be selected. This consultant may utilize services of other subcontractors to perform elements of the work. IPC's principal investigator will develop an RFP to solicit bids from interested consultants and administer contracts. Interested agencies and groups will assist in developing the RFP.

Deliverables

A draft report will be prepared by November 1999 with the final report completed during 2000.

8.2.25.
Title: Effects of Water Level Fluctuations on Threatened and Endangered Species: Bald Eagle

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T3. Cultural and natural resource inventories.

T5. Impacts to *threatened*, *endangered*, and *sensitive* species from flow changes and flooding of original habitat from construction.

T9. Operational effects on both reservoir and downstream areas.

T10. Post-construction loss of habitat.

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T14. Study design and quality? How do we know what we know?

T17. Impact identification.

T18. Mitigation plans.

T25. Loss of anadromous link in the wildlife food chain.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free flowing reaches).

T27. Wildlife habitat fragmentation caused by project construction and operation.

T31. Flooding/dewatering of terrestrial species - microhabitat.

T33. IPC land management practices' effects on terrestrial resources.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

T45. Water level fluctuations per mile of shoreline riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What are the riparian resources in reservoir reaches in the study area?
2) What are the water level fluctuations in the reservoir reaches?
3) What are the effects to riparian habitat, including microhabitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
4) What *threatened*, *endangered*, and *sensitive* species are present in the study area?
5) What are the effects to *threatened* and *endangered* species in the study area caused by water level and flow fluctuations by Hells Canyon Project operations?
6) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize the impacts of project operations of Hells Canyon reservoir on *threatened* and *endangered* species. FERC requires that license applications describe wildlife resources, including *threatened* and *endangered* species in the vicinity of the project and the impact of the project on those resources (FERC 1990).

Management goals for *threatened* and *endangered* species have been formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990), and state conservation organizations (Marshall 1986, IDFG 1991). Specific management objectives can be found in USDA (1989) and USDI (1986).

Abstract

The purpose of this study is to evaluate the impact of water level fluctuations on wintering bald eagles (*Haliaeetus leucocephalus*). The bald eagle, an *endangered* species, historically nested along the Snake River in the Hells Canyon Study Area. Substantial numbers of bald eagles winter along the Snake River and associated reservoirs in the Hells Canyon Study Area. Water level fluctuations and drawdowns could impact bald eagles by affecting prey availability. The general goal of this study is to minimize the impacts of project operations in the reservoir reach on bald eagles. Sufficient information is available on the distribution and numbers of bald eagles wintering in the study area to design an appropriate sampling design to track numbers and distribution of bald eagles over time. However, operation of the project is less clear and will have to be investigated in detail before a sampling design can be proposed. Bald eagle numbers and distribution are likely to be surveyed by a combination of road, jetboat, and aerial surveys. A bi-

weekly survey intensity is anticipated. Relationships will be determined between bald eagle numbers and distribution and operation of the project. This may provide insight in changes in the temporal and spatial distribution of bald eagles relative to changes in vegetation cover types due to operation of the projects.

Introduction

Threatened and *endangered* species and federal *candidate* species are protected by the Endangered Species Act. State *species of special concern* receive protection under state conservation laws (**Idaho Code** 36-103, 36-201, and the State of Oregon Endangered Species Act; CDC 1994, ONHP 1995). Information on *threatened* and *endangered* species will be provided in the Hells Canyon license application. Baseline data (i.e., distribution and numbers) are important for planning and management purposes. Management goals for *threatened* and *endangered* species are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Water level fluctuations and drawdowns could impact bald eagles by affecting prey availability (Steenhof 1987). However, the impact of the operation of the project cannot be evaluated because baseline data is limited. Therefore, objectives of this study will be to:

1) characterize hourly, daily, monthly, and annual reservoir and unimpounded river level fluctuations for the Hells Canyon Complex, including operations related to other purposes than power generation (e.g., fish flushes),
2) determine the temporal distribution and numbers of wintering bald eagles,
3) link project operation to spatial and temporal distribution and numbers of wintering bald eagles, and

4) determine appropriate mitigation or enhancement for the resource based on stated desired future resource goals.

State of Knowledge

A summary of reservoir and unimpounded river level fluctuations for the Hells Canyon Complex is currently being compiled. This will provide a general overview of project operations. Also, during the course of this study information on water level fluctuations will be collected on a daily basis that can be compiled at any desired time interval.

Historic and present distribution of the bald eagle are essentially the same. However, numbers of eagles in the continental U.S. have decreased dramatically in the last 200 years. In response to this decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous states and *threatened* in the remaining states, including Oregon. Bald eagles historically nested along the Snake River in the Hells Canyon Study Area. Taylor (1989) reported one pair nested at the mouth of Two Creeks in the early 1900s. At least five other historic bald eagle nest sites have been reported (Isaacs *et al.* 1989).

Currently, seven existing and suspected bald eagle nest sites occur in the vicinity of the Hells Canyon Study Area (Isaacs *et al.* 1989). Existing nests occur at Unity Reservoir, Phillips Reservoir, and Wallowa Lake. Nests, suspected to have been built by bald eagles, were reported at the Grande Ronde, Wallowa, and Lostine Rivers, and at Eagle Island Creek. The Unity Reservoir bald eagle pair has produced young for several years prior to 1989 (Isaacs *et al.* 1989). Substantial numbers of bald eagles winter in Wallowa, Union, and Baker Counties.

Concern about the potential impacts of habitat alteration and other human activities on this species, and the need to identify important wintering areas, resulted in a study on wintering bald eagles in northeastern Oregon from 1988 through 1991 (Isaacs *et al.* 1989, 1990). Similar trends in numbers of wintering eagles were found in the winters of 1988/1989 and 1989/1990. Numbers increased from November through December, peaked in January and February, and declined rapidly through April (Isaacs *et al.* 1990, 1992). Average weekly counts in 1989/1990 were 67 in November, 168 in December, 231 in January, 263 in February, 141 in March and 34 in April. The highest count was in the middle of February with 282 bald eagles. Forty-nine percent of all bald eagles were observed at the three Hells Canyon reservoirs in 1988/1989 and 56 percent in 1989/1990.

Twenty-seven night roosts were located and an additional 27 were suspected. Exceptional roost counts were at two bald eagle roosts along IPC reservoirs, namely, 55 at Eagle Island Creek and 100 at Soda Creek (Isaacs *et al.* 1990).

Methods

Study Area

The study area consists of three reservoir reaches. The reservoir reach is comprised of Brownlee Reservoir, which is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles in length (RM 284.6 - 272.2), and Hells Canyon Reservoir is approximately 25 miles long (RM 272.2 to 247.0). The lateral extent of the reservoir reach will be 50 m above full pool elevation.

Water Level Fluctuations

The IPC Water Management Department will compile information on the *typical* operation of the projects based on historic information. This will include information on: hourly, daily, monthly and annual water level fluctuations (i.e., reservoir and unimpounded river), and water level changes related to non-power production water releases (i.e., flood control, fish flushes).

Specifically, historic information will be summarized that include minimum and maximum headwater elevations recorded on a daily, monthly, and annual basis; mean, median, 90 and 98 percent of maximum elevations on a daily, monthly, and annual basis over the period of record or a representative time period (10 to 15 years). During the course of this study, all these types of data will also be collected by the IPC Water Management Department. Also, information on water surface elevation fluctuations will be calculated using the DWOPER model at each of the locations where bald eagle data are collected.

Experimental Design and Field Methods: Bald Eagle

A sampling design will be developed that includes at least three parameters. These are:

1) the temporal dynamics in the numbers of wintering bald eagles in the study area, and
2) operations of the project, and
3) prey availability.

Sufficient information is available on the distribution and numbers of bald eagles wintering in the study area to design an appropriate sampling design to track numbers and distribution of bald eagles over time. Operation of the project is less clear and will have to be investigated in detail before a sampling design can be proposed. Bald eagle numbers and distribution are likely to be surveyed by a combination of road surveys and jetboat surveys. A bi-weekly survey intensity is anticipated.

Information on prey taken by bald eagles may be important in determining the species' distribution and presence. Investigating the diet of wintering bald eagles may be decided upon at a later date and specific sampling methods have not been developed.

Analysis

Relationships between bald eagle numbers and distribution and operation of the project, and prey availability will be examined. This may provide insight into changes in the temporal and spatial distribution of bald eagle avifaunal communities, related to changes in vegetation cover types due to operation of the projects. However, number of factors may potentially affect the survey data (e.g., weather conditions, icing of the river). These factors are anticipated to be included in the data analysis when data collection has been completed.

Link to Protection, Mitigation, and Enhancement Measures

Insight into the process (water surface elevation fluctuations), influencing vegetation cover types, and, thereby, bald eagle distribution and numbers, will provide recommendations for protection, mitigation, and enhancement of avifaunal communities.

Timetable

The study will require one and possibly two field seasons. The first season will be in 1998. A progress report of results should be available in April 1999. A comprehensive draft report will be prepared by April 2000 if a second field season is required. A final report should be submitted by July 2000.

Cooperation

Vegetative, geologic, hydrologic, and landscape field data may be collected jointly during this study with other wildlife and botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Geologic and hydrologic data will be collected in conduction with all related wildlife and botanical flow fluctuation studies. Accordingly, flow fluctuation modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (BLM, USFWS, and USFS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho County Commissions) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,

2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC's principal investigator for the study will be Dr. Anthonie M. Holthuijzen. He holds a Ph.D. in Wildlife Ecology and has 20 years experience conducting, overseeing and administering wildlife studies. He has worked for the past 13 years on wildlife projects in Idaho. Field work will be conducted by two field assistants, who will hold B.Sc. degrees in Wildlife or related fields. Fieldwork will be overseen by Mr. Von Pope and Kelly Wilde; both hold B.Sc. degrees in Biology. IPC has the required facilities and equipment, including 4-wheel-drive vehicles, a jetboat, and a field house in the vicinity of the study area for logistical support. Computer hardware and software, including a fully staffed GIS department, are available to conduct data analysis.

Deliverables

A project progress summary will be prepared by Dr. Holthuijzen after each completed field season, summarizing experimental design, field methods, and survey results, if applicable. A draft report of results should be available in April 1999. Another comprehensive draft report will be prepared by April 2000 if a second field season is required. A final report should be submitted by July 2000.

8.2.26.
Title: Effects of Water Level Fluctuations on Species of Special Concern

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T3. Cultural and natural resource inventories.

T4. Effects of flow changes below dams.

T5. Impacts to *threatened*, *endangered*, and *sensitive* species from flow changes and flooding of original habitat from construction.

T7. Terrestrial species habitat impacts in units/acres by habitat type (both sides of the river, all known species).

T9. Operational effects on both reservoir and downstream areas.

T10. Post-construction loss of habitat.

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T14. Study design and quality? How do we know what we know?

T17. Impact identification.

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free-flowing reaches).

T27. Wildlife habitat fragmentation caused by project construction and operation.

T31. Flooding/dewatering of terrestrial species - microhabitat.

T33. IPC land management practices effects on terrestrial resources.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

T45. Water level fluctuations per mile of shoreline riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What are the riparian habitats from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hells Canyon Dam to the confluence of the Salmon River?
3) What are the effects to riparian habitats including micro-habitat from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by Hells Canyon Project operations?
4) What are the riparian resources in reservoir reaches in the study area?
5) What are the water level fluctuations in the reservoir reaches?
6) What are the effects to riparian habitat, including microhabitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
7) What *threatened*, *endangered*, and *sensitive* species are present in the study area?

8) What are the effects to *threatened*, *endangered*, and *sensitive* species in the study area caused by water level and flow fluctuations by Hells Canyon Project operations?
9) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goals

The general goal is to minimize the impacts of water fluctuations, related to project operations, on *species of special concern* occurring in the Hells Canyon Study Area. FERC requires that license applications describe wildlife resources, including *threatened*, *endangered*, and *sensitive* species in the vicinity of the project and the impact of the project on those resources (FERC 1990). Specific management goals for *species of special concern* are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Abstract

The purpose of this study is to evaluate the impact of water level fluctuations on *species of special concern*. Fifty-five species known or suspected to occur in the study area are listed by state or federal agencies either in Oregon or Idaho as *species of special concern* (former federal *candidate* species, state *species of special concern*, or *sensitive* species). Information on many of the species in the Hells Canyon Study Area is limited. Therefore, the overall condition of these resources cannot be effectively assessed at this date. In many cases, habitat requirements of *sensitive* species are not well known and the impact of the operation of the project cannot be evaluated. The general goal is to minimize the impacts of project operations in the reservoir reach on *species of special*

concern. Relationships will be determined between the presence of *species of special concern* and operation of the project. GIS will be employed to investigate possible relationships. Insight into the processes (e.g., water surface elevation fluctuations), influencing vegetation cover types, and, thereby wildlife distributions and numbers will provide recommendations for protection, mitigation, and enhancement of *species of special concern*.

Introduction

State *species of special concern* receive protection under state conservation laws (**Idaho Code** 36-103, 36-201, and the State of Oregon Endangered Species Act; CDC 1994, ONHP 1995). Information about the *candidate* species is particularly important to avoid potential future listing of these species and for appropriate management. Also, resource agencies often request information about (former) federal *candidate* species and *species of special concern*; baseline data (i.e., distribution and numbers, if possible) are important for planning purposes.

A large number of *species of special concern* are likely, or known, to occur in the study area. Apparently, Hells Canyon provides environmental conditions suitable to the life requisites of many *rare* species. Thus, the study area appears to be important to a variety of *rare* species at the regional level, and for some species, at the national level. However, information on many of the species in the Hells Canyon Study Area is limited. In many cases, basic habitat requirements are not well known. Therefore, the overall condition of these resources cannot be effectively assessed at this date. Because many *species of special concern* are *sensitive* to habitat changes, with many changes potentially influenced by the operation of the Hells Canyon Project, their status and life requisites should be carefully evaluated.

For most species the impact of the operation of the project cannot be evaluated because baseline data are limited. For a few species, data are available that may suggest impacts. For example, amphibians may be impacted by diel water fluctuations, drawdowns, and changes in the natural hydrograph that affect breeding sites. Many of these potential, or actual, impacts have been discussed elsewhere in this document.

The objectives of this study will be to:

1) characterize daily, monthly, and annual reservoir level fluctuations for the Hells Canyon Complex, including operations related to other purposes than power generation (e.g., fish flushes),
2) determine the presence of spatial distribution of *species of special concern* in the study reach, if possible,
3) determine relationships between project operations and the presence and distribution of *species of special concern*,
4) link project operation to *species of special concern* through spatial and temporal changes in vegetation cover types, if possible, and
5) determine interrelationships among project operations, water surface elevations, vegetation cover types, and *species of special concern* to appropriate mitigation or enhancement for the resource based on stated desired future resource goals.

State of Knowledge

A summary of reservoir water level fluctuations for the Hells Canyon Complex is currently being compiled. This will provide a general overview of project operations. Also, during the course of this study, information on water level fluctuations will be collected on a daily basis that can be compiled at any desired time interval.

Fifty-five species known, or suspected to occur in the project area were listed by state or federal agencies either in Oregon or Idaho as *species of special concern* (former federal *candidate* species, state *species of special concern*, or *sensitive* species). The largest taxon with listed species was birds (37 species), followed by mammals (16 species), amphibians (one species), and reptiles (one species). Table 5-8 lists the *species of special concern* known, or likely to occur, in the study area. General information on the relative abundance of vertebrates in the Blue Mountains Province in Oregon can be found in Marshall (1986) and Thomas (1979). Distribution of avian species by county in Idaho can be found in Stephens and Sturts (1991).

Methods

Study Area

The study area consists of three reservoir reaches and extends along a 59-mile stretch of the Snake River from Hells Canyon Dam, at river mile (RM) 247.0 to the confluence of the Salmon River (RM 188.2). The Brownlee Reach is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles long (RM 284.6 to 272.2), and Hells Canyon Reservoir is approximately 25 miles (RM 272.2 to 247.0). The lateral extent of the study area will include the reservoir reaches and 50 m (164 feet) above full pool level. The lateral extent of the study area downstream of Hells Canyon Dam will encompass all lands inundated by a 150,000-cfs flood event.

Water Level Fluctuations

The IPC Water Management Department will compile information on the *typical* operation of the projects based on historic information. This will include information on: daily, monthly and annual water level fluctuations, and water level changes related to non-power production water releases (i.e., flood control, fish flushes).

Specifically, historic information will be summarized that include minimum and maximum headwater elevations recorded on a daily, monthly, and annual basis; mean, median, 90 and 98 percent of maximum elevations on a daily, monthly, and annual basis over the period of record or a representative time period (10 to 15 years). During the course of this study, all these types of data also will be collected by the IPC Water Management Department. Using the DWOPER model, information on water surface elevation fluctuations will be calculated at each of the locations where avian data are collected.

Field Methods

Amphibians and Reptiles

Information on herptiles in the Hells Canyon Study Area is sparse. Data on species distributions and numbers are very limited. Data on amphibians and reptiles, including *species of special concern*, are collected in a separate proposed study to which further reference is made.

Diurnal Birds of Prey

Special surveys will not be conducted for the ferruginous hawk (*Buteo regalis*), Swainson's hawk (*B. swainsoni*), northern goshawk (*Accipiter gentilis*), and merlin (*Falco columbarius*). However, information on these species will be gathered using data 1) collected during general raptor surveys, and 2) incidental observations during field activities in the study area.

Owls

Six species of owls that are of special concern may occur in the Hells Canyon Study Area: the great grey owl (*Strix nebulosa*), burrowing owl (*Athena cunicularia*), boreal owl (*Aegolius funereus*), northern saw-whet owl (*A. acadicus*), flammulated owl (*Otus flammeolus*), and northern pygmy owl (*Glaucidium gnoma*). The great grey owl and boreal owl are unlikely to occur along the Snake River, because these species inhabit higher-elevation forests. Burrowing owl habitat appears to be limited along the Snake River in Hells Canyon.

Surveys of the three small forest owls, the most likely *candidate*s to be present in the Hells Canyon Study Area, will be conducted as follows. First, habitat associations of these three owl species are known sufficiently well to target specific habitats for surveying. The cover type map for the Hells Canyon Study Area will be used to develop a suitability map employing GIS. Based on these suitability maps for the owl species, a sampling design will be developed, ensuring adequate geographical coverage of the study area. Surveying at the selected sites will be conducted using data loggers. Passive data loggers that sample at specific intervals during optimal calling times for these owls will be used. Data loggers will be placed at selected sites for a specified time period during periods of optimal auditory activity of the owls.

Gallinaceous Birds

The sage grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), spruce grouse (*Dendrogapus canadensis*), and mountain quail (*Oreoptyx pictus*) are likely to occur in the Hells Canyon Study Area. Upland bird surveys will be conducted as part of a study on upland game birds. These surveys will provide information on both sage grouse and sharp-tailed grouse. A survey specifically for mountain quail was conducted in tributaries considered to be suitable for mountain quail.

Waterfowl

Harlequin ducks (*Histronicus histronicus*) have been found along swiftly flowing mountain streams in Idaho (Cassirer *et al.* 1991). Tributaries to the Snake River in the Study Area do not appear to be suitable to harlequin ducks, because many are too small and do not provide the vegetation cover required by harlequin ducks.

Therefore, specific surveys are not proposed for harlequin ducks. However, incidental observations will be reported during other proposed studies.

Shorebirds

Two species of shorebirds of special concern, the long-billed curlew (*Numenius americanus*) and upland sandpiper (*Bartramius longicauda*), are likely to occur in the Hells Canyon Study Area. The upland sandpiper occurs in high elevation marshes and is unlikely to be encountered along the Snake River corridor in the study area. Specific surveys are not proposed for the long-billed curlew. Data collected on this species will be compiled during upland surveys, and as incidental observations.

Perching Birds

Six species of perching birds that are of special concern are likely to occur in the Hells Canyon Study Area. These are the loggerhead shrike (*Lanius ludivicianus*), rosy finch (*Leucosticte arctoa),* bank swallow (*Riparia riparia*), yellow-billed cuckoo (*Coccyrus americanus*), black-throated sparrow (*Amphispiza bilineata*), and grasshopper sparrow (*Ammodramus savannarum).* A subspecies of the rosy finch (*Leucosticte arctoa wallowa*) occurs in summer around snow fields in the Eagle Cap Wilderness. This species is unlikely to be encountered along the Snake River corridor in the study area. Specific surveys are not proposed for either the loggerhead shrike or the rosy finch. Any data collected on these species will be compiled during avian surveys and as incidental observations.

Woodpeckers

Four woodpecker *species of special concern* may inhabit the Hells Canyon area. These are the pileated woodpecker (*Dryocopus pileatus*), white-headed woodpecker (*Picoides albolarvatus*), three-toed woodpecker (*Picoides tridactylus*), and Lewis' woodpecker (*Melanerpes lewis*). The white-headed woodpecker, Lewis' woodpecker, and the three-toed woodpecker are likely to occur along the Snake River. Specific surveys are not proposed for these woodpeckers. Any data collected on these species will be compiled during avian surveys, and as incidental observations. In addition, any ancillary information on the occurrence of the three woodpecker species will be recorded.

Bats

Eight species of bats that may inhabit the Hells Canyon area are of special concern. These are the spotted bat (*Euderma maculatum*), Townsend's big-eared bat (*Plecotus townsendii*), long-legged myotis (*Myotis volans*) long-eared myotis (*Myotis evatis*), pallid bat (*Antrozous pallidus*), silver-haired bat (*Lasionycteris noctivagans*), western small-footed myotis (*Myotis cilolabrum*), and Yuma myotis (*Myotis yumanensis*). Surveys of bats are described elsewhere.

Lagomorphs

The only species of Lagomorph that is classified as a *species of special concern* is the pygmy rabbit (*Brachylagus idahoensis*). Asherin and Claar (1976) did not report any pygmy rabbits in the Hells Canyon Study Area. Therefore, specific surveys are not proposed for the pygmy rabbit. Any data collected on this species will be compiled during upland game surveys and as incidental observations.

Insectivores

One insectivorous rodent that is a *species of special concern,* the Preble's shrew (*Sorex preblei*), may occur in the Hells Canyon Study Area. Specific surveys are not proposed for the Preble's shrew. Any data collected on this species will be compiled during small mammal surveys, which will be conducted as part of the general studies to describe the environment in the study area.

Rodents

The northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) is the only squirrel *species of special concern* in Hells Canyon. This species, which is a federal *candidate* species, occurs in several isolated colonies in western Idaho bordering the Snake River and may occur in the Snake River corridor in the study area. The presence of Idaho ground squirrel colonies in the study area will be determined using aerial surveys. Dr. E. Yensen of Albertson College, who found many of the currently known Idaho ground squirrel colonies, is interested in the distribution of this species. Therefore, Dr. Yensen will be solicited to design and conduct these surveys

Carnivores

Four species of carnivores are considered *species of special concern*. These are the wolverine (*Gulo gulo*), fisher (*Martes pennanti*), lynx (*Felis lynx*), and kit fox (*Vulpes macrotis*). All species, except the kit fox, are likely to occur in the Hells Canyon area, but usually at higher elevations than the Snake River Canyon. Wolverine, fisher, and lynx are strongly tied to coniferous forests and would rarely be observed inside the Snake River Canyon. It is doubtful if the kit fox will occur in the Hells Canyon Study Area or vicinity, based on their currently known distribution. Any information on the occurrence of carnivores in the study area will be recorded.

Analysis

An initial screening will be conducted of all *sensitive* species to determine which species are likely to occur in the study area and whether these species may be impacted by project operations (i.e., water level fluctuations). This screening will be conducted based on a hierarchical model. In this model, range, status, and habitat requirements will be used in addition to information on life requisites of each species, if known. A complete list of criteria will be developed at a later date, in cooperation with interested agencies and other groups.

Potential relationships will be identified between the presence of *species of special concern* and operation of the project. The GIS will be employed to investigate these possible relationships.

Link to Protection, Mitigation, and Enhancement Measures

Insight into the process (i.e., water surface elevation fluctuations) influencing vegetation cover types, and, thereby distributions and numbers of *species of special concern* will provide recommendations for protection, mitigation, and enhancement of *species of special concern*.

Timetable

Data will be gathered during 1998 through 2000 in conjunction with other field activities. Thus, the study will be terminated when all other studies are completed. A final report will be completed in late 2000.

Cooperation

Field data may be collected jointly with other wildlife studies, and several botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFWS, and USFS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho County Commissions) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC's principal investigator for the study will be Dr. Anthonie M. Holthuijzen. He holds a Ph.D. in Wildlife Ecology and has 20 years experience conducting, overseeing and administering wildlife studies. He has worked for the past 13 years on wildlife projects in Idaho. Field work will be conducted by two field assistants, who will hold B.Sc. degrees in Wildlife or related fields. Fieldwork will be overseen by Mr. Von Pope and Kelly Wilde; both hold B.Sc. degrees in Biology. IPC has the required facilities and equipment, including 4-wheel-drive vehicles, a jetboat, and a field house in the vicinity of the study area, for logistical support. Computer hardware and software, including a fully staffed GIS department, are available to conduct data analysis.

Deliverables

A draft report of results should be available in April 1998. A comprehensive draft report will be prepared by early 2000. A final report will be completed in late 2000.

8.2.27.
Title: Effects of Water Level Fluctuations on Amphibians and Reptiles

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirements to identify needs of wildlife resource associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories.

T4. Effect of flow changes below dams.

T5. Impacts to *threatened*, *endangered*, and *sensitive* species from flow changes.

T8. Operational effects on both reservoir and downstream areas.

T9. Operational effects on both reservoir and downstream areas.

T10. Post-construction loss of habitat.

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free-flowing reaches).

T31. Flooding/dewatering of terrestrial species - microhabitat.

T33. IPC land management practices' effects on terrestrial resources.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

T45. Water level fluctuations per mile of shoreline riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife/botanical resources.

1) What are the riparian habitats from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hells Canyon Dam to the confluence of the Salmon River?
3) What are the effects to riparian habitats including micro-habitat from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by Hells Canyon Project operations?
4) What are the effects to riparian habitats including microhabitats on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
5) What are the riparian resources in reservoir reaches in the study area?
6) What are the water level fluctuations in the reservoir reaches?
7) What are the effects to riparian habitat, including microhabitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
8) What *threatened, endangered,* and *sensitive* species are present in the study area?
9) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goals

The general goal is to minimize the impacts of the Hells Canyon Project operations in the reservoir reach on amphibians and reptiles. FERC requires that license applications describe wildlife resources in the vicinity of the project and the impact of the project on those resources (FERC 1990). Preserving habitat for amphibians and reptiles can be considered a priority. The BLM (USDI 1990) has formulated a broad goal for habitat management. Specific management guidelines have been stated for the tailed frog (USDI 1987). While general management goals for herptiles are proposed by the IDFG (1991) and Marshall (1986).

Abstract

The purpose of this study is to determine the impact of water level fluctuations on amphibians and reptiles in the Hells Canyon Study Area. Eleven species that are federal or state *sensitive* species potentially occur within the study area. Limited information on species distribution and relative abundance have been collected in the study area. However, the impact of the Hells Canyon Project cannot be assessed at this date, because of lack of information, although a variety of potential impacts are likely to exist. The general goal is to minimize the impacts of project operations in the reservoir reach on amphibians and reptiles. For amphibians, the primary sampling technique will consist of visual encounter surveys at wetland sites identified from various sources (e.g., USGS maps). The main sampling technique for reptiles will be conducted using drift fences with funnel traps and pitfall traps in the reservoir reach. In addition to the two main techniques described above, limited calling surveys will be conducted for anurans and road driving for snakes and toads. Relationships will be determined between amphibian and reptile communities and standard

vegetation cover types in the study area. The spatial and temporal distribution and extent of vegetation cover types in the study area will be coupled with the operation of the project. This may provide insight into changes in the herptile communities, related to changes in vegetation cover types due to operation of the projects.

Introduction

Eleven herptile species with federal status (formerly *C1*, *C2*, or *sensitive* species) and/or state *species of special concern/sensitive* species status potentially occur in Hells Canyon (CDC 1994, ONHP 1995). *Threatened* and *endangered* species and federal *candidate* species are protected by the Endangered Species Act. State *species of special concern* receive protection under state conservation laws (**Idaho Code** 36-103, 36-201, and the state of Oregon Endangered Species Act). The study area potentially contains most of the species of amphibians and reptiles that are *species of special concern* in Idaho and eastern Oregon. The Hells Canyon reach provides unique environmental conditions suitable to the life requisites of herptiles. The herptile community, with such a large proportion of rare species, therefore, can be considered unique. The study area is likely to be important at least at the regional level for amphibians and reptiles.

Amphibians and reptiles are important functional components in many ecosystems (as predators, prey, biomass, and transporters of nutrients). Consequently, proper management requires a basic understanding of the common amphibian and reptile species, as well as *sensitive*, *threatened* and *endangered* species.

Amphibians and reptiles are considered to be excellent bioindicators of change (e.g., Pechmann and Wilbur 1994). Reported declines of amphibian populations globally have drawn considerable attention (Bishop and Petit 1992, Richards *et al.* 1993, Blaustein 1994, Pechmann and Wilbur 1994). For example, the western toad (*Bufo boreas*) once was common in the Rocky Mountains, but now occurs at fewer than 20 percent of known localities from southern Wyoming to northern New Mexico (Bury *et al.* 1995).

Amphibian skin absorbs moisture of its environment and functions as a biomagnifier. Also, amphibians have very specific requirements in order to reproduce. Changes in the natural hydrograph may impact breeding sites and thus affect population numbers of a variety of pool breeders such as western toads and salamanders. Thus, the condition of the amphibian population may provide insight in the operational effects of the project. Amphibian species may especially be affected by diel fluctuations and prolonged drawdowns imposed by operations of the Hells Canyon Project. Breeding sites may be destroyed, by either inundation or flooding. The natural hydrograph may be changed in such a way that breeding pools are not available during the reproductive season. Reptiles are unlikely to be affected by continued operation of the project. However, some impacts could be expected during periods of drawdowns.

Information on amphibians and reptiles is extremely limited in Hells Canyon and the project impacts cannot be determined at this date, although a variety of potential impacts may exist. Therefore, objectives of this study are to:

1) characterize daily, monthly, and annual reservoir level fluctuations for the Hells Canyon Complex, including operations related to purposes other than power generation (e.g., flood control and fish passage),

2) determine relationships between project operations and the spatial and temporal distribution of vegetation cover types,
3) estimate relative population densities, richness, and composition of amphibian and reptile communities in major vegetation cover types,
4) investigate relationships between amphibian and reptile communities and vegetation cover types,
5) link project operation to amphibian and reptile community density, composition, and temporal dynamics through spatial and temporal changes in vegetation cover types, and
6) determine interrelationships among project operations, water surface elevations, vegetation cover types, and herptile resources to allow selection of appropriate mitigation or enhancement methods for the resource based on future resource goals.

State of Knowledge

A summary of water level fluctuations for the Hells Canyon Complex is currently being compiled. This will provide a general overview of project operations. Also, during the course of this study, information on water level fluctuations will be collected on a daily basis and thus compiled in any desired time interval.

Eleven species of amphibians and reptiles that were formerly classified as USFWS *candidate* species, or that hold state *species of special concern/sensitive* species status, potentially occur in Hells Canyon. These include one USFWS *category one* species [i.e., the Great Basin Population-Oregon side of the Snake River of spotted frog (*Rana pretiosa*)], and three former USFWS *category two* species [i.e., the Main Population-Idaho side of the Snake River of spotted frogs, the tailed frog (*Ascaphus truei*), and the sagebrush lizard (S*celoporus graciosus*)]. The following *sensitive* species or *species of special concern* may also occur: tiger salamander (*Ambystoma tigrimum*), western toad (*Bufo boreas*), leopard frog (*Rana pipiens*), Mojave black-collared lizard

(*Crotaphytus bicinctores*), ringneck snake (*Diadophis punctatus*), longnose snake (*Rhinocheilus lecontei*), and ground snake (*Sonora semiannulata*) (CDC 1994, ONHP 1995).

However, specific information on distribution and relative abundance of amphibians and reptiles in the study area is exceedingly limited. Asherin and Claar (1979) conducted several surveys in the Hells Canyon reach, resulting in a species list. Considerable work has been conducted on Craig Mountain, which is near the confluence of the Snake and Salmon Rivers (Cassirer 1995, Llewellyn and Peterson 1995). A profound need exists for regional inventories and population studies. Some regional surveys and inventories exist (e.g., Asherin and Claar 1976), but are limited in scope (Bury *et al.* 1995). Preliminary information on species distribution and relative abundance have been collected in the reservoir reaches in 1996 (IPC, *unpubl. data*).

Methods

Study Area

The study area consists of three reservoir reaches and extends from Hells Canyon Dam, at river mile (RM) 247.0, to the confluence of the Salmon River (RM 188.2). The Brownlee Reach is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles long (RM 284.6 to 272.2), and Hells Canyon Reservoir is approximately 25 miles long (RM 272.2 to 247.0). The lateral extent of the study area will include the reservoir reaches and 50 meters (164 feet) above full pool level. The lateral extent of the study area downstream of Hells Canyon Dam will encompass all lands inundated by a 150,000-cfs flood event.

Water Level Fluctuations

The IPC Water Management Department will compile information on the *typical* operation of the projects based on historic information. This will include information on: hourly, daily, monthly and annual reservoir level fluctuations, and water level changes related to non-power production water releases (e.g., flood control, fish passage, and navigation).

Specifically, historic information will be summarized to include minimum and maximum headwater elevations recorded on a daily, monthly, and annual basis; mean, median, 90 and 98 percent of maximum elevations on a daily, monthly, and annual basis over the period of record or a representative time period (10 to 15 years). During the course of this study, all these types of data also will be collected by the IPC Water Management Department. Using the DWOPER model, information on water surface elevation fluctuations will be calculated at locations where biological data are collected.

Amphibian and Reptile Communities

Several sources of information will be used to describe the distribution, habitat relationships, and relative abundance of amphibians and reptiles in the study area. These will include:

1) The literature, including published books, papers, and agency reports and unpublished documents (theses, surveys, etc).
2) Museum specimen records from all known U.S. and Canadian collections.
3) Observations reported to the Idaho Conservation Data Center and the Northern Intermountain Herpetological Database (Idaho Museum of Natural History). Incidental observations provided a great deal of useful data for the survey of the Craig Mountain Wildlife Management Area (Cassirer 1995).

Study Design and Field Methods

Reservoir Reach

For all sites searched or trapped, differentially corrected UTM coordinates will be determined with a Trimble GeoExplorer Global Positioning System and basic habitat types recorded. These site coordinates will be provided to the persons conducting the vegetation surveys for a more thorough characterization.

For amphibians, the primary sampling technique will consist of visual encounter surveys at wetland sites identified from topographic maps, National Wetland Inventory maps, aerial photographs, Gap cover type maps, and sites reported by IPC and agency personnel. The standard amphibian survey protocol developed by Dr. Stephen Corn of the National Biological Service will be followed. Also a fixed, automated recording system (FrogLogger) will be used to sample calling amphibians at a known reference wetland site and two mobile FrogLoggers will be used to sample other potential amphibian breeding sites (approximately three days, under appropriate conditions, per site).

The main sampling technique for reptiles will be drift fences with funnel traps and pitfall traps. In addition to the two main techniques described above, limited calling surveys will be conducted for anurans, and road driving will be performed to sample for snakes and toads. Any incidental observations will also be incorporated into the herpetological database.

Downstream Reach

Ideally, the same techniques will be employed to sample below Hells Canyon Dam. However, the limited access and potential restrictions due to wilderness status of some of adjacent lands does not allow use of trapping arrays over most of this portion of the study area. Consequently, the sampling plan is to survey 12 drainages from the Snake River to 1 km (0.62 miles) up the tributary streams (six per side of the river). One-day visual encounter surveys will be conducted for both amphibians and reptiles per stream or canyon. Each site will be surveyed once in the spring and once in the summer. Access will be by jet boat or raft. Also, hiking trips will be made from the rim down to the river along one or two drainages on each side of the river. Visual encounter surveys will be conducted along transects perpendicular to the streams at 1-km (0.62-mile) to 2-km (1.24-mile) intervals. This sampling scheme was tested in the Craig Mountain Wildlife Mitigation Area (Cassirer 1995). To detect and control for yearly variation in sampling (e.g., the effect of wet versus dry years), four of the drift fence arrays and two of the amphibian breeding sites located above the dam will be monitored in 1997.

Analysis

Relationships will be determined between amphibian and reptile communities and standard vegetation cover types in the study area. The spatial and temporal distribution and extent of vegetation cover types in the reservoir reaches will be coupled with the operation of the project. This may provide insight to changes in the herptile community related to changes in vegetation cover types due to operation of the projects.

After the 1997 field season, the survey data will be used to evaluate the Gap Analysis and other models/maps. Models will be revised to better fit the situation in the Hells Canyon Study Area. During the field season of 1998, the revised models will be tested by sampling new sites throughout the study area (approximately half of the number of sites done in the previous two years). As in 1997, to detect and control for year effects, sampling will be repeated at the same four drift fence sites and two amphibian breeding sites above the dam. The calibrated Gap Analysis models can be used to predict changes in presence and populations of amphibians and reptiles under changing conditions. Thus, changes to amphibian and reptilian habitat influenced by the different operation scenarios of the project can be evaluated at both the micro- and macro-level.

Link to Protection, Mitigation, and Enhancement Measures

Insight into the process (water surface elevation fluctuations) influencing vegetation cover types, and, thereby avian communities will provide a basis for developing recommendations for protection, mitigation, and enhancement of avifaunal communities.

Timetable

This study will be conducted by Dr. C. H. Peterson, Idaho State University. Dr. Peterson will review available literature, plan field work and data analysis methods, and conduct the study. The study will require one and possibly two field seasons, and will begin in 1997. A draft report of results should be available in December 1997. Another comprehensive draft report will be prepared by December 1998 if a second field season is required. A final report should be submitted by March 1999.

Cooperation

Vegetative, geologic, hydrologic, and landscape field data may be collected jointly during this study and other wildlife and botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Geologic and hydrologic data will be collected in conduction with all related wildlife and botanical flow fluctuation studies. Accordingly, flow fluctuation modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description’s objectives will be sought from all federal (e.g., BLM, USFWS, and USFS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC's principal investigator for the study will be Dr. C. Peterson, while aided by a research associate, will oversee and administer the study. IPC has the required facilities and equipment, including 4-wheel-drive vehicles, a jetboat, and a field house in the vicinity of the study area, for logistical support. Computer hardware and software, including a GIS, are available to conduct data analysis at Idaho State University.

Deliverables

A project progress summary will be prepared by the contractor after each completed field season, summarizing experimental design, field methods, and survey results, if applicable. A draft report of results should be available in December 1997. Another comprehensive draft report will be prepared by December 1998 if a second field season is required. A final report should be submitted by March 1999.

8.2.28.
Title: Effects of Reservoir Icing on Big Game Populations

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize this hydroproject's operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T8. Direct species impacts due to reservoir operational changes during the winter (i.e., winter loss of deer, elk, bighorn--that become stranded on winter ice (operational).

T9. Operational effects on both reservoir and downstream areas.

T23. Current impacts of project operations on wildlife habitat--altered migration routes.

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) Where and when does reservoir ice occur?
2) What are the effects of reservoir ice-up on big game mortality?

3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The overall goal is to minimize the negative impacts of the Hells Canyon Hydroelectric project operations that may be affecting wildlife resources in the Hells Canyon Study Area. This goal results from the FERC requirement that hydroproject license applications describe wildlife resources in the vicinity of the project and any impacts on those resources that may result (FERC 1990).

Abstract

The freezing patterns of reservoirs located in big game winter range can cause negative impacts to wildlife. The goal of this study is to elucidate potential negative impacts to big game populations due to mortality from reservoir icing. Therefore, information on reservoir hydrology, icing patterns, and rates of big game mortality due to icing will be described for Hells Canyon. This information will then be used to qualitatively assess the relative importance of big game losses due to reservoir icing and thus impacts to these populations. Options for appropriate mitigation for impacts due to project operations, and opportunities for resource protection and enhancement will be developed.

Introduction

Big game species are an ecologically and economically important component of the natural resources occurring in Hells Canyon. Despite this recognized importance, relatively little big game research has been conducted specifically in this area. Nine big game species occur in the Hells

Canyon area during all or portions of the year (USDA 1994). The reason that this large number of species, with its assorted life history strategies, is capable of inhabiting in Hells Canyon has been attributed to the diverse array of habitats provided by many distinct vegetation communities in the canyon and adjacent to the Snake River (USDE 1985). Additionally, these habitats (e.g., grass/forb, shrub/grass, riparian-woodland, conifer-stringer, rock cliff, and talus slope), are generally in close proximity to each other and water. This juxtaposition of habitats to water coupled with the extreme elevational gradient, results in the observed diversity of big game species (USDE 1985). This is especially evident during harsh winters, when large numbers of ungulates concentrate at lower elevations along the river and reservoirs in Hells Canyon.

When considering relicensing of hydroprojects, FERC requires that applicants provide descriptions of important wildlife resources occurring in the project area and identify negative impacts to these resources due to project operations (FERC 1990). Big game can be considered important under FERC regulations for their economic and recreation-oriented qualities (Connelly and Brown 1990). Also, obtaining reliable information specific to big game populations in Hells Canyon will be useful for identifying opportunities for resource protection, mitigation, and enhancement (Scott 1991, Unsworth 1991).

However, impacts of ongoing operations of the hydroelectric project on big game resources are difficult to assess due to the large number of species involved, and their widely varying habitat requirements. Directly assessing the influences of project operations on population dynamics is difficult because studies cannot be conducted under controlled conditions, limiting inferences that can be drawn. It is known, however, that big game populations can incur direct mortalities when individuals break through ice while attempting to cross frozen reservoirs. The extent to which this occurs and the net effect on population dynamics is currently unknown. Therefore, the goal of this study is to identify potential negative impacts to big game populations due to operation and maintenance of the hydroelectric complex in Hells Canyon. This includes specific objectives for investigating sources of mortality, specifically reservoir icing, that may significantly impact big game population dynamics.

State of Knowledge

Big game species comprise an important component of the biodiversity in Hells Canyon. Six species classified as big game commonly occur in Hells Canyon. These are:

1) Rocky Mountain mule deer (*Odocoileus hemionus*),
2) Rocky Mountain elk (*Cervus elaphus*),
3) mountain goat (*Oreamnos americanus*),
4) Rocky Mountain bighorn (*Ovis canadensis*),
5) black bear (*Ursus americana*), and
6) mountain lion (*Felis concolor*).

Three others also occur, but generally in small populations or as transients. These are:

1) white-tailed deer (*O. virginianus*),
2) shiras moose (*Alces alces*), and
3) pronghorn (*Antilocapra americana*).

The Hells Canyon Project consists of three dams and associated reservoirs. These reservoirs constitute the reservoir reach of the project and consist of Brownlee Dam and storage reservoir, Oxbow Dam and run-of-river reservoir, and Hells Canyon Dam and run-of-river reservoir. Also, water conditions of the unimpounded section of the Snake River below Hells Canyon Dam, termed the river reach, are directly affected by dam operations in the complex. Currently, information on reservoir and river water level fluctuations for the Hells Canyon Complex is being compiled by IPC. No information is currently available describing icing patterns nor influences of operations on reservoir icing.

Freezing patterns of reservoirs located in big game winter range can cause negative impacts to wildlife. Several authors report big game mortality when animals broke through ice on other reservoirs (Skogland and Molmen 1980, Bedrossian *et al.* 1984, USDI 1985, IDFG 1986). At Palisades Reservoir in Idaho, about ten elk (*Cervus elaphus*) per year die by breaking through ice. IDFG (1986) stated that about six mule deer died annually from falling through ice while crossing Anderson Ranch Reservoir. No data are currently available documenting the significance of this source of mortality to big game populations in Hells Canyon. However, it is anticipated that mule deer encounter the reservoir enough to potentially experience mortality. Elk and bighorn may encounter reservoir icing to a lesser extent.

Methods

Study Area

The study area will consist of the surfaces of the three reservoirs comprising the Hells Canyon Project. However, effort will concentrate on Brownlee Reservoir, where icing probably occurs most frequently.

Study Design

An extensive review of available information and relevant literature will be conducted prior to the final study design and implementation of methods. This review will allow refinement of study design and methods, facilitate identification of gaps in the current information base, and help modify specific study objectives so as to increase efficiency in filling information gaps. Also, as part of the information review, subject experts and resources agency representatives will be contacted and consulted as necessary. Therefore, final development of the design, objectives, and methodologies will be completed as part of this study. Generally, however, information on reservoir hydrology, icing patterns, and rates of big game mortality due to icing will be described. The influence of hydroproject operations on ice formation will also be investigated (e.g., using modeling). This information will then be used to qualitatively assess the relative importance of big game losses due to reservoir icing and thus impacts to these populations.

Field Methods

The Hells Canyon reservoirs will be surveyed during three winters to establish temporal and spatial patterns of icing. During these surveys, observations of big game (alive and dead) on, near, or in the reservoir ice will be documented.

Analyses

The temporal and spatial distributions of reservoir ice will be described using graphical GIS mapping. The feasibility of modeling and predicting icing conditions under various operation scenarios and environmental conditions will also be assessed. Numbers and relative proportions of big game species dying in the ice will also be calculated. The relative importance of mortality due to reservoir icing for big game populations will then be assessed.

Link to Protection, Mitigation, and Enhancement Measures

Analyses of the relative importance of icing mortality to big game population dynamics will be used to develop recommendations for operation and maintenance of the project. Also, options for appropriate mitigation for ongoing impacts, if identified, and opportunities for resource enhancement will be developed.

Timetable

The study will be initiated in winter 1998 and require three years for completion. Field work will be completed during winter 2000. A draft report will be prepared by November 2000, with the final report submitted by January 2001.

Cooperation

Geologic, hydrologic, and landscape field data may be collected jointly during this study with other wildlife and botanical studies. Information on landscape characteristics in the study area will mostly be collected during botanical investigations. Geologic and hydrologic data will be collected in connection with all related wildlife and botanical flow fluctuation studies. Accordingly, flow fluctuation and related icing modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Principal investigators will be Dr. Toni Holthuijzen and Frank Edelmann. Dr. Holthuijzen holds a Ph.D. in wildlife biology; Mr. Edelmann has a Master's Degree in Wildlife Resources. Dr. Holthuijzen has 20 years experience designing and implementing wildlife and plant ecology studies; 13 of these years were spent in southern Idaho. Dr. Holthuijzen and Mr. Edelmann will be assisted by a wildlife technician.

Deliverables

A draft report will be prepared by November 2000 and the final report by January 2001.

8.2.29.
Title: Effects of Road and Transmission Line Corridors on Wildlife Habitat

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T7. Terrestrial species habitat impacts in unit/acres by habitat type (both sides of river, all known species).

T13. Changes in quality of upland and riparian habitat on land currently or formerly under IPC control.

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (rights of way).

T23. Current impacts of project operations on wildlife habitat, i.e., altered migration routes.

T27. Wildlife habitat fragmentation caused by project construction and operation.

T32. Public access/recreational versus impact of new roads, public, wildlife species, terrestrial habitat, winter ranges, etc., people use in former, wildlife habitat.

T33. IPC land management practices' effects on terrestrial resources.

T40. Livestock grazing impacts in relation to current management plans.

T43. Secondary terrestrial species impacts associated with construction/maintenance of power line corridors.

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What habitats are fragmented by transmission line corridors, reservoirs, altered river flows, roads, or other project facilities?
2) What are the effects of habitat fragmentation caused by transmission line corridors, reservoirs, altered river flows, roads, or other project facilities on wildlife migration or movement patterns?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Maintenance

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural, wildlife, botanical and soil resources.

1) What are the cultural, wildlife, botanical and soils resources associated with roadways and other facilities in the study area?
2) What are the effects of roadways and other facility maintenance on cultural, wildlife, botanical and soil resources?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Present power line locations and operations including associated facilities may affect wildlife and botanical resources.

1) What are the effects, including secondary effects, of power line location and operation (including associated facilities) on wildlife and botanical resources?
2) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The overall goal is to minimize the negative impacts of the Hells Canyon Project's operations and maintenance activities on wildlife resources in the Hells Canyon Study Area. This goal results from the FERC requirement that hydroproject license applications describe wildlife resources, identify operational impacts to these resources that may result, and provide measures for resource protection, mitigation, and enhancement (FERC 1990).

Abstract

This study is proposed to determine existing and future wildlife habitat conditions associated with roads and transmission line corridors in the Hells Canyon Study Area. Information on vegetation and wildlife resources will be used to describe baseline habitat conditions in the study area. This information will then be used to model vegetation changes through time under various scenarios representing potential project operations and maintenance activities. Quantity and quality of wildlife habitat will be evaluated under current and alternative scenarios. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Analyses will lead to recommendations for maintenance and operations of roads and transmission line right-of-ways,

and appropriate mitigation, protection and enhancement measures to help attain desired future resource goals.

Introduction

Corridors (i.e., roads and transmission line right-of-ways) can have a variety of effects on wildlife populations (Andrews 1990) including:

1) habitat loss and modification,
2) extension of edge effects into natural areas,
3) barrier effect,
4) disturbance effect,
5) direct killing of animals, and
6) providing human access.

It is difficult to assess impacts of roads on wildlife resources due to the large number of species involved, and their widely varying habitat requirements. Additionally, directly assessing the influences of roads and their use on wildlife population dynamics is difficult because studies cannot be conducted under controlled conditions in Hells Canyon, which limits the inferences that can be drawn. Rather than addressing impacts to wildlife populations and their dynamics, impacts can be indirectly assessed through influences to habitat in relation to project facilities, operations, and maintenance.

Quantitative evaluation of habitat for wildlife has emerged as an important component of resource assessment (Hobbs and Hanley 1990), because natural resource managers are increasingly expected to predict the consequences of management activities on wildlife species (Verner *et al.* 1986). Central to habitat evaluation are models defining the functional relationships between species and their habitats (Krohn and Salwasser 1982, Hobbs and Hanley 1990). Species-habitat relationship models have been developed to assess changes in habitat quality and quantity that may occur as a result of resource development or habitat management actions.

Biologists have traditionally used knowledge of animal life history attributes to model animal ecology. A common approach is to model animal habitat by linking known habitat use patterns with maps of existing vegetation, thereby identifying the spatial extent of important habitat features for use in conservation and management. These kinds of models transcend a variety of different scales and purposes, from species-specific Habitat Suitability Index (HSI) models, multiple-species wildlife-habitat matrices, to spatially explicit descriptions of animal distributions for conservation planning (Edwards *et al.* 1995). Kinds and use of different modeling approaches are outlined in texts by Verner *et al.* (1986), Morrison *et al.* (1992), and Anderson and Gutzwiller (1994).

Evaluating habitat has several advantages over conducting detailed population analyses that are often required for impact analyses. First, habitat is stationary and therefore relatively easy to quantify. Second, although many factors affect survival and reproduction of individuals in a population, all wildlife populations are ultimately dependent on habitat for existence. Finally, empirical data can be augmented with fundamental principals of wildlife ecology (e.g., foraging theory, intra-specific competition, habitat selection, and predator avoidance) to allow formulation of functional relationships that exist between a species' habitat and population parameters (Morrison *et al.* 1992). Hence, these models can be used to quantify species-specific habitat conditions as they may change through time, or predicted to change through time, based on natural and unnatural processes or perturbations, including combinations of these.

Species-habitat relationship models can also be used in combination with vegetation models (e.g., succession models) to evaluate habitat conditions in some predicted landscape at points through time. Vegetation succession models can be constructed to predict future vegetation/habitat patterns based on various scenarios of management actions or perturbations in a landscape. Actions can include various operations and maintenance activities associated with managing these corridors.

Integrating species-habitat relationship models with predictive vegetation models provides an opportunity to evaluate potential habitat conditions under various corridor management scenarios and contributions of individual components (i.e., line patrolling, road maintenance, etc.) to those scenarios and the resulting landscape. This approach could allow:

1) quantitative evaluation of competing strategies for managing operations and maintenance of the Hells Canyon Project,
2) identification of influences of operation strategies and individual corridor management activities on wildlife resources,
3) determination of the best balanced landscape to reach desired future goals for the numerous resources to be considered, and
4) development of a management plan (including project operations, protection, mitigation, and enhancement measures) that may achieve the desired resource goals for Hells Canyon.

Therefore, this study is proposed to identify corridor management options and protection, mitigation, and enhancement measures needed to achieve the desired wildlife habitat goals, based on a balancing of resource values, for Hells Canyon. Specific objectives will be to:

1) describe the wildlife resources occurring in Hells Canyon;
2) characterize the transmission line and road corridors in the study area;
3) describe project facilities, and operation and maintenance influences on habitat;
4) determine desired future wildlife, habitat, and landscape goals for the Hells Canyon Study Area;

5) select wildlife evaluation species;
6) determine habitat values for current baseline conditions;
7) determine and model future operation and maintenance scenarios;
8) determine habitat values for predicted future conditions and estimate changes in values;
9) identify the scenario that is most likely to meet desired future resource goals;
10) assess influences of project operations on wildlife resources and the desired future resource goals; and
11) develop suggestions for future project operations and protection, enhancement, and mitigation measures that will most likely lead to the desired future resource conditions and goals.

A primary and overriding objective of this study is to determine the efficacy and feasibility of this proposed approach to habitat evaluation. Issues of wildlife avoidance of habitat (i.e., behavioral responses) due to the presence of roads and transmission lines, and/or increased vulnerability to mortality factors due to roads will not be addressed in this study.

State of Knowledge

Several hundred miles of transmission lines are associated with the Hells Canyon Project. Many of these transmission lines, licensed as part of the project facilities, will require relicensing with the FERC. The new license application will require:

1) a detailed characterization of wildlife resources occurring in the study area (e.g., transmission line corridors),
2) evaluation of impacts imposed on resources due to project operations, and
3) development of mitigative and enhancement measures for impacts (FERC 1990).

Currently, little is known about the natural resources that occur under, along, or near these transmission lines. Information on line location, habitat, and wildlife occurrences is needed and is currently being compiled.

A vegetation cover type map for the study area is also being developed by IPC. This map will be used as the baseline data describing the current availability and distribution of vegetation types in the study area. Further, structural and community characteristics of cover types are currently being characterized by IPC. Additionally, vegetation cover type maps developed for the GAP analysis in Idaho and Oregon will be available in 1997. These maps will be derived from remote sensing data (thematic data) and will be directly imported into IPC's GIS. These maps and associated species models will be useful for assessing the potential impacts of right-of-way corridors on wildlife species (e.g., Jennings 1995, Scott *et al.* 1993).

Methods

Study Area

The Hells Canyon Project consists of three dams and associated reservoirs. These are:

1) Brownlee Dam (RM 284.6) and storage reservoir,
2) Oxbow Dam (RM 272.2) and run-of-river reservoir, and
3) Hells Canyon Dam (RM 247.0) and run-of-river reservoir.

Although hydropower facilities associated with the Hells Canyon Complex occur entirely within Hells Canyon, areas influenced by the project reservoirs (namely Brownlee) extend south of Hells Canyon to (approximately) Weiser, Idaho, and west up the Powder River in Oregon. The hydrologic influence of the Hells Canyon Project directly related to hydropower operations is believed to be minor downriver from the confluence of the Snake and Salmon Rivers (RM 188.2). Therefore, the northern extent of the project area is defined by this river confluence.

Also, several hundred miles of transmission lines are associated with the Hells Canyon Project, and extend beyond Hells Canyon. Roads are defined as areas cleared for vehicles, whether dirt or paved. Only those roads created as part of the operation and maintenance of the Hells Canyon Project will be considered in this study. This includes roads used for the operation and maintenance of associated transmission lines.

Study Design

An extensive review of available information and relevant literature will be conducted prior to the final study design and implementation of methods. This review will allow refinement of study design and methods, facilitate identification of gaps in the current information base, and help modify specific study objectives so as to increase efficiency in filling information gaps. Also, as part of the information review, subject experts and resources agency representatives will be contacted and consulted as necessary. Therefore, final development of the design, objectives, and methodologies will be completed as part of this study. Generally, however, information on project operation and maintenance, corridor location, vegetation, and wildlife species in the study area will be described to establish baseline conditions. This information will then be used to model vegetation changes through time under various scenarios representing potential corridor operation and maintenance activities. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Quantity and quality of wildlife habitat will be evaluated under baseline conditions and alternative scenarios.

Field Methods

Field work will be required for characterizing vegetation in right-of-way corridors, and is currently being conducted by IPC as part of FERC relicensing requirements. The study area will be mapped by cover type, based on the 26 vegetation, natural feature, and land use cover types used by IPC's earlier relicensing studies. The map will be developed through standard photo-interpretation techniques using July/August 1993 1:15,000-scale color infrared aerial photos.

The objective of field sampling will be to collect data on the existing conditions of each vegetation cover type. The approach will be similar to the "subjective without preconceived bias" concept of Müller-Dombois and Ellenberg (1974). That is, placement of sample sites within cover types will be done without any assumption of eventual classification or apparent condition, but rather for the representation of homogeneous vegetation. Obvious ecotones, microsites, exceptionally dense clumps or openings, or areas of recent severe disturbance will be avoided. Sample locations will be selected using a stratified-random method. Detailed data on species composition, cover, woody species density and height, and vegetation structure will be collected using standard sampling techniques. Field collection of vegetation data is ongoing and expected to be completed in 1998. However, additional field work may be required to gather site specific information necessary for constructing and parameterizing any vegetation modeling efforts.

Analyses

Consultation

A private consultant will be solicited and selected to conduct data analyses. Thereafter, a detailed study plan describing analyses will be generated by the selected contractor. However, a team, comprising representatives from interested resource agencies, non-governmental organizations, and IPC staff, will be involved in all phases of this study.

Transmission Line and Road Corridors

Preliminary descriptions of road and transmission line right-of-way corridors are necessary for identifying, developing, and preparing resource assessments required as part of the FERC relicensing effort for the Hells Canyon Project. Therefore, specific objectives of this study are to:

1) identify the transmission line and road corridors associated with the Hells Canyon Project,
2) digitally map the locations of these corridors,
3) map boundaries of cover types in rights-of-way, and
4) visually reconnoiter these corridors for wildlife species and habitats that may be of special concern.

Existing information on the corridors associated with the Hells Canyon Project will be requested from IPC's Transmission and Distribution, and Right-of-Way Departments. Information about roads will include:

1) patrol maps,
2) easements,

3) road ownership,
4) river crossings, and
5) access points.

Many of the roads are associated with transmission lines and are located within the transmission line rights-of-way. Technical information requested for each transmission line will include:

1) length,
2) tower/pole construction,
3) voltage,
4) amperage,
5) conductor, and
6) insulator.

Information about line locations and routes will include:

1) patrol maps,
2) easements,
3) line ownership,
4) river crossings, and
5) access roads.

Analyses will consist of summarizing both existing information and that obtained during reconnaissance surveys. Also, digital data on locations of the corridors will be prepared for GIS mapping. This data will be used for study area and cover type mapping during subsequent resource studies for Hells Canyon.

Vegetation Description

The cover types and plant communities occurring in the study area will be quantified and described. The cover type map will be analyzed to describe the extent, representation, and distribution of cover types in the corridors. Species composition, cover, woody species density and height, and vegetation structure will be summarized to describe the different cover types and plant communities occurring in each cover type.

Vegetation Modeling

Existing conditions will be used as a basis of comparison with simulated potential maintenance scenarios. Future conditions will be predicted based on expected changes in vegetation conditions simulated over a period of years and through various successional pathways. The time frame for simulations will be based on the expected duration of the project license plus the period between the present and the date of current license expiration. A period of 30 to 50 years probably will be reasonable. Future vegetation conditions will be determined using vegetation models constructed with botanical, corridor, and operation and maintenance information currently being collected by IPC.

Using these models, changes in vegetation cover types can be evaluated at various time intervals (e.g., short-term perturbations and long-term changes). Future scenarios of project operations will be developed in cooperation between IPC and interested resource agencies and non-governmental organizations. Output from the vegetation models will be spatially explicit and displayed as scenario cover type maps with a GIS.

Wildlife Habitat Modeling

Once the baseline vegetation description has been established and future vegetation conditions have been simulated through the vegetation modeling procedures, influences on wildlife species will be evaluated indirectly using appropriate species-habitat relationship models. Evaluation species and habitat models used will be restricted to those currently available. The focus of this analysis will be on overall habitat conditions rather than specific influences to individual wildlife evaluation species. Evaluation species' variables will be used as a tool to measure habitat condition and value. Current and future habitat values will be calculated for each selected evaluation species and each future corridor operation and maintenance scenario.

Link to Protection, Mitigation, and Enhancement Measures

Analyses of future conditions may lead to recommendations for use and maintenance of roads associated with project facilities. Also, options for appropriate mitigation for ongoing impacts, if identified, and opportunities for resource protection and enhancement will be explored.

Timetable

The study will be initiated in early 1998 and require two years for completion. Field work for developing the vegetation simulation models will be completed during 1998. A draft report will be prepared by November 1999, with the final report submitted by January 2000.

Cooperation

Vegetative and landscape field data may be collected jointly during this study with other wildlife studies and botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Vegetation and disturbance modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,

4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

A consultant with expertise in vegetation ecology, vegetation modeling, sampling techniques, and a strong background in quantitative analysis and GIS applications will be contracted to conduct this study. A single consultant will be selected. This consultant may utilize services of other subcontractors to perform elements of the work. IPC's principal investigator will develop an RFP to solicit bids from interested consultants and administer contracts. Interested agencies and groups will assist in developing the RFP.

Deliverables

A draft report will be prepared by November 1999 and the final report by January 2000.

8.2.30.
Title: Effects of Roads and Transmission Line Corridors on Wildlife Habitat: Threatened and Endangered Species and Species of Special Concern.

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T13. Changes in quality of upland and riparian habitat on land currently or formerly under IPC control.

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (rights of way).

T27. Wildlife habitat fragmentation caused by project construction and operation.

T32. Public access/recreational versus impact of new roads, public, wildlife species, terrestrial habitat, winter ranges, etc., people use in former, wildlife habitat.

T33. IPC land management practices' effects on terrestrial resources.

T40. Livestock grazing impacts in relation to current management plans.

Problem Statements and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife and botanical resources.

1) What habitats are fragmented by transmission line corridors, reservoirs, or other project facilities?
2) What are the effects of habitat fragmentation caused by transmission line corridors, reservoirs, or other project facilities on wildlife migration or movement patterns?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Maintenance

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural, wildlife, botanical and soil resources.

1) What are the cultural, wildlife, botanical and soils resources associated with roadways and other facilities in the study area?
2) What are the effects of roadways and other facility maintenance on cultural, wildlife, botanical and soil resources?
3) How are the results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize the impacts of corridors on fragmentation of habitat used by *threatened* and *endangered* species, and *species of special concern*. FERC requires that license applications describe wildlife resources, including *threatened, endangered*, and *sensitive* species in the vicinity of the project and the impact of the project on those resources (FERC 1990). Species-specific management goals are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Abstract

This study is proposed to evaluate the impact of roads and transmission line corridors (hereafter referred to as "corridors") on *threatened* and *endangered* species and *species of special concern*. Human activities have fragmented natural systems into fewer and smaller pieces and at an accelerated pace. Information on structure, function, and change of landscape elements in the study area is not available. Likewise, information on *threatened* and *endangered* species and *species of special concern* resources utilizing corridors is sparse. Therefore, to conduct future assessments of resources related to corridors, preliminary information of location of corridors, habitat, and presence of *species of special concern* is essential. The general goal is to minimize the impacts of corridors on habitat used by *threatened* and *endangered* species, and *species of special concern*. A review of available information and relevant literature will be conducted prior to the final study design and implementation of methods. Also, as part of the information review, subject experts and resource agency representatives will be contacted and consulted as necessary. Baseline conditions will be used to model habitat changes through time under various maintenance activity scenarios and plant successional pathways. The degree to which wildlife habitat in corridors is impacted will then be evaluated under current and alternative scenarios. Potential scenarios will be developed in cooperation with resource agencies and other interested parties.

Introduction

Threatened and *endangered* species and federal *candidate* species are protected by the Endangered Species Act. State *species of special concern* receive protection under state conservation laws (**Idaho Code** 36-103, 36-201, and the State of Oregon Endangered Species Act; CDC 1994, ONHP 1995). Information about these species is important for developing appropriate management strategies to avoid future listing of these species. Information on *threatened* and *endangered* species also must be provided in the Hells Canyon Project license application. Further, resource agencies often request baseline data (i.e., distribution and numbers) and information about federal *candidate* species and *species of special concern* for planning purposes.

A large number of *species of special concern* are likely, or known, to occur in the study area and potentially the right-of-way corridors. Apparently, the Hells Canyon reach provides environmental conditions suitable to the life requisites of rare species. Thus, the study area appears to be important for a variety of rare species (at least at the regional level and at the national level for other species). However, road and transmission line corridors can have a variety of effects on wildlife populations (Andrews 1990). These can include:

1) habitat loss and modification,
2) extension of edge effects into natural areas,
3) barrier effect,
4) disturbance effect,
5) directly killing animals, and
6) providing human access.

Populations of many organisms exist as subpopulations that are linked by dispersal (Harris 1984). The viability of a subpopulation is strongly influenced by habitat size and shape, which in turn affects dispersal patterns (Donovan *et al.* 1995). Habitat fragmentation, potentially due to road and transmission line corridors, can alter the spatial configuration of habitats, leading to population subdivision and the creation of a metapopulation structure, which can affect population stability or persistence (Gilpin and Hanski 1991). Fragmentation of a landscape produces a series of remnant vegetation patches surrounded by a matrix of different vegetation and/or land use (Saunders *et al.* 1991). All landscape fragments are exposed to physical and biographic changes to a greater or lesser degree, but their effects are modified by the size, shape, and position in the landscape (Saunders *et al.* 1991). Another important aspect of a landscape fragment is its degree of isolation, or conversely, its connectivity to adjacent areas. Connectivity is important for the demographic dynamics of a metapopulation (Merriam 1984).

Human activities have fragmented natural systems into fewer and smaller pieces and at an accelerating pace. Smaller patch size of available habitat increases the distance between patches, the amount of edge compared to interior, and landscape diversity. Species differ in their sensitivity to such changes. Generally, habitat fragmentation is detrimental to many species and may contribute substantially to the loss of regional and global diversity (Harris 1984, Saunders *et al.* 1991). Also, it has become clear that habitat variation and its effect on ecological processes and vertebrate populations occur at many spatial scales (Wiens 1989a,b). This makes the evaluation of landscape structure and function a difficult task, because it is scale-dependent (McGarigal and Marks 1995).

Information on structure, function, and change of landscape elements in corridors associated with Hells Canyon is currently not available. Likewise, information on wildlife species utilizing habitat fragments in the study reach is sparse. Therefore, the overall structural condition of the landscape, and those resources occupying that landscape, cannot be effectively assessed at this date. For most species, the impact of the operation of the project cannot be evaluated because baseline data are limited. In many cases, basic habitat requirements are not well known. Species of special concern associated with Hells Canyon should be carefully evaluated because they may be *sensitive* to habitat changes potentially influenced by the operation of the Project.

Hence, the objectives of this study will be to:

1) characterize transmission line and road rights-of-way (including maintenance activities associated with these corridors),
2) assess habitat conditions,
3) assess the use of corridors by *threatened* and *endangered* species and *species of special concern*,
4) identify influences of road and transmission line maintenance activities to habitat conditions, and
5) develop appropriate protection, mitigation, and enhancement measures to reach desired resource goals.

State of Knowledge

Threatened and Endangered Species

Bald Eagle

Historic and present distribution of the bald eagle (*Haliaeetus leucocephalus*) are essentially the same. However, numbers of eagles in the continental U.S. have decreased dramatically in the last 200 years. In response to this decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous states and *threatened* in the remaining states, including Oregon. Bald eagles historically nested along the

Snake River in the Hells Canyon Study Area. One pair reportedly nested at the mouth of Two Creeks in the early 1900s (Taylor 1989). At least five other sites have been reported as historically used by bald eagles (Isaacs *et al.* 1989).

Currently, seven existing and suspected bald eagle nest sites occur in the vicinity of the Hells Canyon Study Area (Isaacs *et al.* 1989). Existing nests occur at Unity Reservoir, Phillips Reservoir, and Wallowa Lake. Nests, suspected to have been built by bald eagles, were reported at the Grande Ronde, Wallowa, and Lostine Rivers, and at Eagle Island Creek. The Unity Reservoir bald eagle pair has produced young for several years prior to 1989 (Isaacs *et al.* 1989). Substantial numbers of bald eagles winter in Wallowa, Union, and Baker Counties.

Concern about the potential impacts of habitat alteration and other human activities on the species, and the need to identify important winter areas, resulted in a study on wintering bald eagles in northeastern Oregon from 1988 to 1991 (Isaacs *et al.* 1989, 1990). Twenty-seven night roosts were located and an additional 27 were suspected. Exceptional roost counts were at two bald eagle roosts along IPC reservoirs, specifically, 55 at Eagle Island Creek and 100 at Soda Creek.

Considerable amount of information is available on the impact of disturbance by human activities to wintering and nesting bald eagles (Buehler *et al.* 1991, McGarigal *et al.* 1991, Grubb *et al.* 1992, Chandler *et al.* 1995).

Peregrine Falcon

The peregrine falcon (*Falco peregrinus*) nested on the cliffs and bluffs above the Snake River prior to 1950. Since 1987, the Peregrine Fund, IDFG, ODFW, and the USFS have cooperatively released approximately 62 peregrine falcons at three locations in or adjacent to the Hells Canyon Recreation Area. Monitoring of these birds has been limited to proposed project surveys and incidental reports of observations from hack-site attendants.

A survey of known and potential nesting sites of peregrine falcons was conducted in 1996 below Hells Canyon Dam. One active nest site was located that was successful (Akenson 1996). Another active nest site was found at the mouth of Steamboat Gulch, along the Hells Canyon Reservoir Reach (IPC unpubl. data).

Limited information is available on the effect of human activities on nesting peregrine falcons (e.g., Ellis 1981, Ritchie 1987), not necessarily directly related to activities on corridors. Human activities may flush incubating adults from nests resulting in loss of eggs or small chicks (Platt 1977, Harmata *et al.* 1978, Rosenaeu *et al.* 1981), and nest abandonment (Grier *et al.* 1977, 1978).

Species of Special Concern

Fifty-five species known or suspected to occur in the project area were listed by the state or federal agencies either in Oregon or Idaho as *species of special concern* (former federal *candidate* species, state *species of special concern*, or *sensitive* species). The largest taxon with listed species was birds (37 species), followed by mammals (16 species), amphibians (1 species), and reptiles (1 species). The following groups of species are included: herptiles (spotted frog, tailed frog, sagebrush lizard, tiger salamander, western toad, leopard frog, Mojave black-collared lizard, ringneck snake, longnose snake, and ground snake), diurnal birds of prey (ferruginous hawks, Swainson's hawk, northern goshawk, and merlin), owls (great gray owl, burrowing owl, boreal owl, northern saw-whet owl, flammulated owl, and northern pygmy owl), gallinaceous birds (sage grouse, Columbian sharp-tailed grouse, spruce grouse, and mountain quail), waterfowl (harlequin duck), shorebirds (long-billed curlew, and upland sandpiper), perching birds (loggerhead shrike, rosy finch, bank swallow, yellow-billed cuckoo, black-throated sparrow, grasshopper sparrow), woodpeckers (pileated woodpecker, white-headed woodpecker, three-toed woodpecker, and Lewis' woodpecker), bats (spotted bat, western big-eared bat, pallid bat, long-eared myotis, long-legged myotis, Yuma myotis, and silver-haired bat), lagomorphs (pygmy rabbit), insectivores (Preble's shrew), rodents (Idaho ground squirrel), and carnivores (wolverine, fisher, lynx, and kit fox).

General information on the relative abundance of vertebrates in the Blue Mountains Province in Oregon can be found in Marshall (1986) and Thomas (1979). Distribution of avian species by county in Idaho can be found in Stephens and Sturts (1991).

Habitat loss related to human activities is likely to be the main impact to *species of special concern*. For more detailed information about most of these species, reference is made to Marshall (1986) and Thomas (1979). Thomas (1979) provides a detailed descriptions of the habitat requirements of most of the above-mentioned species.

Methods

Study Area

The Hells Canyon Project consists of three dams and associated reservoirs: Brownlee Dam (RM 284.6) and storage reservoir, Oxbow Dam (RM 272.2) and run-of-river reservoir, and Hells Canyon Dam (RM 247.0) and run-of-river reservoir. Although generation facilities associated with the Hells Canyon Project occur entirely within Hells Canyon, areas influenced by the project reservoirs (namely Brownlee) extend south of Hells Canyon to (approximately) Weiser, Idaho, and west up the Powder River in Oregon. The hydrologic influence of the Hells Canyon Project directly related to operations is believed to be minor downriver from the confluence of the Snake and Salmon Rivers (RM 188.2). Therefore, the northern extent of the project area is defined by this river confluence.

Corridors are defined as areas cleared for vehicles, whether dirt or paved. Only those corridors are considered in this study that are directly created as part of the operation and maintenance of the Hells Canyon Project. This includes corridors that are used for the operation and maintenance of transmission lines. Several hundred miles of transmission lines and roads are associated with the Hells Canyon Project.

Study Design

A review of available information and relevant literature will be conducted prior to the final study design and implementation of methods investigating *threatened* and *endangered* species and *species of special concern*. This review will allow refinement of study design and methods, facilitate identification of gaps in the current information base, and help modify specific study objectives to increase efficiency in filling information gaps. Also, as part of the information review, subject experts and resources agency representatives may be contacted and consulted as necessary. Therefore, final development of the study design, objectives, and methodologies will be completed as part of this study. Generally, however, information on corridors, vegetation, *threatened* and *endangered* species and *species of special concern* in the study area will be described to establish baseline conditions. This information will then be used to model habitat changes through time under various maintenance activity scenarios and plant successional pathways. The degree to which *sensitive* species are impacted due to project operations will then be evaluated under current and alternative scenarios. Potential scenarios will be developed in cooperation with resource agencies and other interested parties.

Field Methods

Threatened and Endangered Species and Species of Special Concern

Information on bald eagles, peregrine falcons, and *species of special concern* will be summarized for the corridors and surrounding area. Surveys of the corridors and information requested from agencies and Natural Heritage Programs in both Idaho and Oregon will be merged with the baseline data on *threatened* and *endangered* species and *species of special concern*. Also, a vegetation cover type map for the study will be developed based on the GAP analyses maps for Idaho and Oregon. These data will be available in 1997. These maps will facilitate predictions about the presence of the species of interest in the study area.

Road and Transmission Line Corridors

Preliminary descriptions of road and transmission line right-of-way corridors are necessary for identifying, developing, and preparing resource assessments required as part of the FERC relicensing. Therefore, specific objectives of this study are to:

1) identify the transmission line and road corridors associated with the Hells Canyon Project,
2) digitally map the locations of these corridors,
3) map boundaries of cover types in rights-of-way, and
4) visually reconnoiter these corridors for wildlife species and habitats that may be of special concern.

Existing information on the corridors associated with the Hells Canyon Project will be requested from IPC's Transmission and Distribution, and Right-of-Way Departments. Information about roads will include:

1) patrol maps,
2) easements,
3) road ownership,
4) river crossings, and
5) access points.

Many of the roads are associated with transmission lines and are located within the transmission line rights of way. Technical information requested for each transmission line will include:

1) length,
2) tower/pole construction,
3) voltage,
4) amperage,
5) conductor, and
6) Insulator.

Information about line locations and routes will include:

1) patrol maps,
2) easements,
3) line ownership,
4) river crossings, and
5) access roads.

Vegetation Description

The vegetation cover type map developed for the Idaho and Oregon GAP analyses will be used to describe the surrounding vegetation of right-of-way corridors. Other sources of information also will be explored. Field work may be required to gather physical descriptions of the corridors and associated vegetation types. This information will be necessary to construct and establish parameters for the vegetation simulation models discussed below.

Efforts to map the corridors will capitalize on routine line patrols. A GPS will be used to digitally map corridors. While mapping the corridors, visual delineation of cover type boundaries will also be recorded referencing GPS positions. Observations of *threatened* and *endangered* species and *species of special concern* resources and habitats will be noted.

Vegetation Modeling

Vegetation simulation models will be developed to evaluate current influences of rights-of-way on habitats of *species of special concern,* and to predict future influences under other potential corridor operation and maintenance scenarios. Existing conditions will be used as a basis of comparison with simulated potential maintenance scenarios. Future conditions will be based on predicted changes in vegetation condition simulated over a period of years and through various successional pathways. The time frame for simulations will be based on the expected duration of the project license plus the period between the present and the date of license expiration. A period of 30 to 50 years probably will be reasonable. Future vegetation conditions will be determined using vegetation models constructed with botanical and right-of-way information currently being collected by IPC.

Using these models, changes in vegetation cover types will be evaluated at various intervals (e.g., short-term perturbations and long-term changes). Future scenarios of project operations will be developed in cooperation between IPC and interested resource agencies and non-governmental organizations. Output from the vegetation models will be spatially explicit and displayed as scenario cover type maps using GIS. Underlying this study is an assessment of the feasibility of developing these simulation and prediction models.

Threatened and Endangered Species and Species of Special Concern Habitat Modeling

Once the baseline vegetation description has been established and future habitat conditions have been simulated through the vegetation modeling procedures, influences on *species of special concern* in rights-of-way corridors will be evaluated indirectly using appropriate species-habitat relationship models if such models are available. If not, an attempt will be made to use species that are considered to have similar habitat requirements as groups of *sensitive* species will be used (e.g., an indicator species for perching birds or woodpeckers). Evaluation species and habitat models used will be restricted to those currently available.

Specific information on the distribution, numbers, and nesting sites of bald eagles and peregrine falcons will be used to evaluate any potential impacts of corridors to these species. All distributional data will be entered into IPC's GIS for analysis.

Analyses

Analyses will consist of summarizing both existing information and data obtained during reconnaissance surveys. Also, digital data on locations of the corridors will be prepared for GIS mapping.

Consultation

A private consultant will be solicited and selected to conduct data analyses. Thereafter, a detailed study plan describing analyses will be generated by the selected contractor. However, a team, comprising representatives from interested resource agencies, non-governmental organizations, and IPC staff, will be involved in all phases of this study.

Link to Protection, Mitigation, and Enhancement Measures

Analyses of future conditions may lead to recommendations for maintenance of rights-of-way and associated project facilities. Also, options for appropriate mitigation for ongoing impacts, if identified, and opportunities for resource protection and enhancement will be explored.

Timetable

Studies will be initiated in 1998 and completed in 2000.

Cooperation

Vegetative and landscape field data may be collected jointly during this study with other wildlife and botanical studies. Information on vegetative and landscape characteristics in the study area will mostly be collected during botanical investigations. Accordingly, vegetation and disturbance modeling will also be coordinated among related studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,

2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

A consultant with expertise in vegetation ecology, vegetation modeling, sampling techniques, and a strong background in quantitative analysis and GIS applications will be contracted to conduct this study. A single consultant will be selected. This consultant may utilize services of other subcontractors to perform elements of the work. IPC's principal investigator will develop an RFP to solicit bids from interested consultants and administer contracts. Interested agencies and groups will assist in developing the RFP.

Deliverables

A draft report of results will be prepared in March 1999. A final report will be completed in June 2000.

8.2.31.
Title: Effects of Human Recreational Activities on Nesting Peregrine Falcons in the Hells Canyon Study Area

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T32. Public access/recreational versus impact of new roads, public, wildlife species, terrestrial habitat, winter ranges, etc.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

Problem Statements and Study Questions

Operational

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of human presence related to operational activities on cultural, wildlife, and botanical resources?
2) What are the effects of recreational human presence on cultural, wildlife and botanical resources?

3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize the impacts of human activities on nesting peregrine falcons in the Hells Canyon Study Area. FERC requires that license applications describe wildlife resources, including *threatened* and *endangered* species, in the vicinity of the project and evaluate the impact of the project on those resources (FERC 1990). Specific management goals for *threatened* and *endangered* species are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991). Specific management goals for the peregrine falcon (*Falco peregrinus*) are found in two recovery plans (USDI 1984, USDA 1990).

Abstract

The purpose of this study is to evaluate the impact of human recreational activities on nesting peregrine falcons in the Hells Canyon Study Area. Human activities can affect both raptor behavior and breeding success. Increased recreational pressure along the Snake River corridor may impact nesting peregrine falcons. However, the status of nesting peregrine falcons in this and other areas of high-intensity recreational use has not been effectively assessed to date. The general goal of this study is to identify and minimize the impacts of human activities on nesting peregrine falcons. All suitable and known nest site locations will be assessed using historic information about nesting peregrine falcons in the study area. This information will be requested from federal and state agencies. Recreational activities in the vicinity of occupied nest sites will be evaluated using

any information that can be obtained from state and federal agencies, as well as data collected by IPC (e.g., number of floating permits, number of people per party, use of campgrounds). This information will be incorporated into the GIS for analysis. Statistical analyses will be performed relating various characteristics of human recreational activities (e.g., number of people, time of day and year, recreational activity involved) and landscape characteristics (e.g., type of nesting cliff, distance to trail or campsite) to occupancy and productivity of traditional peregrine falcon nest sites.

Introduction

Threatened and *endangered* species and federal *candidate* species are protected by the Endangered Species Act (CDC 1994, ONHP 1995). Hence, information on *threatened* and *endangered* species must be provided in the Hells Canyon Project license application. Most important, increased recreation along the Snake River corridor has raised concerns that these activities may impact nesting peregrine falcons. Because of a lack of baseline information, the peregrine falcon population in the study area cannot be effectively assessed at this time. Baseline data (i.e., distribution and numbers) will also be important for planning purposes. Therefore, objectives of this study will be to:

1) characterize recreational activities in the study area,
2) determine the distribution and numbers of peregrine falcons nesting in the study area,
3) link human recreational activities to spatial distribution and numbers of nesting peregrine falcons, and
4) determine appropriate mitigation or enhancement for the resource based on stated desired future resource goals.

State of Knowledge

The peregrine falcon nested on the cliffs and bluffs above the Snake River prior to 1950. Since 1987, the Peregrine Fund, IDFG, ODFW, and USFS have cooperatively released approximately 62 peregrine falcons at three locations in or adjacent to the HCNRA. However, monitoring of these birds has been limited to one field survey and incidental reports of observations from hack-site attendants. The single survey covered known and potential nesting sites of peregrine falcons, and was conducted in 1996 below Hells Canyon Dam. One active nest site was located that was successful (Akenson 1996). Another active nest site was found at the mouth of the Grande Ronde River, along the Hells Canyon Reservoir Reach (IPC, *unpubl. data*).

Considerable information is available on the potential and actual effects of human activities on nesting raptors. Human activities can affect both raptor behavior and breeding success. Raptors can be affected during the nesting cycle (Fyfe and Olendorff 1976), or outside the nesting season in areas important for feeding and roosting (Newton 1979). In general, it is thought that raptors are most *sensitive* to disturbance during courtship and egg-laying and less vulnerable towards the end of the incubation period or when they have young (Newton 1979). Human activities that may affect raptors include military exercises (Ellis 1981, Andersen *et al.* 1986), agriculture (Schmutz 1984), livestock grazing (Kochert *et al.* 1988), construction, mining, and blasting (Stahlecker and Alldredge 1976, Haugh 1982, Bednarz 1984, Holthuijzen 1989, Holthuijzen *et al.* 1990).

Human activities may flush incubating adults from nests, resulting in loss of eggs or small chicks (Platt 1977, Harmata *et al.* 1978, Roseneau *et al.* 1981), nest abandonment (Grier *et al.* 1977, 1978), or destruction of nesting cliffs (Postovit and Postovit 1987). Recreational activities have affected red-tailed hawks (*Buteo jamaicensis*) (Wiley 1973), accipiters (Hennessy 1978, Lee 1981, Hall 1984), European kestrels (*Falco tinnunculus*) (Van der Zande and Verstrael 1985), prairie falcons (*Falco mexicanus*) (Boyce 1977, 1988; Boyce and Garrett 1977), gyrfalcons (*Falco rusticolus*) (Platt 1977), bald eagles (Haliaeetus leucocephalus) (Steenhof 1978, Fraser 1984), and ospreys (*Pandion haliaetus*) (Swenson 1979, Haga 1981, Van Daele and Van Daele 1982, Levenson and Koplin 1984), as well as entire raptor communities (Craighead and Mindell 1981). Boyle and Samson (1985) reported generally negative effects of outdoor non-consumptive recreational activities on wildlife in studies they reviewed; few studies demonstrated positive or neutral effects.

Methods

Study Area

The Hells Canyon study area extends along the Snake River from (approximately) Weiser, Idaho to the confluence of the Snake and Salmon Rivers. This section of river consists of the three reservoir reaches and the unimpounded river reach. Brownlee Reservoir is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles long (RM 284.6 to 272.2), and Hells Canyon Reservoir is approximately 25 miles in length (RM 272.2 to 247.0). The unimpounded reach extends approximately 59 miles from Hells Canyon Dam (RM 247.5) to the confluence of the Snake and Salmon Rivers (RM 188.2). The lateral extent of the study area will encompass all lands within 0.5 miles of the Snake River or associated reservoirs.

Field Methods: Peregrine Falcon

All suitable and known nest site locations will be determined using historic information about nesting peregrine falcons in the study area. All historical information on peregrine falcon nest sites in the study area will be requested from federal and state agencies, including the Natural Heritage Programs in both Idaho and Oregon. Criteria for cliffs considered to be *suitable* for nesting peregrine falcons have been established by the USFS and will be used in combination with the GIS to map potential nesting habitat in the study reach. All sites within the study reach will be visited to determine occupancy by peregrine falcons. Standard protocol will be followed during surveys of potential or known peregrine falcon nest sites (Pagel 1992). Occupied sites will be visited at least once to determine productivity of these sites.

Field Methods: Recreational Activities

Data concerning recreational activities (e.g., location, timing of day and year, number of people, and activity) collected by IPC (see recreation studies) and any appropriate information that can be obtained from state and federal agencies will be used (e.g., number of floating permits, number of people per party, use of campgrounds). Appropriate information will be incorporated into the GIS for analysis.

Analysis

The spatial distribution of occupied peregrine falcon nest sites will be evaluated in relation to human activities in the study reach. Location and productivity of each nest site will be assessed, if possible. The GIS will be used to investigate how far peregrine falcon aeries are located from actual or potential recreational activities. Human recreational activities near each aerie will be characterized. Statistical analyses will be performed relating various characteristics of human recreational activities (e.g., number of people, time of day and year, and recreational activity involved) and landscape characteristics (e.g., type of nesting cliff, distance to trail or campsite) to occupancy and productivity of traditional peregrine falcon nest sites.

Link to Protection, Mitigation, and Enhancement Measures

The analyses of the data may provide insight into possible human activities that could disturb nesting peregrine falcons. The analyses will provide a basis from which to propose appropriate protection, mitigation, and enhancement measures.

Timetable

The study will require two field seasons. The first season will be in 1998, and progress report outlining results should be available in September 1998. A comprehensive draft report will be prepared by September 1999 if a second field season is required. A final report should be submitted by December 2000.

Cooperation

Field data may be collected opportunistically during this study with other wildlife and recreation studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, IDEQ, and ODFW), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC's principal investigator for the study will be Dr. Anthonie M. Holthuijzen, assisted by Frank Edelmann. Dr. Holthuijzen holds a Ph.D. in Wildlife Ecology and has 20 years experience conducting, overseeing and administering wildlife studies. He has worked for the past 13 years on wildlife projects in Idaho. Mr. Edelmann has a M.Sc. degree in Wildlife Ecology and has five years experience conducting and overseeing field studies. Field work will be conducted by two field assistants, who will hold B.S. degrees in wildlife or related fields. Fieldwork will be overseen by Mr. Von Pope and Kelly Wilde; both hold B.S. degrees in Biology. IPC has the required logistics to conduct the proposed study. IPC has the required facilities and equipment, including 4-wheel-drive vehicles, a jetboat, and a field house in the vicinity of the study area, for logistical support.

Computer hardware and software, including a fully staffed GIS, are available to conduct data analysis.

Deliverables

A project progress summary will be prepared after each completed field season, summarizing experimental design, field methods, and survey results, if applicable. Annual progress reports will be available in August 1998 and 1999. A comprehensive draft report will be completed in 1999. A final report should be submitted in 2000.

8.2.32.
Title: Effects of Human Recreational Activities on Wintering Bald Eagles In the Reservoir Reaches of the Hells Canyon Study Area

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T32. Public access/recreational versus impact of new roads, public, wildlife species, terrestrial habitat, winter ranges, etc.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

Problem Statement and Study Questions

Operational

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of human presence related to operational activities on cultural, wildlife, and botanical resources?
2) What are the effects of recreational human presence on cultural, wildlife and botanical resources?

3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize the impacts of human recreational activities in the reservoir reach on wintering bald eagles (*Haliaeetus leucocephalus*). FERC requires that license applications describe wildlife resources, including *threatened* and *endangered* species, in the vicinity of the project and the impact of the project on those resources (FERC 1990). Management goals for *threatened* and *endangered* species are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991). Specific management goals for the bald eagle are found in two recovery plans (USDI 1986, USDA 1989).

Abstract

This study is proposed to evaluate potential impacts of human recreational activities on wintering bald eagles in the reservoir reaches of the Hells Canyon Study Area. A sampling plan will be designed based on the spatial and temporal dynamics of the abundance and behavior of wintering bald eagles in the study area. Foraging and roosting sites, where bald eagles concentrate, could be prone to human disturbance. Available information on the distribution and numbers of bald eagles wintering in the study area will be analyzed to determine whether there is sufficient information to determine possible locations where impacts could occur. Relevant available information will be entered into the GIS. Based on the identified potential impacts to these roosts (and additional information collected in two other bald eagle studies), sites will be selected where the potential for

human disturbance is considered to be high. At these sites more intensive field work is proposed to determine the effects of human activities on roosting and foraging bald eagles. Data concerning local recreational activities (location, timing of day and year, number of people, and activity) will be collected. In addition, any appropriate information that can be obtained from state and federal agencies (e.g., use of campgrounds) will be used. This information will be incorporated into the GIS for analysis. Once it has been decided how to implement the second phase of this study (i.e., the study of roosting and foraging sites that are likely to be most impacted by human activities), a detailed study plan will be developed to measure human activities near these sites.

Introduction

Threatened and *endangered* species and federal *candidate* species are protected by the federal Endangered Species Act. State *species of special concern* receive protection under state conservation laws (**Idaho Code** 36-103, 36-201, and the State of Oregon Endangered Species Act: CDC 1994, ONHP 1995). Thus, information on *threatened* and *endangered* species is a requisite element of the Hells Canyon Project license application. Baseline data (i.e., distribution and numbers) are also important for planning purposes.

The impact of human recreational activities on wintering bald eagles in the study area cannot currently be evaluated because baseline data is limited. It has been demonstrated that human activities have to potentially affect wintering bald eagles (McGarigal *et al.* 1991, Skagen *et al.* 1991).

The objectives of this study are:

1) characterize winter recreational activities in the study area,
2) determine the distribution and numbers of wintering bald eagles in the study area,
3) identify the correlation between human recreational activities and the spatial distribution and numbers of wintering bald eagles, and
4) determine appropriate protection, mitigation, or enhancement for the resource based on future resource goals.

State of Knowledge

Historic and present distribution of the bald eagle are essentially the same, however, numbers of eagles in the continental U.S. have decreased dramatically in the last 200 years. In response to this decline, the bald eagle was declared *endangered* in 43 of the 48 contiguous states and *threatened* in the remaining states, including Oregon. Bald eagles historically nested along the Snake River in the Hells Canyon Study Area. One pair reportedly nested at the mouth of Two Creeks in the early 1900s (Taylor 1989). At least five other sites have been reported to have been historically used by bald eagles (Isaacs *et al.* 1989). Substantial numbers of bald eagles winter in Wallowa, Union, and Baker Counties in Oregon.

Considerable information is available on the effects of human activities on both wintering and nesting bald eagles (e.g., Buehler *et al.* 1991, Grubb and King 1991, McGarigal *et al.* 1991, Montipoli and Anderson 1991, Skagen *et al.* 1991, Grubb *et al.* 1992).

Concern about the potential impacts of habitat alteration and other human activities on the species, and the need to identify important winter areas, resulted in a study on wintering bald eagles in northeastern Oregon conducted from 1988 to 1991 (Isaacs *et al.* 1989, 1990). Similar trends in numbers of wintering eagles were found in the winters of 1988/1989 and 1989/1990. Numbers increased from November through December, peaked in January and February and declined rapidly through April (Isaacs *et al.* 1990). Average weekly counts in 1989/1990 were 67 in November, 168 in December, 231 in January, 263 in February, 141 in March and 34 in April. The highest count was in the middle of February with 282 bald eagles. Starting in 1979, bald eagle counts were conducted above Hells Canyon Dam during the midwinter bald eagle counts.

Methods

Study Area

The study area consists of three reservoir reaches. Brownlee Reservior is approximately 55 miles long (RM 339.2 to 284.6), Oxbow Reservoir is approximately 12 miles long (RM 284.6 to 272.2), and Hells Canyon Reservoir is approximately 25 miles in length (RM 272.2 to 247.0).

Methods: Bald Eagle Distribution and Numbers

Foraging and roosting sites where bald eagles concentrate may be prone to human disturbance. One of these locations is directly below Brownlee Dam. Bald eagles roost in trees in McCormack Park and forage on fish in the tailrace. The presence of recreationists may interfere with both roosting and foraging eagles (IPC, *unpubl. data*). Roosting sites in the vicinity of the study area have been described and potential impacts to these roosting sites were addressed (Isaacs *et al.* 1992). This available information will be analyzed, where sufficient data are available on the distribution and numbers of bald eagles wintering in the study area, to determine where impacts of human activities may occur. All available information will be entered into the GIS. Based on the identified potential impacts to these roosts, including information collected in two other bald eagle studies, sites where the potential for human disturbance is considered to be high will be selected. At these sites more intensive field work is proposed to determine the effects of human activities on roosting and foraging bald eagles. A sampling design based on the temporal dynamics of the numbers and behavior of wintering bald eagles in the study area will be developed. A detailed study plan will be developed after it has been determined which sites are suitable for additional work and if additional work is warranted.

Methods: Recreational Activities

Information on the distribution, numbers, and activities of recreationists is currently being collected by IPC, but has not been analyzed to date. Recreational activities (location, timing of day and year, number of people, and activity) will be collected throughout the study area (see recreational studies). In addition, appropriate information that can be obtained from state and federal agencies (e.g., use of campgrounds) will be used. This information will be incorporated into the GIS for analysis. When how to implement the second phase of this study has been determined (i.e., the roosting and foraging sites likely to be most impacted by human activities), a detailed study plan will be developed to assess the level of human activities near these sites.

Analysis

Statistical analyses will be performed relating various characteristics of human recreational activities (number of people, time of day and year, recreational activity involved), landscape characteristics (e.g., type of nesting cliff, distance to trail or campsite), and project operations, to the numbers, behavior and foraging activity of wintering bald eagles.

Link to Protection, Mitigation, and Enhancement Measures

Information pertaining to the distribution, numbers, and activities of recreationists, and bald eagle distribution may suggest protection, mitigation, and enhancement measures bald eagles in the unimpounded reach of the study area.

Timetable

The study will require at least two field seasons. The study will be initiated in the winter of 1997/1998. A progress report will be available in June 1998. A comprehensive draft report will be completed by June 1999 and a final report in November 1999.

Cooperation

Field data may be collected opportunistically during this study with other wildlife and recreation studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

IPC's principal investigator for the study will be Dr. Anthonie M. Holthuijzen. He holds a Ph.D. in Wildlife Ecology and has 20 years experience conducting, overseeing and administering wildlife studies. He has worked for the past 13 years on wildlife projects in Idaho. Field work will be conducted by Mr. Von Pope and Kelly Wilde; both hold B.S. degrees in Biology. A consultant may be hired to conduct the second phase of this study. IPC has the required facilities and equipment, including 4-wheel-drive vehicles, a jetboat, and a field house in the vicinity of the study area for logistical support. Computer hardware and software, including a fully staffed GIS, are available to conduct data analysis.

Deliverables

Reports will be prepared by Dr. Holthuijzen, summarizing experimental design, field methods, and survey results, if applicable. A draft report of results should be available in April 1998. A final report will be completed by July 1998.

8.2.33.
Title: Effects of Human Recreation Activities on the Distribution and Relative Abundance of Townsend's Big-Eared Bats and Spotted Bats in the Unimpounded Reach of the Hells Canyon Study Area

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T32. Public access/recreational versus impact of new roads, public, wildlife species, terrestrial habitat, winter ranges, etc.

T34. Potential effects of recreation on cultural, botanical, and wildlife resources.

Problem Statement and Study Questions

Operational

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of human presence related to operational activities on cultural, wildlife, and botanical resources?

2) What are the effects of recreational human presence on cultural, wildlife and botanical resources?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize the impacts, if any, of Hells Canyon Project operations in the reservoir reach on *sensitive* bat species. FERC requires that license applications describe wildlife resources, including *threatened*, *endangered*, and *sensitive* species, in the vicinity of the project and the impact of the project on those resources (FERC 1990). Specific management goals for *threatened* and *endangered* species are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Abstract

The purpose of this study is to evaluate the potential impacts of human recreational activities on two species of bats that are *species of special concern*, the Townsend’s big-eared bat (*Plecotus townsendii*) and the spotted bat (*Euderma maculatum*). Limited information on these bats in the study area is available. There is considerable concern about the impacts of recreational activities along the Snake River corridor on maternity colonies of Townsend’s big-eared bats, as well as roosting sites for these and other bats. Suitable bat habitat within the river corridor, or other areas of high-intensity use, will be visited to establish the presence of bats. Data concerning recreational activities (location, time of day and year, number of people, and activity) will be collected. In addition, any information that can be obtained from state and federal agencies (e.g., number of

floating permits, number of people per party, use of campgrounds) will be used. This information will be incorporated into the GIS for analysis. The spatial distribution of occupied bat roosting and maternity sites will be evaluated in relation to human activities in the study reach. The GIS will be used to investigate the proximity of bat roosting and maternity sites to actual or potential recreational areas. Statistical analyses will be performed relating various characteristics of human recreational activities (number of people, time of day and year, recreational activity involved), landscape characteristics (e.g., type of nesting cliff, distance to trail or campsite), to bat roosting and maternity sites.

Introduction

State *species of special concern* receive protection under state conservation laws (i.e., **Idaho Code** 36-103, 36-201, and the State of Oregon Endangered Species Act; CDC 1994, ONHP 1995). Two bat species are *species of special concern* in Hells Canyon. These are the Townsend's big-eared bat and the spotted bat. Information on *threatened* and *endangered* species is a requisite element of the Hells Canyon Project license application. More importantly, concerns have been expressed that recreational activities along the Snake River corridor may be impacting roosting bats and maternity colonies. However, this issue, or the overall condition of these resources in Hells Canyon, cannot be effectively assessed at this date because even

baseline data are limited. Baseline data (i.e., distribution and numbers) is also important for planning purposes. Hence, the objectives of this study are:

1) characterize recreational activities in the study area,
2) determine the distribution and numbers of maternity colonies and bats roosting in the study area,

3) assess the correlation between human recreational activities and spatial distribution and numbers of maternity colonies and bats roosting, and
4) determine appropriate protection mitigation or enhancement methods for the resource based on stated desired future resource goals.

State of Knowledge

Limited information on the spotted bat and the Townsend's big-eared bat in the study area is available. The Townsend's big-eared bat occurs throughout western North America from British Columbia to southern Mexico, and east to South Dakota and western Texas and Oklahoma. The species is widely distributed throughout the intermountain region. Townsend's big-eared bats use juniper/pine forests, shrub-steppe habitats, deciduous forests, and mixed coniferous forests from sea level to an elevation of 3300 meters (10,826 feet). The species does not migrate, but remains at hibernacula from October through February. Low reproductive rates, limited roost sites, and susceptibility to human disturbance make the species vulnerable (Spahr *et al.* 1991). Information on population status for the Hells Canyon Study Area and vicinity is limited (USDA 1990). Asherin and Claar (1976) did not collect either spotted bats or Townsend's big-eared bats in Hells Canyon, nor have surveys been conducted along reservoirs in the study area.

The range of the spotted bat is restricted to western North America and northern Mexico (Hall 1981). The species ranges as far north as British Columbia. Little is known about the status of the spotted bat. The species appears to be widespread but rarely abundant (Fenton *et al.* 1987). It seems to prefer arid areas with canyons and cliffs where it can roost (Poché and Bailie 1974, Poché and Ruffner 1975, Woodsworth *et al.* 1981, Leonard and Fenton 1983). The critical factor appears to be the presence of cracks and crevices ranging from 0.8 to 2.1 inches in width at the opening

(Poché 1981). In Utah, Poché (1981) found numerous spotted bats in cracks and small crevices. They were not found in caves or trees. Poché (1981) suggested that the spotted bat may select from a narrow range of roosting parameters. These include the absence of forests or trees, availability of cliffs, little annual rainfall, and mild winters with a few nights where temperatures drop below 0°C. Spotted bats appear to feed mainly on moths (Poché 1981, Woodsworth *et al.* 1981, Fullard *et al.* 1983, Leonard and Fenton 1984, Wai-Ping and Fenton 1989). No records are available on spotted bats in Oregon, and only a single record exists for southwestern Idaho (Hall 1981).

There is considerable concern about the impacts of recreational activities along the Snake River corridor on maternity colonies of Townsend's big-eared bats, as well as roosting sites for these and other bats. There is ample evidence that human activities can impact bat populations (Riddle 1995).

Methods

Study Area

The study area extends from Hells Canyon Dam, at RM 247.0 to the confluence of the Salmon River at RM 188.2. The lateral extent of the study area will encompass all lands inundated by a 150,000-cfs flood event.

Field Methods: Bats

Suitable sites (old mine shafts, caves, buildings, and bridges) that could provide habitat for bats and that are located within the river corridor will be visited to determine the presence of bats. Suspected bat use points will be selectively sampled using harp traps, mist-nets, hand nets, and the use of an Anabat system. Specific sampling designs and safety concerns are discussed by Riddle (1995).

Sampling sites will be chosen for net and harp-trap collection to encompass a variety of different habitats within the area affected by the reservoirs. Bat census techniques yield the best results where bat densities are likely to be high. The presence of water often results in increased densities because bats usually drink upon exiting day roosts and also because concentrations of the insects on which bats feed generally occur near water.

Sonograms will be collected to identify species of bats producing echolocation calls because each species produces unique call characteristics. No echolocation data were available for the study area. All bats caught will be processed for basic biological information and banded.

Field Methods: Recreational Activities

Information on recreational activities (location, time of day and year, number of people, and activity) will be collected throughout the study area (see recreational studies). In addition, information that can be obtained from state and federal agencies (e.g., number of floating permits, number of people per party, use of campgrounds) will be used. This information will be incorporated into the GIS for analysis.

Analysis

The spatial distribution of occupied bat roosting and maternity sites will be evaluated in relation to human activities in the study reach. The GIS will be used to investigate the proximity of bat roosting and maternity sites to actual or potential recreational activities. Human recreational activities will be characterized near each bat roosting and maternity site. Statistical analyses will be performed relating various characteristics of human recreational activities (number of people, time of day and year, recreational activity involved), landscape characteristics (e.g., type of nesting cliff, distance to trail or campsite), to bat roosting and maternity sites.

Link to Protection, Mitigation, and Enhancement Measures

The spatial distribution of occupied roost sites and maternity colonies may suggest measures for protection, mitigation, and enhancement of this habitat. The consultant will recommend protection, mitigation, and enhancement measures.

Timetable

The study will require two field seasons. The first season will be in 1997. A comprehensive draft report will be prepared by November 2000. A final report should be submitted by January 2001.

Cooperation

Field data may be collected opportunistically during this study with other wildlife and recreation studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

Study tasks will also be conducted in consultation between IPC and interested resource agencies and groups. Shared tasks will include development of:

1) study designs,
2) study objectives,
3) project operation and maintenance scenarios,
4) field methods,
5) analysis methods, and
6) draft document reviews.

Statement of Capabilities

A consultant with expertise in bat ecology, sampling techniques, and statistical analysis will be contracted to conduct this study. This study is likely to be conducted as a cost challenge grant with the USFS. A single consultant will be selected in close cooperation with all contributors to this study. A RFP will be drafted cooperatively by all contributors to the study.

Deliverables

A project progress summary will be prepared by the contractor after each completed field season, summarizing experimental design, field methods, and survey results, if applicable. A comprehensive draft report will be prepared by November 2000. A final report should be submitted by January 2001.

8.2.34.
Title: An Evaluation of Raptor Electrocution at Transmission Lines Associated with the Hells Canyon Project

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (rights of way).

T33. IPC land management practices effects on terrestrial resources.

Problem Statements and Study Questions

Maintenance

Present power line locations and operations including associated facilities may affect wildlife and botanical resources.

1) What are the effects, including secondary effects, of power line operation (including associated facilities) to wildlife and botanical resources?

2) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize avian electrocutions at transmission lines and related facilities associated with the Hells Canyon Project. FERC requires that license applications describe wildlife resources in the vicinity of the project and the impact of the project on those resources. Specific species management goals are formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Abstract

The purpose of this study is to evaluate the potential problem of avian electrocution caused by transmission lines associated with the Hells Canyon Project. Several hundred miles of transmission lines are associated with this project. Design criteria for these lines will be evaluated to identify structures which may represent potential electrocution threats to birds of prey. Criteria outlined in "Suggested practices for raptor protection on power lines: The state of the art in 1996" (APLIC 1996) will be used for evaluation purposes. If potential problem structures are identified, corrective actions will be recommended.

Introduction

Raptor power line interactions indicate that raptor electrocution remains a widespread problem in North America and throughout the world. Electrocution of raptors occurs most often on lines of 69,000 volts or less. However, on rare occasion, they have been reported to occur on lines of higher voltage. The objectives of this study will be to: 1) evaluate the design criteria of transmission lines included in the relicensing the Hells Canyon Project, 2) evaluate transmission line designs (based on criteria identified in "Suggested Practices for the Protection of Raptors on Power Lines - The State of the Art 1996" (APLIC 1996)) for their potential to cause raptor electrocution, 3) perform an "on ground" evaluation of potential problem sites if potential problem designs are identified, and 4) develop appropriate protection or mitigation measures to reach desired resource goals.

State of Knowledge

A large number of electrocuted raptors were discovered along western electrical lines in the early 1970s (APLIC 1996). This discovery led to a concerted utility/government effort to identify causes and develop solutions to the problem of accidental electrocution of birds of prey. The effort resulted in the publication "Suggested Practices for Raptor Protection on Power Lines" (Miller *et al.* 1975). This document recommended measures to make power line structures safer for raptors. In 1981, the publication was updated to reflect additional information that had been discovered (Olendorff *et al.* 1981). In 1996, the document was again revised to reflect the growing body of knowledge developed between 1981 and the present (APLIC 1996). Together, these three documents represent a summation of most recent knowledge for identifying and correcting problems associated with raptor electrocutions.

Methods

Study Area

The study will be confined to the design characteristics and rights-of-ways of the following transmission lines: Oxbow to Pallette Junction, Hells Canyon to Pallette Junction, Paddock to Ontario, Pallette Junction to Mountain Sheep, Boise to Brownlee to Baker, Boise to Brady No. 2, Brownlee to Boise Bench Nos. 3 and 4, and Boise Bench to Midpoint.

Study Design

Existing information on the Hells Canyon transmission lines will be compiled from IPC's Transmission and Distribution, and Rights-of-Way Departments. Technical information requested for each line will include:

1) an engineering description of each line, including; voltage, amperage, conductor type, ground wire placement, insulator type (including dimensions and placement), line locations, and lengths, and related equipment (e.g. switches, transformers),
2) detailed drawings of all structure types, including phase-to-phase and ground-to-phase spacing of all energized parts, and
3) information about line locations and routes including;
    a) patrol maps,
    b) easements,
    c) line ownership,
    d) river crossings,
    e) access roads, and
    f) maintenance procedures.

Analyses will consist of summarizing both existing information and that obtained during reconnaissance surveys. Also, digital data on locations of the transmission lines will be prepared for GIS mapping.

Field Methods

Field visits will be made to all potential problem areas identified during the structure evaluation. Potentially dangerous structures will be photographed and evaluated for appropriate modification. Field visits will be coordinated with ongoing line patrol activities, to the extent practical. A structure-by-structure list of required modifications will be developed.

Link to Protection, Mitigation, and Enhancement Measures

Recommendations will be made for modifications to existing transmission towers and associated equipment, where necessary, to promote the protection of birds of prey from accidental electrocution.

Timetable

Studies will be initiated in 1997 and completed in 1999.

Cooperation

Field data may be collected opportunistically during this study with other wildlife and botanical studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying hazardous design criteria,
2) review of facility design survey results, and
3) review of draft reports. Interested agencies or groups are expected to review and comment on subject matters in a timely and expeditious manner.

Statement of Capabilities

This study will be conducted under the supervision of Allan R. Ansell. He has conducted and supervised a wide variety of environmental studies throughout southern Idaho since 1976. He is one of the principal authors of "Suggested practices for raptor protection on power lines: the state of the art in 1996." He has over twenty years experience in dealing with avian/power line issues. Idaho Power has long been recognized as a leader in the development of raptor safe designs for power facilities.

Deliverables

A draft report of results will be prepared in March 1998. A final report will be completed in June 1999.

8.2.35. Title: An Evaluation of Avian Collision with Transmission Lines Associated with the Hells Canyon Project.

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of wildlife resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T3. Cultural and natural resource inventories.

T14. Study design and quality.

T17. Impact identification.

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (rights of way).

T33. IPC land management practices’ effects on terrestrial resources.

Problem Statement and Study Questions

Maintenance

Present power line locations and operations including associated facilities may affect wildlife and botanical resources.

1) What are the effects, including secondary effects, of power line operation (including associated facilities) on wildlife and botanical resources?
2) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize avian collisions with transmission lines associated with the Hells Canyon Project which could significantly affect a bird population's ability to sustain or increase its numbers. Species management goals were formulated for the HCNRA (USDI 1987) and more broadly by the BLM (USDI 1990) and state conservation organizations (Marshall 1986, IDFG 1991).

Abstract

The purpose of this study is to evaluate the potential impact of avian collision with transmission lines in the Hells Canyon Study Area. An interagency assessment team will be formed and a qualified contractor selected. The study will be carried out in two phases. In the first phase, information on transmission line locations and design will be gathered, along with relevant biological data associated with line rights of way. Data will be digitized and compiled using the GIS. Compiled data will be evaluated by the assessment team and consultant to identify potential

high-risk areas and/or avian populations. The second phase of study may involve site-specific evaluations if determined necessary by the results of the first-phase effort.

Introduction

Avian collisions with overhead transmission lines have been noted since the turn of the century. The issue has become more important as power lines have become more prevalent in the landscape. Collisions may be biologically significant if they affect a bird population's ability to sustain or increase its numbers.

The objectives of this study are:

1) evaluate the potential of avian collisions occurring along existing transmission lines,
2) identify areas of high risk,
3) evaluate potential risk to avian populations, and
4) recommend appropriate protection, mitigation, and enhancement measures to reach desired resource goals.

State of Knowledge

Avian collisions with many different types of overhead lines have been noted since the turn of the century. Most published literature, however, has focused on collisions with power lines (APLIC 1994). In 1978 a conference sponsored by the USFWS, the EPA, and the Oak Ridge Associated Universities brought together the state of knowledge as known at that time (Avery 1978). In 1978, the Electric Power Research Institute (EPRI) funded an evaluation of completed, ongoing and planned research of the issue. It also identified several research needs (Gauthreaux 1993). In 1989, the Avian Power Line Interaction Committee (APLIC) was formed. The committee, consisting of representatives from several electric utilities, the USFWS, and the National Audubon Society, was charged with evaluating the effectiveness of various types of aerial markers in reducing avian collisions. The results of those efforts are detailed in Brown and Drewien (1995) and APLIC (1994).

Birds can exist near power lines in many situations without significant risk of collisions. Problems may occur in very specific, localized situations where certain factors exist. Several of these factors have been identified. Risk factors may generally be divided into the following categories: biological, environmental, human-related, and engineering design and placement.

Methods

Study Area

The study will address the design characteristics and rights-of-ways of the following transmission lines: Oxbow to Pallette Junction, Hells Canyon to Pallette Junction, Paddock to Ontario, Pallette Junction to Mountain Sheep, Boise to Brownlee to Baker, Boise to Brady No. 2, Brownlee to Boise Bench Nos. 3 and 4, and Boise Bench to Midpoint.

Study Design

This study will be conducted in two phases. Phase I will consist of a data collection and evaluation. An interagency assessment team will be formed. It is anticipated that this team will include representatives from the IDFG, ODFW, USFWS, USFS, and the BLM. Relevant transmission line data will be gathered, as well as available biological information. The goal will be to determine if regularly-used bird flight paths (e.g. migration corridors, feeding flights, river crossings) occur along the transmission line rights of way. If sufficient data are available, potentially affected areas and species will be identified. Potentially affected areas and populations will be assessed for biological significance (i.e., will losses due to collision adversely affect population viability). Implementation of Phase II will be dependent upon the findings of the Phase I study. Study design for Phase II will occur once appropriate study questions have been identified. It is anticipated that Phase II studies may involve site-specific surveys.

Field Methods

Phase I field methods will be limited to surveys to confirm the accuracy of existing biological data. It is anticipated that one observation flight will be required to confirm existing conditions identified by the interagency assessment team. A limited number of ground visits may also be required. It is expected that the Phase I evaluation will be a coordinated effort between IPC and appropriate resource management agencies.

Analyses

Once Phase I data has been collected, it will be evaluated in a group setting by the interagency assessment team. The evaluation will focus on the quality of data collected and the identification of potential high-risk areas and/or avian populations. Analyses will consist of summarizing both existing information and that obtained during reconnaissance surveys. Also, digital data on locations of the transmission lines and relevant natural resources will be prepared for GIS mapping. These data will form the basis of discussion by the study team.

Timetable

Studies will be initiated in 1997 and completed in 1999 or 2000, depending on the requirements of Phase II studies.

Cooperation

Field data may be collected opportunistically during this study with other wildlife and botanical studies.

External cooperation will be required for information assimilation, study development, and study review. Currently available information pertinent to this study description's objectives will be sought from all federal (e.g., BLM, USFS, and USFWS), state (e.g., IDFG, ODFW, and IDEQ), and local (e.g., Wallowa, Baker, Malheur, Adams, Washington, and Idaho Counties) governmental agencies and bodies. Also, useful information possessed by non-governmental organizations will be solicited.

The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying existing data sources for Phase I,
2) Phase I data evaluation,
3) identification of high-risk areas and/or populations, and
4) review of draft report. It is anticipated that appropriate agencies will commit to participation in this effort at a meaningful level.

Statement of Capabilities

This study will be conducted by a consultant with expertise in bird/power line collisions under the supervision of Allan R. Ansell. Mr. Ansell has conducted and supervised a wide variety of environmental studies throughout southern Idaho since 1976. He is one of the principal authors of "Suggested practices for raptor protection on power lines: the state of the art in 1996." He is also a member of the Avian Power Line Interaction Committee, the originators of the document "Mitigating bird collisions with power lines: The state of the art I 1994." He has studied bird collision issues for over twenty years. A request for proposal will be developed and bids solicited from interested consultants. Interested agencies and groups will be invited to assist in developing the RFP.

Deliverables

A draft Phase I report will be prepared by March 1999. A final report will be completed in June 1999. Phase II studies will also result in a draft and final report. A schedule is not available at this time.

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8.3. Botanical

8.3.1. Title: Vegetation Description of Hells Canyon -- Weiser, Idaho to the Salmon River

This descriptive study was initiated by IPC in 1994 to meet FERC requirements to describe botanical resources of the Hells Canyon Project and its vicinity. This study was not developed as part of the Collaborative Team process. The Collaborative Team participants have been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process. Data to describe botanical resources associated with the Hells Canyon transmission lines will be collected as part of the impact study titled "Effects of Road and Transmission Line Rights-of-Ways on Botanical Resources."

Abstract

This investigation proposes to inventory, map, and describe the botanical resources along the Snake River corridor from Weiser, Idaho to the confluence of the Salmon River. A cover type map will be based on 26 vegetation, natural feature, and land use cover types. The botanical characteristics of each vegetation cover type and the plant communities associated with each vegetation cover type will be described. The nature, extent, and distribution of botanical resources in this area are unknown. The information gained from this study will be used to meet FERC requirements for relicensing the Hells Canyon Complex and to provide baseline data for several other terrestrial relicensing studies.

Introduction

An accurate cover type map and understanding of the botanical composition and structure of habitat is critical for natural resource managers to determine resource values and management actions. Vegetation reflects many abiotic and biotic characteristics of an area (Stoms 1994) and is usually the basis for conservation assessments and management activities (Specht 1975, Austin 1991, Scott *et al.* 1993). It also represents the ecosystem's primary producers and serves as habitat for wildlife (Scott *et al.* 1993). Cover type maps can be used to identify biologically *sensitive* areas, describe spatial patterns or changes in abundance, and frequency of particular characteristics of the landscape (Scott *et al.* 1993, Caicco *et al.* 1995). Biologists have long used knowledge of an animal's habitat and vegetation patterns as surrogates to model, predict, and map wildlife distributions and other conservation evaluations (Specht 1975, Austin 1991).

Quantitative descriptions of the extent, representation, or distribution of plant communities in the Hells Canyon area of northeastern Oregon and west-central Idaho are limited. Previous investigations have been primarily concerned with characterizing potential natural vegetation and successional status of vegetation types, or have described only a few plant communities. Detailed knowledge of the nature, extent, and distribution of riparian and upland habitats is needed to plan management of the traditional uses of surface resources. A description of the resources of the project and its vicinity, and of downstream areas affected by the project is a requisite of the FERC license application (18 CFR §4.51 (f)(3)).

The objectives of this study are to:

1) identify the existing vegetation, natural features, and land use cover types,
2) quantify the extent and distribution of cover types,
3) describe the botanical, edaphic, and other site characteristics of the vegetation cover types, and
4) describe the plant assemblages (plant communities) affiliated with each vegetation cover type.

Riparian vegetation will be investigated using two approaches. The first approach will be to investigate the resources occurring in the general vicinity of the Hells Canyon Complex, and the second will be to investigate those resources more directly influenced by water level fluctuations of the Hells Canyon Complex. The first task will be to develop a map of cover types found in the study area. The second task will be to randomly select and sample sites within each vegetation cover type.

The cover type map and botanical data produced from this study will provide baseline information for several other environmental studies required to support IPC's relicensing activities in the study area. Uses of these data include:

1) assessing current wildlife habitat value,
2) modeling wildlife distributions,
3) providing data for land use planning and management actions,
4) conducting GIS suitability analyses for mitigation, protection and enhancement planning, and
5) providing a temporal data set for vegetation trend analyses.

State of Knowledge

Several researchers have studied vegetation communities in Hells Canyon and surrounding areas. Upland plant communities have received the most attention. Cambell (1962) studied the grasslands at the northern end of Hells Canyon in northern Idaho and adjacent Washington. On a basis of very limited sampling he described two climax plant communities: *Agropyron spicatum/Festuca idahoensis* and *Festuca idahoensis/Koeleria cristata*. Daubenmire's (1970) detailed study of the steppe vegetation of Washington covers the Palouse and Columbia Basin areas but not the Snake River in Hells Canyon or its tributaries. He described his study area as climatic climax plant associations of steppe vegetation. Franklin and Dyrness (1973) presented a generalized account of the major vegetation types in Oregon and Washington. Evans and Tisdale (1972) described some ecological characteristics of *Aristida longiseta* (red threeawn) and *Agropyron spicatum* (bluebunch wheatgrass). Tisdale (1979) classified the grasslands of the middle Snake River Valley and its tributaries into two vegetational series (zones), the *Festuca idahoensis* (Idaho fescue) and *Agropyron spicatum* (bluebunch wheatgrass) series, and described different habitat types occurring in each series. Later, Tisdale (1986) expanded on this work and classified the grasslands and associated shrublands in west-central Idaho. The work by Steele *et al.* (1981) and Steele and Geier-Hayes (1987, 1989, 1992, 1993, 1994) investigated the forest habitat types in central Idaho, which approach and sometimes occur in the study area.

Other recent studies of upland vegetation include work by Mancuso and Moseley (1995). They mapped and qualitatively classified and described vegetation resources on the 22,838 acres of the Cecil D. Andrus Wildlife Management Area (formerly the Brownlee Wildlife Management Area), adjacent to Brownlee Reservoir. Mancuso (1995) conducted a similar study on the Rocking M Ranch, also adjacent to Brownlee Reservoir.

Probably the most extensive and detailed investigation of upland vegetation in the Hells Canyon vicinity was done by Johnson and Simon (1987) who studied over 1,400 sites (729 in steppe vegetation, 676 in forested vegetation) on lands administered by the USFS, Wallowa-Whitman National Forest, exclusive of the Blue Mountains. This work focused on the potential natural vegetation and successional status of vegetation types.

Riparian plant communities have received comparably less attention. Huschle (1975) investigated both riparian and upland habitats along a narrow strip of land immediately adjacent to the Snake River. Huschle's work was later incorporated into a more extensive study of the Columbia River Basin by Asherin and Claar (1976), but the latter study was based on limited sampling efforts. Miller (1976) and Miller and Johnson (1976) focused on the distribution and characteristics of *Alnus rhombifolia* (white alder) communities and Debolt (1992) studied *Celtis reticulata* (netleaf hackberry) communities along the Snake River, including the Hells Canyon area. Mancuso and Moseley (1995) and Mancuso (1995) also describe some of the tributary drainages to the Snake River on lands near Brownlee Reservoir.

Probably the most extensive and detailed investigation of riparian vegetation that includes part of the Hells Canyon corridor is being conducted by the USFS (Crowe and Clausnitzer 1995 draft report). The focus of this study is inventorying and classifying mid-montane wetlands of the

Malheur, Umatilla, and Wallowa-Whitman National Forests, focusing on potential natural vegetation and successional status of vegetation types.

Most past studies provide little information on the extent or spatial characteristics of plant communities in the Hells Canyon area. Only a few provide insight on current conditions of the vegetation resources, and these often omit quantification of early seral plant communities, such as sites dominated by introduced weedy species. No detailed cover type map or botanical data regarding current conditions and spatial characteristics are available for the study area.

Methods

Study Area

This study proposes to map and sample upland and riparian vegetation along the Snake River and associated reservoirs, from the Highway 30N Bridge (RM 351.2), at Weiser, Idaho, downriver to the confluence of the Salmon River (RM 188.2), near Lewiston, Idaho, and along associated river arms of Brownlee Reservoir. The lateral extent of the study area will include lands within 0.5 miles of each shoreline above Hells Canyon Dam (RM 247.0) and lands within 0.25 miles of each shoreline below Hells Canyon Dam. The study area below Hells Canyon Dam is restricted because it is extremely difficult to access and sample. In some instances, the boundaries of the cover type map will be reduced, as limited by the lateral extent of the 1993 aerial photo coverage used in this study.

Cover Type Mapping

Methods used to prepare vegetation maps are selected based on the purposes for which each map will be used (Küchler 1956, 1967, 1988). No single mapping strategy will work best in all locations (Küchler 1988, Scott *et al.* 1993). The map to be prepared for the Hells Canyon Study Area must portray the vegetation in sufficient detail to answer questions about the areal extent, representation, and distribution of fairly specific cover types. The map must also be sufficiently detailed to support wildlife studies, land use planning, and other GIS applications for relicensing the Hells Canyon Complex.

The cover type map will be based on the vegetation, natural features, and land use cover types used in past IPC relicensing studies which are as follows:

No.	Cover Type	No.	Cover Type
	Vegetation		Natural Feature
1	Emergent Herbaceous Wetland	6	Lentic (Standing Water)
3	Shore & Bottomland Wetland	7	Lotic (Moving Water)
4	Scrub-Shrub Wetland	17	Barrenland (i.e. Sand Dunes)
5	Forested Wetland	18	Cliff/Talus Slope
8	Forested Upland		
9	Shrubland		Land Use
10	Tree Savanna	19	Disturbed
11	Shrub Savanna	20	Agriculture (Cultivated)
12	Desertic Woodland	21	Grazing Land/Pasture
13	Desertic Shrubland	22	Urban
14	Desertic Herbland	23	Residential
15	Grassland	24	Industrial
16	Forbland	25	Parks/Recreation
		26	Roads
		27	Forested/Orchard

Wetland cover types will generally follow the classification system described by Cowardin *et al.* (1979) as modified for wildlife habitat evaluation procedures (USFWS 1981). However, these wetland cover types will contain “riparian” lands, in addition to wetlands. Riparian lands are those transitional areas between wetland and upland habitats. This will be done because it is impossible to accurately distinguish between some wetland and upland plant species, or to interpret hydrologic indicators during aerial photo-interpretation. The actual extent of legally recognized wetland boundaries will not be indicated on the cover type map and must be determined on the ground through formal wetland delineation techniques (see Environmental Laboratory 1987, Federal Interagency Committee for Wetland Delineation 1989).

Upland cover types will generally follow the classification system as outlined in USFWS (1981), and will involve nine types (see list above). The map will include four natural feature cover types and nine land use cover types.

The map will be developed through standard photo-interpretation techniques using July/August 1993 1:15,000-scale color infrared aerial photography. The photo-interpretation will be contracted to an outside consulting firm. It will be an iterative process based on evidence from the aerial photos, ancillary sources (e.g., existing road and vegetation maps, contemporary 1993 true-color 1:8,400-scale aerial photos), field observations, and knowledge of local vegetation communities, ecological relationships, and natural and anthropogenic perturbations. As the photo-interpretation progresses, two trained IPC staff members will field-check all delineated polygons, where reasonably feasible. All corrections identified during the field visits will be incorporated.

A contractor will also be selected to perform photogrammetric data processing to obtain rectified digital coverage of cover type polygons and linear features. Location boundaries of all distinct thematic features, such as roads, buildings, lakes, rivers, or agricultural lands, will meet or exceed the National Map Accuracy Standards of 40 feet for a 1:24,000-scale map. The spatial accuracy of other cover type boundaries will not have a true location of which the accuracy can be tested. The landscape displays continuous variation in species composition at all scales. Hence, polygon boundaries imply a discontinuity that seldom is as abrupt as a map will suggest (Stoms 1994). They are a subjective interpretation of those instances where between-polygon variation is greater than within-polygon variation.

Map Analysis

Analyses will be performed to summarize the extent and distribution of cover types within the study area. Summaries will include: total acres mapped, total acres of each cover type within the study area and within designed reaches, number and size (minimum, maximum, mean, median) of polygons in the study area and within reaches, and total acres and relative proportions of each cover type within the legal project areas for Brownlee Dam, Oxbow Dam, and Hells Canyon Dam, as compared to the entire study area.

General Considerations for Field Sampling

The objective of field sampling will be to collect data on the existing conditions of each vegetation cover type. The approach to sampling will be similar to the "subjective without preconceived bias" concept of Müller-Dombois and Ellenberg (1974), in that placement of transects within cover types will be done without any assumption of eventual classification or apparent condition, but rather for the representation of homogeneous vegetation. Obvious ecotones, microsites, exceptionally dense clumps or openings, or areas of recent severe disturbance will be avoided.

Upland Sampling

Because field sampling began in 1994 and because the cover type map will not be available until 1997 to aid in developing sampling methods, upland sampling locations are selected in the field from within 0.5 x 0.5 mile (0.25 mi^2) sampling blocks above Hells Canyon Dam, and from within 0.25 x 0.25 mile (0.06 mi^2) sampling blocks below Hells Canyon Dam. Prior to arriving in the field, the study area will be stratified into 5-mile-long river segments, and by left and right river bank to insure that data will be collected over the total length of the study area. Each side of the river in each 5-mile segment will be divided into ten 0.5-mile stretches in the reaches above Hells Canyon Dam, and into twenty 0.25-mile stretches below Hells Canyon Dam. Two of the stretches will be randomly selected on each side of the river within each 5-RM segment (four blocks/5-mile segment). All upland sample blocks will be mapped on USGS 7½-minute topographic maps.

After locating a sample block in the field, a field crew trained in identification of cover types will sketch all available cover type polygons and, where present, readily distinguishable plant communities within cover types (i.e., *Rhus glabra* dominated *Shrubland* polygons versus *Purshia tridentata*-dominated *Shrubland* polygons). This will be done by using binoculars and by boating and hiking to different vantage points. One polygon per cover type in each block will be randomly selected for sampling. If the selected polygon is not accessible (e.g., high up on an extremely steep slope, treacherous cliff faces) with reasonable effort, another polygon will be randomly selected. During each year of sampling, the crew will strive to sample several 5-mile river segments throughout the study area to mediate for variation in annual climatic conditions.

All upland vegetation will be measured along a single, permanently marked, straight, 50-m transect line. For each transect, the slope, aspect, elevation to the nearest contour (USGS 7½-minute topographic map), general location, and a UTM coordinate will be recorded. Ground cover and herbaceous plant cover will be measured using an 0.2 x 0.5 m (0.10 m^2) quadrat (Daubenmire frame) and six cover classes described by Daubenmire (1959). Shrub and tree (woody) cover will be estimated using the Line Intercept method (Canfield 1941). Woody species density will be estimated using variable-sized belt transects. One of five belt sizes will be selected (1 x 50 m, 2 x 50 m, 6 x 50 m, 10 x 50 m or 20 x 50 m) in order to obtain a count of at least 20 individuals and still remain within the cover type. Soil characteristics will be measured by sampling ten soil cores representing the upper 15 cm (6 inches) of the mineral soil along each transect, and combining all ten cores into a composite sample for the site. Finally, notes will be taken to rank each site based on native/perennial species composition, abundance of seedlings and young plants, state of plant litter accumulation, plant vigor, condition of the soil surface, soil erosion condition class, bare soil index, ground cover index, and domestic grazing use.

After the cover type map is completed, GIS analyses will be conducted to determine the spatial efficacy of upland sampling. The field sketches that delineate all cover type polygons in the sample blocks will also be used to select additional sampling locations to fill in data gaps (i.e., undersampled cover types).

Approach for Riparian Sampling

Sampling of riparian vegetation resources will be conducted using two approaches. The first approach will be to obtain information on the general riparian habitat occurring in the study area, and the second will be to obtain more specific information on the riparian habitat directly influenced by the project; that occurring along the reservoir and river shorelines associated with the water level fluctuation zone.

General Riparian Sampling

To obtain general information on the riparian resources in the study area, sampling will focus on the larger vegetation patches of homogenous riparian habitat and avoid transition zones where upland species intergrade with wetland species. These larger patches are often away from the water fluctuation zone, running along the bottoms of tributary drainages or on seasonally moist canyon slopes associated with drainages.

First, reconnaissance surveys will be conducted to locate all quantifiable riparian cover type polygons (sites greater than 30 meters diameter) within the study area. The study area will be stratified into 5-mile-long river segments to insure that data will be collected throughout the length of the study area. Because riparian habitats have received such little prior investigation in the study area, a large percentage of sites, approximately 40 percent of the polygons in each riparian cover type, will be randomly selected in each 5-mile river segment for sampling. Each site will be mapped on USGS 7½-minute topographic maps. A large sampling number is also needed because these locations will serve as wildlife sampling sites (namely nongame bird survey locations), where more accurate descriptions of vegetation characteristics will be needed. During each year of sampling, the crew will strive to sample several 5-mile river segments throughout the study area to mediate for variation in annual climatic conditions.

In large riparian polygons, all vegetation will be measured within a 30-meter in diameter plot, along three randomly selected 5-meter transects. For each transect, the slope, aspect, elevation to the nearest contour (USGS 7½-minute topographic map), general location, and a UTM coordinate will be recorded. Vegetation and associated site characteristics will be determined using the same methods described for upland sampling.

After the cover type map is completed, GIS analyses will be conducted to determine the spatial efficacy of riparian sampling. Efforts will focus on the larger patches of Shore and Bottomland Wetland and Emergent Herbaceous Wetland cover types, because these are rare in the study area. All such sites will be identified and sampled, where reasonable feasible.

Shoreline Riparian Vegetation

To obtain specific information on the riparian vegetation resources directly influenced by water level fluctuations, sampling efforts will focus on areas near the drawdown zone. All shoreline in the study area will be stratified into 5-mile-long segments on each side of the river to insure that data will be collected over the total length of the study area. Each strata will be divided into twenty 0.25-mile-long shoreline stretches. Two stretches will be randomly selected on each side of the river within each 5-mile shoreline segment (four sample stretches/5-mile segment). This will provide a 10 percent sample of all shoreline in the study area. All shoreline sample stretches will be mapped on USGS 7½-minute topographic maps.

After locating a sample stretch in the field, shoreline vegetation will be closely examined to determine if riparian species are present. Riparian species will usually be defined as those plant species with a hydrologic indicator ranking of facultative minus (FAC-) or wetter (FAC, FAC+, FACW- FACW, FACW+ or OBL), as ranked by Reed (1988) and updated by the COE (1994). Some plant species such as *Philadelphis lewisii* and *Rubus discolor*, which do not have a hydrologic indicator ranking or have a ranking that is drier than FAC-, may also be selected as indicators of riparian habitat in Hells Canyon, based on the investigator's knowledge and previous work conducted in Hells Canyon environs. A list of additional indicator species will be maintained.

If riparian plant communities occur, the total shoreline length of riparian vegetation will be measured within the sample stretch. The total abundance of each riparian plant community will be estimated in square meters. The upriver and downriver location coordinates of each sample stretch will be determined in the field using a GPS unit capable of greater than a 5-meter accuracy.

All riparian plant communities occurring in the sample stretch will be mapped on a data form. Mapping will be done by hiking and cruising the shoreline in a boat to different vantage points, and drawing the vegetation polygons in relation to visual reference features. All mapped riparian vegetation will be assigned a temporary cover type and plant community name to distinguish between sites during sampling.

All unique riparian plant communities in each sample stretch will be sampled. If more than one polygon of a specific plant community occurs in the sample stretch, then at least one-third of the polygons will be randomly selected and sampled. Vegetation will be measured along a single, linear 5-, 10-, 20-, or 40-meter transect line, depending on the size of the plant community; the longest possible transect will be used. Vegetation and other site characteristics will be estimated using the same methods described for upland sampling. In addition, the elevation (in 15-cm class increments) above and below the high-water mark, the maximum horizontal distance (m) above and below the high-water mark, and the general location of each plant community will be recorded. The high water mark will be the elevation of highest recorded flow or pool level since the construction of each reservoir in the Hells Canyon Complex.

At islands, all unique riparian vegetation polygons will be sampled. However, if more than one polygon of a plant community occurs, then at least one-third will be randomly selected and sampled. Several islands occur in the upper portion of Brownlee Reservoir and upstream to Weiser, Idaho. One island occurs in Hells Canyon Reservoir. During each year of sampling, the crew will strive to sample several 5-mile river segments and several islands throughout the study area to mediate variation in annual climatic conditions.

Field Data Analysis

Cover estimates for each transect will be calculated for four physiognomic types; tree, shrub, forb and grass. Average cover for each herbaceous species will be calculated using data from the Daubenmire frames. Midpoint values of each Daubenmire cover class will be used. Average cover of woody species will be calculated from the line intercept data. The cover estimates will be then used to classify each transect into a vegetation cover type.

TWINSPAN (two-way indicator species analysis) (Cornell Labs, Ithaca, NY) will be used to group transects from each cover type into plant assemblages (Hill 1979, Jongman *et al.* 1987, Gauch 1982, and Kent and Coker 1992). Cover types that are represented on fewer than three transects will be excluded from classification analyses because of the small sample size. Infrequently occurring species with less than 1 percent average cover will be excluded from classification analyses because they act like outliers in classification algorithms, adding a variability that obscures central tendencies (Gauch 1982, Tausch *et al.* 1995). Data from uncommon species are highly variable and often cannot be interpreted (Uresk 1990).

Plant assemblages will be described using average cover, constancy (percent occurrence among transects), average frequency (percent occurrence within a transect) of individual plant species and moss, lichen, rock, litter and bare ground, and using associated edaphic and topographic features. Species with less than 1 percent cover will be excluded from the summary tables. Frequency of woody species will be calculated based on occurrence in each 1-meter segment of the transect length. This measure of distribution is comparable to frequency by plot data (Asherin 1973). Soils data will be tested and analyzed to determine soil texture, pH, salts (mmhos/cm), cation exchange capacity (CEC) (meq/100-g), percent sodium of CEC, lime (percent), organic matter (percent), organic N (lb/A), nitrate-N (ppm), phosphorus (ppm) potassium (ppm), sodium (ppm), calcium (ppm), magnesium (ppm), and sulfur (ppm) for all transects. Important distinguishing soil characteristics and other edaphic factors will be included in the summary tables.

Successional interpretations for the plant assemblages will be made based on work done by previous investigators while recognizing that all succession theories are only hypotheses and are likely to remain so (Smith 1989). A species list will be developed by tallying all species found along vegetation sampling transects. Each plant species encountered will be grouped into its appropriate life form and its location within the study area.

Nomenclature

The plant assemblage (plant community) names used in this study will consist of one or two species in each life form (trees, shrubs, forbs, grasses), which contribute greater than 20 percent of relative plant cover. These names are not taxonomic units, have no successional status, and may not be recognized by all investigators. This nomenclature is analogous to "common names" where no bounds have been set or rules defined by which a particular common name is used. In some instances, generic terms such as mixed deciduous shrub or annual grassland will be used to identify heterogeneous plant communities. In some instances, dominant or co-dominant species may contribute less than 20 percent of relative plant cover, but will be considered key elements of the plant community based on their relative dominance, frequency of occurrence, or constancy among transects. Scientific names will be used in combination with common names to facilitate communication with users accustomed to one or the other. All scientific names will follow Kartesz (1994).

Timetable

It is anticipated that the final GIS data for the cover type map will be completed by February 1997 and delivered to IPC's Real Property Management Department for incorporation into the GIS.

In 1994, a pilot study was conducted to sample upland and riparian habitats, and determine efficacy of sampling methods and data adequacy. Methods were revised as necessary, and are those described in the above sections. These methods will be used from 1995 to 1998 to complete vegetation sampling. The years 1999 and 2000 will be used to fill in data gaps as necessary and prepare final reports. It is anticipated that interim progress reports will be prepared in 1997 and 1999. A final report is expected by April 2001.

Cooperation

Consultants will assist in developing the cover type map. Interested agencies and groups will be updated on study progress, and invited to review and comment on the final report.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Gary Holmstead, the principal investigator, holds a M.Sc. in Plant Ecology, and Valerie Geertson, botanical technician, a B.Sc. in Botany. Mr. Holmstead has 10 years of experience designing and implementing studies. Ms. Geertson has conducted extensive field sampling for vegetation studies over the past five years in the Hells Canyon vicinity. Mr. Holmstead and Ms. Geertson will be assisted by two to four field assistants with B.Sc. degrees in natural resources and one to three years of relevant field experience.

The facilities at IPC are well-suited to all phases of the study. IPC has available 4-wheel-drive vehicles, rafts, and jet and propeller-powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on the IPC's mainframe or personal computers using SAS (Statistical Analysis System, Carey, N.C.) and TWINSPAN software. The IPC GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

Final digital coverage of cover type polygons and linear features will be provided in an ARC/INFO® format. All features will be generated in a Universal Transverse Mercator (UTM) projection, based on NAD27 datum, in meters. All inventory data will be provided in digital format (ASCII) organized for each data type (i.e., plant cover, plant density, soil characteristics) by year and sampling site. Interim progress reports will be prepared in 1997 and 1999. A final report is expected by April 2001.

8.3.2.
Title: *Inventory of Threatened, Endangered and Sensitive Plant Species along the Snake River, Weiser, Idaho to Salmon River*

This is a descriptive study to be initiated in 1998 to assist IPC in meeting FERC requirements to describe botanical resources, specifically *threatened*, *endangered*, and *sensitive* plant species, of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. The collaborative team participants have been informed of ongoing or planned descriptive studies to be conducted by IPC as part of relicensing the Hells Canyon Project.

Abstract

The description of the environmental setting of Hells Canyon Complex requires information regarding *threatened* and *endangered* species. This study proposal outlines the objectives, time-lines and cooperation needed to develop a study to inventory rare plant species occurring in the Hells Canyon Study Area. Completion of the study is expected to occur in 2001.

Introduction

Required relicensing documentation must include data regarding *threatened* and *endangered* species. IPC has been strongly encouraged by state and federal agencies to evaluate rare species in addition to those listed by the USFWS as *threatened* or *endangered*. Information of this nature could be used to identify potential impacts resulting from project operations on rare species and to develop protective land management plans for IPC-owned lands, where needed.

Over one-hundred-sixty rare plant species, including one federally listed species and one *candidate* species, may occur in the Hells Canyon area and along associated transmission facilities. Because such a large number of species may occur in the study area, a screening process will be necessary to increase the effectiveness of inventories done. This study proposes to develop a means to determine which species and areas should be prioritized for inventory in the vicinity of the Hells Canyon Complex and areas downstream to the confluence of the Snake and Salmon Rivers.

Objectives of this study are:

1) determine which rare species may occur in the study area, especially within the vicinity of IPC facilities (dams, reservoirs, transmission corridors, and other generation-related structures) and IPC-held lands;
2) develop a means to prioritize species for inventory;
3) determine habitat characteristics for individual species or suites of species that have been mapped in the study area using GIS analysis if feasible and review of literature sources;
4) based on GIS output, identify sites that will likely contain rare species if feasible;
5) identify other sites in need of inventory;
6) identify areas that have been inventoried in the last 5 years;
7) develop a means to prioritize sites for inventories;
8) develop/select an inventory procedure;
9) perform the inventory using the priorities set for species and sites; and
10) compile the information into maps, tables and text.

Planning will be done in consultation with appropriate agencies having jurisdictional responsibilities for rare species and the Terrestrial Resources Work Group of the Collaborative Team. The study will be executed in concert with other relicensing studies focused on rare plant species in the Hells Canyon Study Area.

State of Knowledge

For the purpose of this study, rare plant species considered will include federally listed and *candidate* species, BLM and USFS *species of special concern*, Oregon Department of Agriculture (ODA) *threatened* and *endangered* species (OAR Ch. 603 (73)) and species identified by the Oregon Natural Heritage Program and Idaho Conservation Data Center. The combination of these lists of species provides more than one hundred-sixty species for consideration in this study (Table 5-9).

Numerous investigations of rare plants have occurred on federal lands in the vicinity of the Hells Canyon Complex, especially downstream of Hells Canyon Dam in the HCNRA. Inventories of project lands and other lands owned by IPC that occur in the vicinity of Brownlee, Oxbow and Hells Canyon Dams have been performed on an as needed basis. Thus, information regarding rare species in the study area is incomplete.

Methods

Study Area

The Hells Canyon Study Area encompasses all lands along the Snake River and associated reservoirs, from the Highway 30N Bridge (RM 351.2), at Weiser, Idaho, down river to the confluence of the Salmon River (RM 188.2), near Lewiston, Idaho, and along the Powder River arm of Brownlee Reservoir to the Powder River Bridge, near the confluence of Eagle Creek, for a distance of 9.6 miles. The lateral extent of the study area includes lands up to 0.5 miles from each shoreline above Hells Canyon Dam (RM 247.0) and lands up to 0.25 miles of each shoreline below Hells Canyon Dam.

Several hundred miles of transmission lines are associated with the Hells Canyon Project. The transmission lines and associated road corridors will be included in the study area as well.

The study area includes three reservoir reaches and a downstream reach. The Brownlee Reservoir Reach will extend for approximately 55 miles, from river mile (RM) 339.2 to 284.6. The Oxbow Reservoir Reach will extend for approximately 12 miles, from RM 284.6 to 272.2. The Hells Canyon Reservoir Reach will extend for approximately 25 miles, from RM 272.2 to 247.0. The reach downstream of Hells Canyon Dam will extend for approximately 59 miles, from RM 247.0 to 188.2.

Because of the large size of the study area, a complete inventory is not feasible. Refinement of the areas in need of inventory, e.g., those areas most likely to be affected by hydro-operations, will take place in consultation with agency personnel.

Rare Species Prioritization

Consultation with affected federal and state land management agencies and regional experts (agencies) will be used to develop a complete list of species that could be expected to occur in the study area. The list of agencies includes the USFS, BLM, Idaho Department of Parks and Recreation (IDPR), IDFG-CDC, ODA, and the ONHP of The Nature Conservancy.

Currently, the list of species that may occur in the study area includes over 160 species. Only one species on the list is protected under the Endangered Species Act of 1973. One species is classified as a federal *candidate* species. Approximately thirty percent of the species are classified as *sensitive* by either the USFS or BLM. The remainder have been identified by the CDC or ONHP.

A means to prioritize species and search areas will be developed in consultation with agencies that will permit effective inventories of the species that are most important and most likely to be present. Criteria that could be used to prioritize species might include designated protection status (*candidate*, *species of concern*, etc.), range, habitat, and immediacy of known threats to species/habitat. The evaluation could be based on known mapped and historic occurrences, range and habitat descriptions provided in the literature, expert advice, etc. Although prioritized species will be the focus of the study, field crews will be expected to be familiar with all of the rare species so that incidental sightings can be included in the rare species inventory.

GIS Analyses--Preinventory

Determining predictable habitat preferences may be possible for some species. Predictions may be based on habitat information collected from herbarium specimens or summarizing information arising from the intersection of data layers, e.g., topography, edaphy, vegetation types at sites of known occurrences. The information gathered may be used to predict the most likely locations with potential for rare species habitat or the greatest number of species likely to be encountered per unit area.

The type and quality of environmental data available for inclusion on GIS will be explored. Sources of data could include federal agencies administering lands within the study area, the NRCS, affected counties and state agencies responsible for vegetation management.

Site Selection

A means of selecting appropriate sites to inventory will be determined in consultation with agencies. Considerations for selection criteria could include legal requirements, known habitat characteristics/likelihood of one or more species occurring, proximity to facilities, or whether the site has been inventoried for rare plant species in the recent past.

Inventory Method

Selection of the field inventory method will explore those currently used by federal and state agencies in the Hells Canyon area. Field inventories could include the use of spotting scopes from accessible observation points when priority areas are difficult to access as well as on-site surveys. Selection will be done in consultation with agencies.

Analysis

All data will be incorporated into an ARC/INFO GIS system. Maps indicating distribution will be prepared. Information on habitat characteristics, phenology and threats to persistence will be summarized. Data will be analyzed and assessed following methods developed in consultation with agencies.

Link to PM&E Measures

Data will be used to support impact studies designed to identify impacts of project operations and associated facilities on rare plant species. Results of the study will be used by IPC and other appropriate organizations in the development of protection, mitigation or enhancement measures.

Timetable

This study is expected to require three field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. A progress report should be available by February 1999 and 2000 with a final report addressing the objectives of the study to be delivered by April 2001.

Cooperation

The following tasks will be conducted in consultation with agencies:

1) identifying rare plant species known or thought to occur in the study area,
2) determining priority of sites and species for inventory,
3) planning field inventory and analysis methods, and
4) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Nancy K. Cole, the principal investigator, holds a M.Sc. in Plant Ecology. Ms. Cole has 15 years of experience designing and implementing studies. Ms. Cole will be assisted by 2-4 field assistants with B.Sc. degrees in natural resources, and 1-3 years of relevant field experience.

IPC's facilities are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet and propeller powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted using SAS (Statistical Analysis System, Carey, N.C.). The IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be completed by February 1999 and 2000, summarizing search species, literature review, field methods, and survey results through the 1998 pilot season and subsequent year. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All rare plant species data will be compiled in a digital format (ASCII).

8.3.3.
Title: *Effects of Water Level Fluctuations on Noxious Weeds*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirements to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts, if any, on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories (FERC requirements).

T4. Effects of flow changes below dams.

T9. Operational effects on both reservoir and downstream areas.

T17. Impact identification (actual).

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free flowing reaches).

T31. Flooding/dewatering of terrestrial species - micro habitat.

T41. Do noxious weeds limit mitigation opportunity?

T45. Water level fluctuations and riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Land management practices may affect spread of noxious weeds.

1) What noxious weed species are present (distribution) in the study area?
2) What are the effects of IPC land management practices on the spread/distribution of noxious weeds?
3) How are results linked to protection, mitigation or enhancement planning & implementation?

Desired Future Resource Goals

The general goal is to identify and control populations of noxious weeds on lands influenced by the IPC's operations. Three specific goals are to:

1) control populations of noxious weeds occurring on IPC lands,
2) to identify alternative water level management prescriptions that reduce the spread of noxious weeds, and
3) for IPC to implement preferred prescriptions within the IPC's ability, considering other uses of water (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE).

FERC requires that relicensing applicants describe botanical resources in the vicinity of the project and the impact of project operation on those resources (18CFR §4.51(f)(3)). Idaho law states that it is the duty of all persons and nonfederal agencies to control noxious weeds on land and property that they own (**Idaho Code**, 22-2271). Specific agency plans that support the general goal include: manage riparian areas to achieve a healthy and productive condition for long-term benefits and values (USDI 1990), riparian and wetland habitat have a high priority for protection and improvement in accordance with state and national policy (USDI 1987).

Abstract

This investigation proposes to assess the influence of the IPC's operations on the spread of noxious weeds in the reservoir reaches of the Hells Canyon Complex and in the Snake River reach from Hells Canyon Dam to the confluence of the Salmon River. Populations of noxious weeds will be inventoried and described. Information on noxious weed species life histories and response to water level fluctuations will be obtained from the literature and used to model vegetation changes through time under various flow scenarios representing potential project operations and flow management activities. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Analyses will identify preferred strategies to reduce the spread of noxious weeds that are influenced by the IPC's operations. Recommendations will be made for appropriate mitigation, protection or enhancement measures to help attain desired future resource goals.

A complete summary of reservoir water level fluctuations or river water level fluctuations for the Hells Canyon Complex has not been compiled. The nature, extent, and distribution of noxious weeds in the study area are unknown. A consultant and interested agencies and groups will assist in planning field inventories of noxious weed populations and methods for assessing the causal factors for the occurrence of each population. Most field work will be conducted by IPC staff. The consultant will assist in interpreting results, modeling alternative management strategies and recommending appropriate protection, mitigation or enhancement measures to control the spread of noxious weeds as influenced by the IPC's operations.

Introduction

Noxious weeds are defined as those species having the potential to cause injury to public health, crops, livestock, land or other property; and which are designated as noxious by the state (**Idaho Code**, 22-2272(8)).

Water level fluctuations resulting from project operations can negatively and positively influence riparian habitats. Reservoir-related effects on shoreline habitats are directly tied to fluctuating water levels. Reservoirs with large water level fluctuations generally result in depauperate shoreline plant communities (Nilsson and Keddy 1988, O'Neil and McDonnell 1995) and may provide an opportunity for invasive noxious weed species to become established (Backeus 1993). Once established, these invasive species may spread to formerly unoccupied upland habitats. Reservoirs with narrow fluctuations can create stable shoreline communities, particularly along wider, shallow-gradient shoreline areas (Kryzanek *et al.* 1986, Wilcox and Meeker 1991). These communities often have well-developed aquatic, emergent and terrestrial wetland components. These conditions may be more resistant to weed invasion (Wilcox and Meeker 1991). Reservoirs with near static water levels tend to have more stable but less diverse shoreline communities than reservoirs with narrow fluctuations.

Timing of reservoir fluctuations has a strong influence on the shoreline plant community (Wilcox and Meeker 1991, Backeus 1993). Reservoirs which peak in the spring and then are gradually drawn down generally have rich shoreline communities. Reservoirs which peak at other times of the year, or remain high throughout the summer generally create difficult conditions for plant growth.

As a result, reservoirs with off-season water level fluctuations tend to have more depauperate shoreline communities.

Regulated water level fluctuations downstream of a hydroelectric dam can negatively and positively influence riparian habitats. Changes in shoreline vegetation tend to increase with increasing alterations from the natural flow regime. Flow regimes can negatively affect riparian vegetation when peak and base flows are altered such that they no longer coincide with vegetation processes (i.e., germination, seed dispersal) dependent on associated water and substrate conditions (GANDA 1996). The nature of change can be highly variable and depends on the ecology of the specific river being studied. Highly altered conditions from the natural flow regime may allow opportunities for invasive noxious weed species to become established and spread to formerly unoccupied adjacent habitats. However, damming for hydropower production on steep-walled canyon rivers can reduce the frequency of catastrophic floods that eliminate riparian vegetation. This can increase the net vegetative coverage of riparian areas (Kondolph *et al.* 1987, Turner and Karpiscak 1980, Johnson 1991) and create more stable plant communities that may be more resistant to weed invasion.

The objectives of this study are to:

1) identify those noxious weed species known or suspected to occur in the study area,
2) identify specific issues surrounding the potential for the IPC’s operations to influence the spread of noxious weed species,
3) inventory populations of noxious weeds in the study area and the associated causal factors for the occurrence of each population,
4) assess the influence of the IPC’s operations on the spread of noxious weeds, and
5) link the IPC’s’s influences on the spread of noxious weeds to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A complete summary of reservoir water level fluctuations for the Hells Canyon Complex has not been compiled. Historic headwater elevation data, available for approximately 1982-1995, can be obtained from power plant log books at the Brownlee, Oxbow and Hells Canyon Dams. These data are recorded by power plant operators off the headwater recorder at each dam. These daily measurements are most frequently recorded at the hours of 8:00, 16:00, 22:00 and 24:00.

A complete summary of river water level fluctuations below Hells Canyon Dam has not been compiled. Historic tailwater elevation data, available for approximately 1988-1995, can be obtained from log books at Hells Canyon Dam. Additional data is available further downstream since the 1940's at several USGS gaging stations.

At least 32 noxious plant species have been identified as known or suspected to occur in the Hells Canyon vicinity (IPC data). The USFS has conducted surveys for noxious plant species in the HCNRA for several years. Recent reports for surveys below Hells Canyon Dam identified and described populations of 12 species of noxious plants (Burton 1993*a*, 1993*b*). Most of these occurrences were associated with recreation sites (e.g., campgrounds, trails). More detailed information regarding the nature, extent, and distribution of noxious weeds in this reach is needed.

Detailed knowledge of the nature, extent, and distribution of noxious weeds in the reservoir reaches are unknown. Brownlee reservoir is subject to large water level fluctuations. Quite often, the shoreline high water mark forms the boundary between the reservoir and upland vegetation, with no riparian species present. Oxbow Reservoir probably has the greatest amount of shoreline occupied by riparian vegetation, followed by Hells Canyon Reservoir. These reservoirs are operated more as run-of-the-river facilities, which can allow riparian vegetation to establish and persist. The ways and extent that noxious weeds are influenced by project operations, specifically water level fluctuations, have not been investigated.

Methods

Study Area

The study area consists of three reservoir reaches and a downstream reach. The Brownlee Reservoir Reach will extend for approximately 55 miles, from river mile (RM) 339.2 to 284.6. The Oxbow Reservoir Reach will extend for approximately 12 miles, from RM 284.6 to 272.2. The Hells Canyon Reservoir Reach will extend for approximately 25 miles, from RM 272.2 to 247.0. The reach downstream of Hells Canyon Dam will extend for approximately 59 miles, from RM 247.0 to 188.2. The lateral extent of the study area will include all lands within approximately 50 meters of each shoreline.

Noxious Weed Identification

A preliminary literature review and data gathering effort will be conducted by the IPC principal investigator to compile/update the list of noxious weed species that may occur within the study area and vicinity. The review will be conducted using all available literature and data base files, in consultation with pertinent agencies and groups. General sources of information to be investigated include, but are not limited to: Idaho and Oregon state governments, county weed control agencies, and state universities and colleges with expertise in weed control.

Contractor Selection

Consultants with expertise in noxious weeds, botanical surveys, riparian ecology, hydrology, statistical analysis and modeling will be consulted to assist in this study. A single consultant will be selected to assist the IPC principal investigator. This consultant may utilize services of other subcontractors to perform elements of the work. The IPC principal investigator will develop a Request for Proposal (RFP) to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area, assess noxious weed species life histories and response to different disturbance vectors, and to address the potential for project operations to influence the spread of noxious weed species.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to search for noxious weed populations in the study area and to assess the causal factors for the occurrence of noxious weeds. Most field data will be collected by IPC staff. It is anticipated that the following conditions will apply.

Searches will take place in mid- to late-summer, during, and soon after, peak flowering to facilitate locating species of interest. The shoreline area will be divided into manageable sections for data collection purposes and field coordination (i.e., 0.5 mile shoreline mile sections in each reservoir reach). When a noxious weed population is encountered, detailed edaphic, topographic and population characteristics data will be collected. If the population is associated with water level fluctuations, the minimum and maximum distance of the population from the high water mark will be recorded. A population will be roughly defined at the point where no more individuals of the species occur for a distance of approximately 50 m.

A key component of the surveys will be an assessment of the type and degree of disturbance factors present within a population of noxious weeds. All disturbance vectors will be identified and their level (degree) of disturbance. Disturbance types may include alluvial (runoff water erosion), water fluctuation zone, livestock, mining, fire, road corridor activity, transmission corridor activity, industrial, agriculture, residential, off-road vehicle use, foot traffic, and recreation facility influences.

Describing Water Level Fluctuations

A summary of available historic headwater and tailwater elevation data will be obtained from the IPC Water Management Department to: characterize daily, monthly and annual reservoir water level fluctuations for each year of record for the Hells Canyon Complex, and distinguish between the water level fluctuations related to the IPC’s operations and those related to other purposes (i.e., fish flushes, flood control). The summary may be limited by the data available. Characterization of changes of water level will include: minimum and maximum elevation recorded; 50, 90, and 98 percent of all elevations; minimum and maximum daily, monthly, and yearly change; 50, 90, and 98 percent of maximum daily, monthly, and annual change. The number of samples recorded and other information will be presented in tables and figures to characterize these data. The IPC Water Management Department will provide an summary to identify river water level fluctuations related to the IPC's operations versus those related to other purposes (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE).

Analysis/Assessment

The consultant will assist in analyzing and assessing the data following the methods outlined in consultation with interested agencies and groups. It is anticipated that the following types of analyses will occur.

The number, types (species), and characteristics of noxious weed populations associated with each disturbance vector will be described. The relative number of occurrences and characteristics (i.e., density, plant cover, total area) of noxious weed populations will be compared for direct IPC operation disturbance vectors versus those not associated with project operations.

Vegetation Modeling

To estimate any changes in populations of noxious weeds that could be expected to occur under future flow scenarios, models will be developed and IPC's GIS will be used to display likely distribution patterns of noxious weeds in the study area. The response of plant species will be based on existing information available in the literature. This will be used to provide modeling parameters for each species. The time frame for simulations will be based on the expected duration of the project license plus the period between the present and the date for license expiration. A period of 30 to 50 years probably will be reasonable. Future noxious weed conditions will be determined using vegetation models (e.g. CHANWID, Simmons and Associates 1990) constructed with botanical and hydrologic information currently being collected by IPC. Output from the vegetation models will be spatially explicit and displayed as "scenario noxious weed maps" (e.g., using program ANUDEM, Hutchinson 1988) with the GIS.

Link to Protection, Mitigation or Enhancement Measures

The consultant will provide recommendations on protection, mitigation or enhancement measures. Beyond the control of noxious weeds on IPC lands, which is required by law, the focus of protection, mitigation or enhancement will be for IPC to implement preferred water level management prescriptions, so far as IPC is able, considering other uses of water (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE). Details and descriptions of all protection, mitigation or enhancement measures will be provided, and will include figures and illustrations, location maps, and other necessary information to implement protection, mitigation or enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early-1998. This study is expected to require two field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. A progress report should be available by February 1999 with a final report delivered by April 2000.

Cooperation

A consultant will be used to assist in most phases of the study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying potential noxious weed species known or suspected to occur in the study area,
2) developing the RFP for interested consultants,
3) planning field inventory and analysis methods,
4) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Gary Holmstead, the principal investigator, holds a M.Sc. in Plant Ecology and Valerie Geertson, botanical technician, a B.S. in Botany. Mr. Holmstead has 10 years of experience designing and implementing studies. Valerie Geertson has conducted extensive field sampling for vegetation studies over the past five years in the Hells Canyon vicinity. Gary Holmstead and Valerie Geertson will be assisted by 2-4 field assistants with B.S. degrees in natural resources, and 1-3 years of relevant field experience.

An expert consultant, with extensive experienced with noxious weeds, botanical surveys, riparian ecology, hydrology, and statistical analysis will be sought to assist with the study.

The facilities at IPC are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet and propeller powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on the IPC's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be prepared by February 1999, summarizing search species, literature review, field methods, and survey results through the 1998 pilot season. A draft of the final report will be prepared by February 2000, and a final report will be due by April 1, 2000. All noxious weed population data will be provided in a digital format (ASCII).

8.3.4.
Title: *Effects of Road and Transmission Line Rights-of-Ways on Noxious Weeds*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirements to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T17. Impact identification (actual).

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (R/W).

T41. Do noxious weeds limit mitigation opportunity?

T43. Secondary terrestrial species impacts associated with construction/maintenance of power line corridors.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Present power line operations including associated facilities may affect wildlife/botanical resources.

1) What are the effects, including secondary effects, of powerline operation (including associated facilities) to wildlife/botanical resources?
2) How are results linked to protection, mitigation or enhancement planning and implementation?

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of human presence related to operational activities on cultural, wildlife and botanical resources?
2) How are results linked to protection, mitigation or enhancement planning and implementation?

Land management practices may affect spread of noxious weeds.

1) What noxious weed species are present (distribution) in the study area?
2) What are the effects of IPC land management practices on the spread/distribution of noxious weeds?
3) How are results linked to protection, mitigation or enhancement planning and implementation?

Maintenance

Maintenance of transmission line facilities (including rights-of-ways) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources within transmission line corridors?
2) What are the effects of transmission maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning & implementation?

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources in the study area?
2) What are the effects of roadways and other facility maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning & implementation?

Desired Future Resource Goal

The general goal is to identify and control populations of noxious weeds on lands influenced by IPC operations. FERC requires that relicensing applicants describe botanical resources in the vicinity of the project and the impact of project operation on those resources (18CFR§4.51(f)(3)). Idaho law states that it is the duty of all persons and nonfederal agencies to control noxious weeds on land and property that they own (**Idaho Code**, 22-2271). Specific agency plans that support the general goal include: ensure optimum populations and a natural abundance and diversity of wildlife resources on public lands by restoring, maintaining, and enhancing habitat conditions through management plans and actions integrated with other uses of public lands through coordination with other programs, the states, by management initiatives, and through direct habitat improvement projects (USDI 1990).

Abstract

This investigation proposes to assess the influence of the IPC operation/maintenance activities on the spread of noxious weeds along roadways owned by IPC and along transmission line corridors associated with the Hells Canyon Project. Noxious weed populations will be inventoried and described. A summary of IPC operations in these associated transmission line corridors has not been compiled. The nature, extent, and distribution of noxious weeds in these areas are unknown. A consultant and interested agencies and groups will assist in planning field inventories of noxious weed populations and methods for assessing the causal factors for the occurrence of each population. Most field work will be conducted by IPC staff. The consultant will assist in interpreting results and recommending appropriate protection, mitigation or enhancement measures to control the spread of noxious weeds as influenced by the IPC operations.

Introduction

Noxious weeds are defined as those species having the potential to cause injury to public health, crops, livestock, land or other property; and which is designated as noxious by the state (**Idaho Code**, 22-2272(8)).

Direct and indirect factors resulting from project operations along transmission line corridor and roadways may influence the spread of noxious weeds. Direct factors can include cutting, burning and use of herbicides on vegetation growing in the transmission line rights-of-way or along roadsides. These practices are most common in habitats with tree and large shrub components which may interfere with overhead or underground lines or structures (EPRI 1995), or where visibility is restricted or the threat of vehicle related fires from roadsides may be great. Numerous researchers have studied rights-of-way vegetation characteristics (Champlin 1973, Sorensen 1974, Vasek *et al.* 1975, Beley *et al.* 1982, Hessing and Johnson 1982, Loney and Hobbs, 1991, Luken *et al.* 1992, Brown 1994). Cleared forest or shrub communities are typically replaced by much simpler, early successional communities dominated by grasses, herbs and/or shrubs. Often, these species are weedy exotics able to quickly colonize the early successional environment of a cleared corridor (MacLellan and Stewart 1986). Herbicides are frequently used to maintain this early successional stage (USFWS 1979).

The indirect effects of corridor maintenance are numerous and can be more subtle. Once a roadway or corridor is established, aggressive exotic species may be introduced to the corridor by passing workers, motorists, wildlife and a variety of recreational users. Once present in the corridor, the weeds can invade adjacent native habitats (MacLellan and Stewart 1986).

The objectives of this study are to:

1) identify those noxious weed species known or suspected to occur in the study area,
2) identify specific issues surrounding the potential for the project operations to influence the spread of noxious weed species,
3) inventory populations of noxious weeds in the study area and the associated causal factors for the occurrence of each population,
4) assess the influence of project operations on the spread of noxious weeds, and
5) link the IPC's influences on the spread of noxious weeds to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A summary of operations in IPC transmission line corridors associated with the Hells Canyon Project License has not been compiled. Locational information and general descriptive information of these corridors should be available in the IPC's files.

At least 32 noxious plant species have been identified as known or suspected to occur in the Hells Canyon vicinity (IPC data). Detailed information regarding the nature, extent, and distribution of noxious weeds along roadway and transmission corridors is not available. The ways and extent that noxious weeds are influenced by project operation/maintenance activities along these corridors have not been investigated.

Methods

Study Area

The roadway area will include all lands impacted by cut/fill activities, or other disturbed areas, of IPC-owned roadways occurring in the Hells Canyon vicinity (generally within three miles of the Snake River; rim to rim area of Hells Canyon) and undisturbed areas out to a distance of about 50 meters on each side of the roadway centerline. Roadways will include unimproved and paved roads. The total miles of such roadways are unknown but anticipated to be approximately 50-75 miles in length. Examples of such roads include the paved Hells Canyon Road, between Oxbow and Hells Canyon dams, and roads in the immediate vicinity of Oxbow Dam and Brownlee Dam.

The transmission line area will include all lands impacted by cut/fill activities or other disturbed areas associated with transmission towers and all roadways specifically constructed to access transmission towers. As a minimum, it will include a 100 m radius around towers and a 50 m buffer on each side of the centerline of all roadways. All lines to be relicensed with the Hells Canyon Project will be included. An estimate of the total length of transmission lines is approximately 910 miles. The total length of access roads is unknown.

Noxious Weed Identification

A preliminary literature review and data gathering effort will be conducted by the IPC principal investigator to compile/update the list of noxious weed species that may occur within the study area and vicinity. The review will be conducted using all available literature and data base files, in consultation with pertinent agencies and groups. General sources of information to be investigated include, but are not limited to: Idaho and Oregon state governments, county weed control agencies, and state universities and colleges with expertise in weed control.

Contractor Selection

Consultants with expertise in noxious weeds, botanical surveys, plant ecology, and statistical analysis will be sought to assist with this study. A single consultant will be selected to assist the IPC principal investigator. This consultant may utilize services of other subcontractors to perform elements of the work. The IPC principal investigator will develop a RFP to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area, assess noxious weed species response to different disturbance vectors, and to address the potential for project operations to influence the spread of noxious weed species.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to search for noxious weed populations in the study area and to assess the causal factors for the occurrence of noxious weeds. Most field data will be collected by IPC staff. It is anticipated that the following conditions will apply.

Searches will take place in mid- to late-summer, during, and soon after, peak flowering to facilitate locating species of interest. The study area will be divided into manageable sections for data collection purposes and field coordination (i.e., 1-mile sections in each roadway or transmission line). When a noxious weed population is encountered, detailed edaphic, topographic and population characteristics data will be collected. If the population is associated with water level fluctuations or roadways, the minimum and maximum distance of the population from the high water mark or roadway will be recorded. A population will be roughly defined at the point where no more individuals of the species occur for a distance of approximately 50 m.

A key component of the surveys will be an assessment of the type and degree of disturbance factors present within a population of noxious weeds. All disturbance vectors will be identified, both primary and secondary vectors, and their level (degree) of disturbance. Disturbance types may include alluvial (runoff water erosion), water fluctuation zone, livestock, mining, fire, road corridor activity, transmission corridor activity, industrial, agriculture, residential, off-road vehicle use, foot traffic, and recreation facility influences.

Describing Operation/Maintenance Activities

A description of the IPC's operation/maintenance activities will be provided by IPC's Transmission Department. It will include, where available, a summary of the types, extent, location, and timing of activities. Types of activities could include: wheeled vehicle travel (i.e., pickup, ATV), helicopter travel, herbicide spraying, vegetation mowing, tree/shrub pruning, and road repair. The extent of activities will be summarized, where possible, by hours/month and hours/year for each activity type. It is anticipated that the location will be summarized by mile points along roads and transmission corridors or along specific sections of roads or transmission corridors for each activity type. Timing will be summarized by days of the week, weeks of the month, and months of the year, as appropriate, for each activity type.

Analysis/Assessment

The consultant will assist in analyzing and assessing the data following the methods outlined in consultation with interested agencies and groups. It is anticipated that the following types of analyses will occur.

The number, types (species), and characteristics of noxious weed populations associated with each disturbance vector will be described. The relative number of occurrences and characteristics (i.e., density, plant cover, total area) of noxious weed populations will be compared for direct IPC operation disturbance vectors versus those not associated with project operations.

To estimate any changes in populations of noxious weeds that could be expected to occur under future transmission line or roadway operational scenarios (i.e., re-blading of dirt roads, mowing along rights-of-way) IPC's GIS will be used to display likely distribution patterns of noxious weed populations in the study area. The response of individual species will be based on existing information available in the literature.

Link to Protection, Mitigation or Enhancement Measures

The consultant will assist with recommendations on protection, mitigation or enhancement measures to control noxious weeds as influenced by project operations. Details and descriptions of all protection, mitigation or enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation or enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early-1998. This study is expected to require three field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. Progress reports should be available by February 1999 and February 2000, with a final report delivered by April 2001.

Cooperation

A consultant will be used to assist in most phases of the study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying potential noxious weed species known or suspected to occur in the study area,
2) developing the RFP for interested consultants,
3) planning field inventory and analysis methods,
4) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Gary Holmstead, the principal investigator, holds a M.Sc. in Plant Ecology and Valerie Geertson, botanical technician, a B.S. in Botany. Mr. Holmstead has 10 years of experience designing and implementing studies. Valerie Geertson has conducted extensive field sampling for vegetation studies over the past five years in the Hells Canyon vicinity. Gary Holmstead and Valerie Geertson will be assisted by 2-4 field assistants with B.S. degrees in natural resources, and 1-3 years of relevant field experience.

An expert consultant, with extensive experienced with noxious weeds, botanical surveys, riparian ecology and statistical analysis will be sought to assist with the study.

The facilities at IPC are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet and propeller powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on IPC's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be delivered in February 1999, for 1998 activities, and in February 2000, for 1999 activities. These progress reports will summarize search species, literature review, field methods, and survey results. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All noxious weed population data will be provided in a digital format (ASCII).

8.3.5.
Title: *Effects of Water Level Fluctuations on Botanical Resources*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirements to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories (FERC requirements).

T4. Effects of flow changes below dams.

T9. Operational effects on both reservoir and downstream areas.

T17. Impact identification (actual).

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free flowing reaches).

T31. Flooding/dewatering of terrestrial species - micro habitat.

T45. Water level fluctuations and riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting wildlife/botanical resources.

1) What are the riparian habitats from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hells Canyon Dam to the confluence of the Salmon River?
3) What are the effects to riparian habitats, including microhabitat, from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by Hells Canyon Project operations?
4) What are the riparian resources in reservoir reaches in the study area?
5) What are the water level fluctuations in reservoir reaches?
6) What are the effects to riparian habitat, including microhabitat, on reservoir reaches caused by water level fluctuations by Hells Canyon Project operations?
7) How are results linked to protection, mitigation or enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to inventory and manage botanical resources that are influenced by the IPC's operations to achieve a healthy and productive condition for long-term benefits and values. FERC requires that relicensing applicants describe botanical resources in the vicinity of the project and the impact of the project operation on those resources (18CFR§4.51(f)(3)). Specific agency plans that support the general goal include: manage riparian areas to achieve a healthy and productive condition for long-term benefits and values (USDI 1990), riparian and wetland habitat have a high priority for protection and improvement in accordance with state and national policy (USDI 1987).

Abstract

This investigation proposes to assess the influence project operations on botanical resources in the reservoir reaches of the Hells Canyon Complex and in the Snake River reach from Hells Canyon Dam to the confluence of the Salmon River. Existing vegetation cover types and plant communities will be inventoried and described. Information on plant species and plant community life histories and response to water level fluctuations will be obtained from the literature and used to model vegetation changes through time under various flow scenarios representing potential project operations and flow management activities. Potential scenarios will be developed in cooperation with resource agencies and other interested parties. Analyses will identify preferred strategies to improve the botanical resources that are influenced by IPC's operations. Recommendations will be made for appropriate mitigation, protection or enhancement measures to help attain desired future resource goals.

A complete summary of reservoir water level fluctuations or river water level fluctuations for the Hells Canyon Complex has not been compiled for purposes of this type of study. The nature, extent, and distribution of botanical resources in the study is not documented. A consultant and interested agencies and groups will assist in planning field inventories of botanical resources and methods for assessing the influence of project operations on those resources. Existing data collected by IPC, augmented by new field data collected in 1998-2000 will be used. Most field work will be conducted by IPC staff. The consultant will assist in interpreting results, modeling alternative management strategies, and recommending appropriate protection, mitigation or enhancement measures.

Introduction

Water level fluctuations resulting from project operations can negatively and positively influence riparian habitats. Reservoir-related effects on shoreline habitats are directly tied to fluctuating water levels. Reservoirs with large water level fluctuations generally result in depauperate shoreline plant communities composed of weedy annual species (Nilsson and Keddy 1988, Backeus 1993, O'Neil and McDonnell 1995). Reservoirs with narrow fluctuations can create stable shoreline communities, particularly along wider, shallow-gradient shoreline areas (Kryzanek *et al.* 1986, Wilcox and Meeker 1991). These communities often have well-developed aquatic, emergent and terrestrial wetland components. These conditions may be more resistant to weed invasion (Wilcox and Meeker 1991). Reservoirs with near static water levels tend to have more stable but less diverse shoreline communities than reservoirs with narrow fluctuations.

Timing of reservoir fluctuations has a strong influence on the shoreline plant community (Wilcox and Meeker 1991, Backeus 1993). Reservoirs which peak in the spring and then are gradually drawn down generally have rich shoreline communities. Reservoirs which peak at other times of the year, or remain high throughout the summer generally create difficult conditions for plant growth. As a result, reservoirs with off-season water level fluctuations tend to have more depauperate shoreline communities.

Regulated water level fluctuations downstream of a project operation can negatively and positively influence riparian habitats. Changes in shoreline vegetation tend to increase with increasing alterations from the natural flow regime. Flow regimes can negatively affect riparian vegetation when peak and base flows are altered such that they no longer coincide with vegetation processes (i.e., germination, seed dispersal) dependent on associated water and substrate conditions (GANDA 1996). The nature of change can be highly variable and depends on the ecology of the specific river being studied. However, damming for hydropower production on steep-walled canyon rivers can reduce the frequency of catastrophic floods that eliminate riparian vegetation. This can increase the net vegetative coverage of riparian areas and create more stable plant communities compared to pre-dam conditions (Kondolph *et al.* 1987, Turner and Karpiscak 1980, Johnson 1991).

The objectives of this study are to:

1) identify specific issues surrounding the potential for the IPC's reservoir operations to influence botanical resources,
2) inventory the botanical resources (not including *threatened*, *endangered*, and *sensitive* species or noxious weed species) that may be influenced by reservoir water level fluctuations,
3) assess the influence of the IPC's operations on the occurrence of botanical resources in the reservoir reaches, and
4) link the IPC's influences on the botanical resources to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A complete summary of reservoir water level fluctuations for the Hells Canyon Complex has not been compiled for purposes of this study. Historic headwater elevation data, available for approximately 1982-1995, can be obtained from power plant log books at the Brownlee, Oxbow and Hells Canyon Dams. These data are recorded by power plant operators off the headwater recorder at each dam. These daily measurements are most frequently recorded at the hours of 8:00, 16:00, 22:00 and 24:00.

A complete summary of river water level fluctuations below Hells Canyon Dam has not been compiled. Historic tailwater elevation data, available for approximately 1988-1995, can be obtained from log books at Hells Canyon Dam. Additional data is available further downstream since the 1940's at several USGS gaging stations.

Detailed knowledge of the nature, extent, and distribution of the surface ecosystems specific to the riparian habitats in the canyon bottoms and the surrounding upland habitat are unavailable. Few botanical studies have been conducted along the Snake River corridor associated with the Hells Canyon Complex. Previous investigations have been primarily concerned with characterizing potential natural vegetation and successional status of vegetation types, or have described only a few plant communities. Past studies provide little information on the extent or spatial characteristics of plant communities in the Hells Canyon vicinity.

Field observations indicate that a significant amount of riparian habitat exists along the reservoirs. Generally along the Snake River in Hells Canyon, upland vegetation communities occur in large, irregular-shaped blocks, while riparian communities are found in linear-shaped polygons, parallelling the river, reservoir, or tributary drainages. On Brownlee Reservoir, most riparian vegetation that is subject to water level fluctuations, occurs at the upper end of the Powder River arm, and at the mouths of larger tributary drainages. Quite often, the shoreline high-water mark forms the boundary between the reservoir and upland vegetation, with no riparian species present. Oxbow Reservoir probably has the greatest amount of shoreline riparian vegetation, followed by Hells Canyon Reservoir. These reservoirs are operated more as run-of-the-river facilities, which can allow riparian vegetation to establish and persist.

Field observations indicate that a significant amount of riparian habitat exists along the river below Hells Canyon Dam to the confluence of the Salmon River. Because of rocky, steep canyon walls, the shoreline high water mark often forms the boundary between the river and upland vegetation, with no riparian species present. However, a significant amount of riparian habitat exists, often dominated by netleaf hackberry (*Celtis reticulata)* along much of the river and by a variety of woody species near the deltas of tributary drainages. The ways and extent that botanical resources are influenced by project operations, specifically water level fluctuations, have not been investigated.

Methods

Study Area

The study area consists of three reservoir reaches and a downstream reach. The Brownlee Reservoir Reach will extend for approximately 55 miles, from river mile (RM) 339.2 to 284.6. The Oxbow Reservoir Reach will extend for approximately 12 miles, from RM 284.6 to 272.2. The Hells Canyon Reservoir Reach will extend for approximately 25 miles, from RM 272.2 to 247.0. The reach downstream of Hells Canyon Dam will extend for approximately 59 miles, from RM 247.0 to 188.2. The lateral extent of the study area will include all lands within approximately 50 meters of each shoreline.

Contractor Selection

Consultants with expertise in plant ecology, botanical surveys, riparian ecology, hydrology, statistical analysis, and habitat modeling will be consulted to assist with this study. A single consultant will be selected to assist the IPC principal investigator. The selected consultant may utilize services of other subcontractors to perform elements of the work. The IPC principal investigator will develop a RFP to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to:

1) obtain descriptive information on the riparian habitats of the study area,
2) identify previous work that may be applicable for addressing potential the IPC's operation influences on botanical resources in the reservoir reaches,
3) obtain information on plant species and plant communities response to changes in water levels, and
4) to develop and identify research methodologies for investigating issues.

The literature review will follow a hierarchical structure starting with publications of national relevance, proceeding to the regional perspective, and ending with focus on the local level.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to describe existing botanical resources associated with the water level fluctuation zone. It is anticipated that most field data will be collected by IPC staff.

IPC is in the final stages of collecting substantial descriptive information on botanical resources in the Hells Canyon vicinity to meet FERC requirements for preparing its relicensing document and to provide baseline information for other environmental studies. These data will be reviewed to determine their usefulness in this study. They include a cover type map, and field descriptions of upland and riparian cover types and associated plant communities of the Snake River corridor in Hells Canyon.

Describing Water Level Fluctuations

A summary of available historic headwater and tailwater elevation data will be obtained from the IPC Water Management Department to: characterize daily, monthly and annual reservoir water level fluctuations for each year of record for the Hells Canyon Complex, and distinguish between the water level fluctuations related to the project operations and those related to other purposes (i.e., fish flushes, flood control). The summary may be limited by the data available. Characterization of changes of water level will include: minimum and maximum elevation recorded; 50, 90, and 98 percent of all elevations; minimum and maximum daily, monthly, and yearly change; 50, 90, and 98 percent of maximum daily, monthly, and annual change. The number of samples recorded and other information will be presented in tables and figures to characterize these data. The IPC

Water Management Department will provide an summary to identify river water level fluctuations related to project operations versus those related to other purposes (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE).

Analysis/Assessment

The consultant will assist in analyzing and assessing the data following the methods outlined in consultation with interested agencies and groups. It is anticipated that the following types of analyses will occur.

The extent, representation and distribution of cover types and plant communities occurring along each reach will be described. The total amount of riparian-vegetated and upland-vegetated shoreline occurring along each reach will be summarized. A qualitative assessment will be made to link the characteristic water level fluctuations with the occurrence of botanical resources in the study area. This will be based on existing information available in the literature on cover type, plant community, and individual species response to different water level fluctuations.

The amount of influence on botanical resources that can be attributed to project operations will be determined by evaluating the available water level fluctuation data for the period of record, assigning a score or percentage for each year, and taking a mean. Specific criteria and values to accomplish this task will be defined in consultation with interested agencies and groups.

Vegetation Modeling

To estimate any changes in botanical resources that could be expected to occur under future flow scenarios, models will be developed and IPC's GIS will be used to display likely distribution patterns of cover types in the study area. The response of plant species and communities will be based on existing information available in the literature. This will be used to provide modeling parameters for each cover type. The time frame for simulations will be based on the expected duration of the project license plus the period between the present and the date for license renewal. A period of 30 to 50 years probably will be reasonable. Future vegetation conditions, based on cover types, will be determined using vegetation models (e.g. CHANWID, Simmons and Associates 1990) constructed with botanical and hydrologic information currently being collected by IPC. Output from the vegetation models will be spatially explicit and displayed as "scenario cover type maps" (e.g., using program ANUDEM, Hutchinson 1988) with the GIS.

Link to Protection, Mitigation or Enhancement Measures

The consultant will assist with recommendations on protection, mitigation or enhancement measures for botanical resources influenced by project operations. The focus of protection, mitigation or enhancement will be for IPC to implement preferred water level management prescriptions, so far as IPC is able, considering other uses of water (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE). Details and descriptions of all protection, mitigation or enhancement measures will be provided, and will include figures and illustrations, location maps, and other necessary information to implement protection, mitigation or enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early-1998. This study is expected to require two field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. A progress report should be available by February 1999 with a final report delivered by April 2000.

Cooperation

A consultant will be used to assist in most phases of the study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) developing the RFP for interested consultants,
2) planning field inventory and analysis methods,
3) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Gary Holmstead, the principal investigator, holds a M.Sc. in Plant Ecology and Valerie Geertson, botanical technician, a B.S. in Botany. Mr. Holmstead has 10 years of experience designing and implementing studies. Valerie Geertson has conducted extensive field sampling for vegetation studies over the past five years in the Hells Canyon vicinity. Gary Holmstead and Valerie Geertson will be assisted by 2-4 field assistants with B.S. degrees in natural resources, and 1-3 years of relevant field experience.

An expert consultant, with extensive experienced with noxious weeds, botanical surveys, riparian ecology, hydrology, and statistical analysis will be sought to assist with the study.

The facilities at IPC are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet and propeller powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on IPC's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be completed by February 1999, summarizing literature review, field methods, and survey results through the 1998 pilot season. A draft of the final report will be prepared by February 2000, and a final report will be due by April 1, 2001. All inventory data collected by the consultant will be provided in a digital format (ASCII).

8.3.6.
Title: *Effects of Road and Transmission Line Rights-of-Ways on Botanical Resources*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirements to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T17. Impact identification (actual).

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (R/W).

T43. Secondary terrestrial species impacts associated with construction/maintenance of power line corridors.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Present power line operations including associated facilities may affect wildlife/botanical resources.

1) What are the effects, including secondary effects, of powerline operation (including associated facilities) to wildlife/botanical resources?
2) How are results linked to protection, mitigation or enhancement planning and implementation?

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of human presence related to operational activities on cultural, wildlife and botanical resources?
2) How are results linked to protection, mitigation or enhancement planning and implementation?

Maintenance

Maintenance of transmission line facilities (including rights-of-ways) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources within transmission line corridors?
2) What are the effects of transmission line maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning and implementation?

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources in the study area?
2) What are the effects of roadways and other facility maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning & implementation?

Desired Future Resource Goal

The general goal is to inventory and manage botanical resources on lands that are influenced by project operations to achieve a healthy and productive condition for long-term benefits and values. The FERC requires that relicensing applicants describe botanical resources in the vicinity of the project and the impact of project operations on those resources (18CFR§4.51(f)(3)). Specific agency plans that support the general goal include: ensure optimum populations and a natural abundance and diversity of wildlife resources on public lands by restoring, maintaining, and enhancing habitat conditions through management plans and actions integrated with other uses of public lands through coordination with other programs, the states, by management initiatives, and through direct habitat improvement projects (USDI 1990).

Abstract

This investigation proposes to assess the influence of IPC operation/maintenance activities on the botanical resources along roadways owned by IPC and along transmission line corridors associated with the Hells Canyon Project. Existing vegetation cover type and plant communities will be inventoried and described. A summary of IPC operations in the transmission line corridors

associated with the Hells Canyon Project has not been compiled. The nature, extent, and distribution of botanical resources in these areas are unknown. A consultant and interested agencies and groups will assist in planning field inventories of botanical resources and methods for assessing the influence of IPC's operations on those resources. Existing data collected by IPC, augmented by new field data collected in 1998-2000 will be used. Most field work will be conducted by IPC staff. The consultant will assist in interpreting results and recommending appropriate protection, mitigation or enhancement measures.

Introduction

Direct and indirect factors resulting from IPC operations along transmission line corridor and roadways may influence botanical resources. Direct factors can include cutting, burning and use of herbicides on vegetation growing in the transmission line rights-of-way or along roadsides. These practices are most common in habitats with tree and large shrub components which may interfere with overhead or underground lines or structures (EPRI 1995), or where visibility is restricted or the threat of vehicle related fires from roadsides may be great. Numerous researchers have studied rights-of-way vegetation characteristics (Champlin 1973, Sorensen 1974, Vasek *et al.* 1975, Beley *et al.* 1982, Hessing and Johnson 1982, Loney and Hobbs, 1991, Luken *et al.* 1992, Brown 1994). Cleared forest or shrub communities are typically replaced by much simpler, early successional communities dominated by grasses, herbs and/or shrubs. Often, these species are weedy exotics able to quickly colonize the early successional environment of a cleared corridor (MacLellan and Stewart 1986). Herbicides are frequently used to maintain this early successional stage (USFWS 1979).

The indirect effects of corridor maintenance are numerous and can be more subtle. Once a roadway or corridor is established, vegetation can be impacted by passing workers, motorists,, wildlife and a variety of recreational users.

The objectives of this study are to:

1) identify and describe roads and transmission line corridors associated with the Hells Canyon Project,
2) identify and describe operational activities occurring along these corridors,
3) identify specific issues surrounding the potential for IPC's operations to influence botanical resources,
4) inventory botanical resources (not including TES or noxious weed species) in the study area and the associated causal factors for the occurrence of the resources,
5) assess the influence of operations on botanical resources, and
6) link operational influences on botanical resources to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A summary of operations in transmission line corridors associated with the Hells Canyon Project License has not been compiled. Locational and descriptive information of these corridors should be available in IPC's files.

Few botanical studies have been conducted along the Snake River corridor or along roads or transmission lines associated with the Hells Canyon Complex. Previous field investigations have been primarily concerned with characterizing potential natural vegetation and successional status of vegetation types, or have described only a few plant communities.

Three vegetation mapping studies of Idaho and Oregon provide some coarse information on the nature, extent and spatial characteristics of vegetation assemblages for this study. Each study maps vegetation using 30-m satellite thematic mapper (TM) data. One study covers northern Idaho, extending down to approximately Oxbow (about the southern boarder of the Payette N.F.) (Univ. of Montana in cooperation with the USFS Region 1). The digital database for this study is available in IPC’s GIS files. Another study maps southern Idaho, and is scheduled for completion in late 1998 (Utah State Univ. in cooperation with the USFS Region 4 and Nat. Biol. Service). The third study is limited to the boundaries of the Wallowa-Whitman National Forest in eastern Oregon. The digital database for this study is also available in IPC’s GIS files.

The ways and extent that botanical resources are influenced by project operation/maintenance along it’s private roads and transmission line corridors have not been investigated.

Methods

Study Area

The roadway area will include all lands impacted by cut/fill activities, or other disturbed areas, on IPC owned roadways occurring in the Hells Canyon vicinity (generally within three miles of the Snake River; rim to rim area of Hells Canyon) and undisturbed areas out to a distance of about 50 meters on each side of the roadway centerline. Roadways will include unimproved and paved roads. The total miles of such roadways are unknown but anticipated to be approximately 50-75 miles in length. Examples of such roads include the paved Hells Canyon Road, between Oxbow and Hells Canyon Dams, and roads in the immediate vicinity of Oxbow Dam and Brownlee Dam.

The transmission line area will include all lands impacted by cut/fill activities, or other disturbed areas, associated with transmission towers and all roadways specifically constructed to access transmission towers. As a minimum it will include a 100 m radius around towers and a 50 m buffer on each side of the centerline of all roadways. All lines to be relicensed with the Hells Canyon Project will be included. The total length of access roads is unknown.

Contractor Selection

Consultants with expertise in botanical surveys, plant ecology, statistical analysis, and habitat modeling will be consulted to assist in this study. A single consultant will be selected to assist the IPC principal investigator. This consultant may utilize services of other subcontractors to perform elements of the work. The IPC principal investigator will develop a RFP to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area, obtain information on cover type, plant community and individual plant species response to disturbances, and to address the potential for project operations to influence botanical resources.

Cover Type Mapping

Where possible, existing data from satellite landsat thematic (TM) mapping projects will be used to map botanical resources for the study area. Because these projects have characterized huge areas, scenes covering lands within 1 mile of transmission line corridors, access roads, and other disturbances associated with constructing the transmission lines will be clipped out and used to build the cover type thematic layer in GIS. The relationships between the cover type classification used with any TM data and the cover type classification used by IPC will be determined. IPC's cover types will be based on 26 vegetation, natural feature and land use cover types, and will generally follow the classification system described by Cowardin *et al.* (1979) and modified for Habitat Evaluation Procedures (USFWS 1981). The TM data will be reclassified to conform with the cover types used by IPC.

Where mapping data are not available, IPC will obtain cover type data will be obtained by driving or flying along the study area and using a GPS unit to record and classify lands. Detailed polygon boundaries will not be determined, rather just zones of cover types that occur in the study area. All cover type data will then be compiled to create a complete cover type thematic layer in the GIS.

The location of transmission line access roads, transmission towers, transmission lines, and other disturbances will be compiled and entered on the GIS as thematic layers. The intersection of these physical features and vegetation cover types can then be identified.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to inventory botanical resources in the study area and to assess the influence of project operation/maintenance activities on those resources. It is anticipated that the following conditions will apply.

A key component of field inventories will be an assessment of the type and degree of disturbance factors associated with botanical resources. All disturbance vectors will be identified, both primary and secondary vectors, and their level (degree) of disturbance. Disturbance types may include alluvial (runoff water erosion), water fluctuation zone, livestock, mining, fire, road corridor activity, transmission corridor activity, industrial, agriculture, residential, off-road vehicle use, foot traffic, and recreation facility influences.

Field inventories will be conducted to collected data to describe each vegetation cover type and to ground truth the cover type map. Methods for these efforts will be outlined in consultation with interested agencies and groups.

Describing Operation/Maintenance Activities

A description of IPC's operation/maintenance activities will be provided by the Transmission Department. It will include, where available, a summary of the types, extent, location, and timing of activities. Types of activities could include: wheeled vehicle travel (i.e., pickup, ATV), helicopter travel, herbicide spraying, vegetation mowing, tree/shrub pruning, and road repair. The extent of activities will be summarized, where possible, by hours/month and hours/year for each activity type. It is anticipated that the location will be summarized by mile points along roads and transmission corridors or along specific sections of roads or transmission corridors for each activity type. Timing will be summarized by days of the week, weeks of the month, and months of the year, as appropriate, for each activity type.

Analysis/Assessment

The consultant will assist in analyzing and assessing the data following the methods outlined in consultation with interested agencies and groups. It is anticipated that the following types of analyses will occur.

The extent, representation and distribution of cover types intersected by roads, transmission towers will be described. To evaluate the influence of IPC's operation/maintenance activities on botanical resources along these corridors, a qualitative assessment will be made to evaluate the types, extent, location, and timing of activities versus the status (health) of botanical resources immediately associated with IPC's activities and the status of botanical resources in the vicinity, outside the influence of IPC's activities. Botanical 'health' will be assessed by comparing the characteristics of cover types and plant communities (i.e., composition, native versus introduced species, cover) directly associated with project operations, to the characteristics of cover types and plant communities in the vicinity, outside the influence of IPC's activities. When possible, the successional status (i.e., early-seral, late-seral, climax) of botanical resources immediately associated with IPC's activities will be compared with previous published information.

To estimate any changes in botanical resources that could be expected to occur under future road and transmission line operational scenarios (i.e., re-blading of dirt roads, mowing along rights-of-way), IPC's GIS will be used to display likely distribution patterns of cover types in the study area. The response of cover types, plant communities, and individual species will be based on existing information available in the literature.

Link to Protection, Mitigation or Enhancement Measures

The consultant will assist with recommendations on protection, mitigation or enhancement measures to control noxious weeds as influenced by IPC's operations. Details and descriptions of all protection, mitigation or enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation or enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early-1998. This study is expected to require three field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. Progress reports should be available by February 1999 and February 2000 with a final report delivered by April 2001.

Cooperation

A consultant will be used to assist in most phases of the study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) developing the RFP for interested consultants,
2) planning field inventory and analysis methods,
3) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Gary Holmstead, the principal investigator, holds a M.Sc. in Plant Ecology and Valerie Geertson, botanical technician, a B.S. in Botany. Mr. Holmstead has 10 years of experience designing and implementing studies. Valerie Geertson has conducted extensive field sampling for vegetation studies over the past five years in the Hells Canyon vicinity. Gary Holmstead and Valerie Geertson will be assisted by 2-4 field assistants with B.S. degrees in natural resources, and 1-3 years of relevant field experience. An expert consultant, with extensive experienced with noxious weeds, botanical surveys, riparian ecology, hydrology, and statistical analysis will be sought to assist with the study.

The facilities at IPC are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet and propeller powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on the IPC's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be completed in February 1999, for 1998 activities, and in February 2000, for 1999 activities. These progress reports will summarize literature review (1999 report only), field methods, and survey results. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All inventory data will be provided in a digital format (ASCII).

8.3.7.
Title: *Effects of Water Level Fluctuations Resulting from Operation of the Hells Canyon Complex upon Threatened, Endangered and Sensitive Species*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirements to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories (FERC requirements).

T4. Effects of flow changes below dams.

T5. Impacts from flow changes and flooding of original habitat from construction.

T9. Operational effects on both reservoir and downstream areas.

T17. Impact identification (actual).

T18. Mitigation plans.

T31. Flooding/dewatering of terrestrial species - micro habitat.

T45. Water level fluctuations and riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating reservoir levels and flow regulation activities may be affecting.botanical resources.

1) What *threatened* and *endangered* species are present in the study area?
2) What are the effects to *threatened* and *endangered* species in the study area caused by water level and flow fluctuations by Hells Canyon Project operations?
3) How are results linked to protection, mitigation or enhancement planning and implementation?

Desired Future Goals

The general goal is to identify and protect rare plant species on lands influenced by IPC operations. FERC requires that relicensing applicants describe botanical resources in downstream areas affected by the project and the impact of project operations on those resources (18 CFR 4.51(f)(3)). The description must include identification of any species listed as *threatened* or *endangered* by the USFWS (18 CFR 4.51(f)(3)(i)). BLM and USFS lists of *species of special concern* include *candidate* and *sensitive* species. These agencies protect or attempt to minimize human disturbance of rare species occurring on lands they administer.

Abstract

This investigation proposes to inventory rare plant species (e.g., USFWS, BLM and USFS lists) occurring adjacent to the reservoir reaches of the Hells Canyon Complex and downstream to the confluence with the Salmon River, and to assess the influence of project operations on reservoir and downstream water level fluctuations and the effects of those operations on the presence of rare

plant species. A summary of water level fluctuations for the Hells Canyon Complex has yet to be prepared for purposes of this study. The known distribution of rare plant species (Element Occurrence Records) in the vicinity of the three reservoirs, Brownlee, Oxbow and Hells Canyon is incomplete. Field inventories will be conducted to identify rare plant species likely to be influenced by current operation practices of the reservoirs. For species with narrowly defined habitat requirements (e.g., a species occupying only limestone outcrops), inventories will include identification of likely habitats located within and adjacent to the zone of fluctuation. The relationship between an Element Occurrence and habitat disturbance due to reservoir fluctuations will be examined. Results will be used to recommend appropriate protection, mitigation and enhancement opportunities as they relate to project operations.

Introduction

Numerous studies have assessed the impacts to shoreline vegetation resulting from water level fluctuations in reservoirs (Austin *et al.* 1979, Allen and Aggus 1983, Thompson 1983, Thibodeau and Nickerson 1984, Amudsen 1994). In general, level of impact depends on the timing and magnitude of fluctuation. In reservoirs with large water level fluctuations, shoreline vegetation is highly variable and often sparse (Nilsson and Keddy 1988). This is due to the severe environmental regime of flooding followed by abrupt drought imposed by drawdown. Typical species found growing under these conditions are small, fast-growing annuals which set seed quickly. Often, these species must germinate and set seed at irregular times during the season depending on when drawdowns occur (Backeus 1993). Total vegetative cover tends to be low, as exhibited by the "bathtub ring" seen in many reservoirs with large fluctuations. The attainment of a more stable state has not been reported from such reservoirs although many have been studied for several years (Tiemeier 1951, Loster 1976, Nilsson 1981 as *cited in* Nilsson and Keddy 1988).

Shoreline erosion can be the most severe in reservoirs with large fluctuations. O'Neil and McDonnell (1995) studied the process of the retreat of bluffs composed of multi-layered sand and clay. Slope failure was initiated by alternate wetting and drying of the clay sediments which produced cracks parallel to the sediment layers. The mechanism appeared to operate optimally when moisture supply to the bluff was abundant and nearly continuous throughout spring and early summer, then followed by complete drying. It follows that the greater the area of inundation and drying, the greater the area prone to slope failure. Slope failure often results in loss of vegetation communities.

The shoreline vegetation of reservoirs with more narrow fluctuations tend to be more stable depending on the seasonal timing of the fluctuations. Reservoirs whose water levels most nearly approach natural lake fluctuations tend to have the most stable shoreline vegetation with the highest species richness. Several studies have found that reservoirs with narrow fluctuations and stable summer levels can attain a fairly stable shoreline vegetation within a couple of decades (Krzyzanek *et al.* 1986 as *cited in* Nilsson and Keddy 1988). Wilcox and Meeker (1991) studied the shoreline vegetation of two man-made reservoirs and a natural lake in Minnesota. One reservoir had greater annual water level fluctuations than the natural lake while the other had more narrow annual fluctuations. The shoreline vegetation of the natural lake was structurally more complex and had a higher species richness than either reservoir. Of the two reservoirs, the one with narrow fluctuations had a richer emergent and aquatic plant community while the other had a richer terrestrial wetland community.

The effects on shoreline vegetation of narrow fluctuations with high water levels at times other than late spring has not been as extensively studied. In a study of Rybinsk Reservoir in the mountains of northeast Europe, Hrbacek (1984) found that water levels are highest in late summer/early fall and lowest in spring. He found considerable development of aquatic macrophytes in shallow parts of the reservoir regardless of the timing of fluctuation. He does not, however, comment on the effects on littoral vegetation. Hauer *et al.* (1988) came to similar conclusions regarding aquatic macrophytes in Flathead Lake, Montana. Possible effects of this regime include decreased coverage of upland plant species which require moisture for germination and growth but cannot tolerate inundation, decreased coverage of wetland plants which can only tolerate short periods of inundation, and increased coverage of emergent vegetation and aquatic macrophytes.

The altered environmental conditions related to reservoir management are likely to affect rare plant species similarly, but no studies of the influence of reservoir fluctuations on rare plant species are available. Thus, the influence of reservoir management on rare plant species is unknown.

Regulated water level fluctuations resulting from project operations can negatively and positively influence riparian habitats downstream of dams. Changes in shoreline vegetation tend to increase with increasing alterations from the natural flow regime. Flow regimes can negatively affect riparian vegetation when peak and base flows are altered such that they no longer coincide with vegetation processes (i.e., germination, seed dispersal) dependent on associated water and substrate conditions (GANDA 1996). The nature of change can be highly variable and depends on the ecology of the specific river being studied.

Hydro peaking operations are similar to storage reservoir operations but they specifically generate electricity during daily or seasonal peak demand periods (Scott *et al.* 1993). This operation can be the most disruptive to the natural flow regime. Flows may fluctuate significantly over the course of a single day creating an environment that is highly unusual and difficult to adjust to for riparian-dependent species. Change in stage (and therefore in impact) is greatest immediately below the dam and typically is attenuated at some point downstream.

Studies examining the influence of changes in altered hydrology on riparian vegetation in steep, channeled rivers are few. Studies of the Colorado River below Glen Canyon Dam may provide the most useful information although some significant operational differences exist between the Hells Canyon Complex and Glen Canyon Dams. Damming of the lower Colorado River stabilized the flow regime. Peak flows have decreased in amplitude and are less restricted seasonally (April to October). Catastrophic floods have been eliminated, and discharge now varies within narrow limits. Annual maximum discharges are strikingly uniform while daily variation and median discharge have increased (Turner and Karpiscak 1980).

As a result of these flow stabilizations, stable riparian communities have developed along the river banks. Post-dam fluvial deposits have transformed the formerly barren banks into a "dynamic double strip of vegetation" with excellent conditions for growth (Turner and Karpiscak 1980). Riparian vegetation has also become established on the deltas of tributaries to the Colorado which were previously scoured and/or eliminated by flood flows (Johnson 1991). The riparian vegetation consists of various native and exotic species. Salt cedar (*Tamarix chinensis*) and sand bar willow (*Salix* sp.) are the dominant tree species. Cottonwood (*Populus fremontii*) has been less successful on the post-dam sediments.

The influence of above and below-dam flow fluctuations on rare plant species is unknown. The ways and extent that rare plant species are influenced by IPC project operations, specifically below-dam water level fluctuations, have not been investigated.

The objectives of this study will be to:

1) obtain data characterizing daily, monthly and annual reservoir water level fluctuations for the Hells Canyon Complex,
2) obtain data characterizing daily, monthly and annual below-dam water level fluctuations for the Snake River between Hells Canyon Dam and the Salmon River,
3) if available, obtain data that distinguish between the water level fluctuations related to IPC's operations and those related to other purposes (e.g., fish flushes, flood control),
4) identify rare plant species known or thought to occur in the vicinity of the Hells Canyon Complex and downstream to the Salmon River,
5) identify specific issues surrounding the potential for project operations to influence the occurrence of rare plant species,
6) inventory rare plant species in the reservoir reaches and the factors underlying their distribution,
7) assess the influence of project operations on the factors underlying their distribution, and
8) link the operational influences to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A complete summary of reservoir and downstream water level fluctuations has not been compiled for purposes of this study. Headwater data have been collected regularly at each of the dams. Daily measurements were recorded up to four times per day. Tailwater data have been collected regularly at Hells Canyon dam since 1988. United States Geologic Survey staging gauges are located above Brownlee Reservoir, immediately below Hells Canyon Dam and at Johnson Bar, approximately 22 miles downstream. The latter has been collecting data since the 1940's. No summary has been compiled that identifies water level fluctuations related to project operations and fluctuations resulting from other purposes (i.e., fish flushes mandated by the NMFS; flood control requirements of the COE).

Brownlee Reservoir is subject to large water level fluctuations. Quite often, the shoreline high water mark forms the boundary between the reservoir and upland vegetation, with no riparian species present. Oxbow Reservoir probably has the greatest amount of shoreline occupied by riparian vegetation, followed by Hells Canyon Reservoir. These latter two reservoirs are operated more as run-of-the-river facilities, which can allow riparian vegetation to establish and persist.

For the purpose of this study rare plant species include federally listed and *candidate* species, BLM and USFS *species of special concern*, and ODA *threatened* and *endangered* species (OAR Ch. 603 (73)). The Idaho Native Plant Society, Idaho CDC and ONHP maintain lists with additional species. The number of rare plant species that may occur in the vicinity of the reservoirs and downstream reaches is approximately 80.

Detailed knowledge of the nature, extent, and distribution of rare plant species in the reservoir reaches is limited. Surveys for rare plant species have occurred extensively within the HCNRA on both sides of the river. How complete this information is below Hells Canyon Dam, especially near the dam where flow fluctuations will be expected to be the greatest, is not known.

Methods

Study Area

The study area consists of two parts. The three reservoir reaches, including the approximately 55-mile long Brownlee reach from river mile (RM) 339.2 to 284.6, the approximately 12-mile long Oxbow reach from RM 284.6 to 272.2, and the approximately 25-mile Hells Canyon reach from RM 272.2 to 247.0 comprise the first part. The second part consists of an approximately 59 mile stretch of land from river mile (RM) 247.0 to 188.2 incorporating the Snake River from Hells Canyon Dam to the confluence of the Snake and Salmon Rivers. The lateral extent of the study area will include all lands within approximately 20 meters of each shoreline.

Describing Water Level Fluctuations

A summary of available historic headwater (HW) and tailwater (TW) elevation data will be prepared by the Water Management Department to: characterize daily, monthly and annual water level fluctuations for each year of record for the Hells Canyon Complex and areas downstream, and distinguish between the water level fluctuations related to IPC’s operations and those related to other purposes (i.e., fish flushes, flood control). The summary may be limited by the data available. Characterization of changes in water level, expressed in units of feet, will include: minimum and maximum elevation recorded; 50, 90, and 98 percent of all HW and TW elevations; minimum and maximum daily, monthly, and yearly HW and TW change; 50, 90, and 98 percent of maximum daily, monthly, and annual HW and TW change. The number of samples recorded and other information will be presented in tables and figures to characterize these data.

Known Rare Plant Species Data

Maps and accumulated data for all known Element Occurrences in the study area will be obtained from the CDC, the ONHP, the Wallowa-Whitman National Forest, and the BLM of Idaho and Oregon (Boise District, Idaho; and Vale and Baker Districts, Oregon). Appropriate agency personnel will be interviewed to find areas that were inventoried in the last five years but for which no rare plant species were found.

Issue Identification

The investigator will conduct a thorough review of available literature to identify previous work that may be applicable to the inventory the study area and to address the potential for IPC's operations to influence the occurrence of rare plant species.

Field Inventories

The investigator, in coordination with interested agencies and groups, will plan field inventory methodologies to search for rare plant species occurrences in the study area. Planning will include summarizing known significant habitat factors determining the distribution of the rare species. It is anticipated that the following conditions will apply. Most field data will be collected by IPC staff.

Prior to beginning field inventories, available habitat information will be used in conjunction with GIS capabilities to identify areas within the bounds of the study area having the highest likelihood of containing one or more rare plant species. Inventories for species will be prioritized by status (e.g., those species with the greatest protection requirements will have a higher inventory priority), and by focusing on areas most likely to have multiple species within a short distance. Among these locations, the sites most likely to be affected by reservoir operations will have the highest priority. The full extent of the area to be inventoried as well as determining the species that will have the highest priority will be done in consultation with knowledgeable agency personnel.

Searches will take place during and soon after peak flowering to facilitate locating species of interest. When a rare plant occurrence is found, detailed edaphic, topographic and population characteristics data will be collected following the method developed during consultation with appropriate agencies and groups.

A key component of the surveys will be an assessment of the type and degree of disturbance factors present within an occurrence. All disturbance vectors and the degree of disturbance will be identified. Disturbance types may include alluvial (runoff water erosion), water fluctuation zone, livestock, mining, fire, road corridor activity, transmission corridor activity, industrial, agriculture, residential, off-road vehicle use, foot traffic, and recreation facility influences.

Analysis/Assessment

Data will be analyzed and assessed following methods developed in consultation with interested agencies and groups.

Link to Protection, Mitigation or Enhancement Measures

Recommendations for protection, mitigation or enhancement measures to protect rare plant species from operational impacts will be based on the results of this study. Details and descriptions of all protection, mitigation or enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to implement protection, mitigation or enhancement measures.

Timetable

This study is expected to require three field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. A progress report should be available by February 1999 and 2000 with a final report delivered by April 2001.

Cooperation

The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying which rare plant species are known or thought to occur in the study area,
2) determining priority of sites and species for inventory,
3) planning field inventory and analysis methods, and
4) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. Nancy K. Cole, the principal investigator, holds a M.Sc. in Plant Ecology. Ms. Cole has 15 years of experience designing and implementing studies. Ms. Cole will be assisted by 2-4 field assistants with B.S. degrees in natural resources, and 1-3 years of relevant field experience.

IPC's facilities are well-suited to all phases of the proposed research. IPC has available 4-wheel drive vehicles, rafts, and jet- and propeller-powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on IPC's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be completed by February 1999 and 2000, summarizing search species, literature review, field methods, and survey results through the 1998 pilot season and subsequent year. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All rare plant species data will be compiled in a digital format (ASCII).

8.3.8.
Title: *Effects of Road and Transmission Line Rights-of-Way on Threatened, Endangered and Sensitive Plant Species*

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Workgroup of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and/or concerned non-governmental groups. Further, this study will help IPC meet the FERC requirement to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T17. Impact identification (actual).

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (R/W).

T43. Secondary terrestrial species impacts associated with construction/maintenance of power line corridors.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Present power line operations including associated facilities may affect wildlife/botanical resources.

1) What are the effects, including secondary effects, of powerline operation (including associated facilities) to wildlife/botanical resources?
2) How are results linked to protection, mitigation or enhancement planning and implementation?

Maintenance

Maintenance of transmission line facilities (including rights-of-way) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources within transmission line corridors?
2) What are the effects of transmission line maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning and implementation?

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources in the study area?
2) What are the effects of roadways and other facility maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation or enhancement planning and implementation?

Desired Future Goals

The general goal is to identify and protect rare plant species on lands influenced by project operations. FERC requires that relicensing applicants describe botanical resources in the vicinity of the project, including identification of any species listed as *threatened* or *endangered* by the USFWS, (18 CFR§4.51(f)(3)(i)) and the impact of project operations on those resources (18 CFR 4.51(f)(3)(iv)). BLM and USFS lists of *species of special concern* include *candidate* and *sensitive* species. These agencies protect or attempt to minimize human disturbance of rare species occurring on lands they administer.

Abstract

This investigation proposes to inventory populations of rare plant species along roadways owned by IPC and along transmission line corridors associated with the Hells Canyon Project. The influence of project operations on the occurrence of rare plant species in these corridors will then be assessed. A summary of IPC operations in the associated transmission line corridors has not been compiled. The nature, extent, and distribution of rare plant species in these areas are unknown. Interested agencies and groups will assist in planning field inventories of rare plant occurrences and methods for assessing the causal factors for each occurrence. Most field work will be conducted by IPC's staff. Results will be used to recommend appropriate protection, mitigation and enhancement opportunities as they related to project operations.

Introduction

Direct and indirect factors resulting from IPC operations along transmission line corridors and roadways may influence the presence of rare plant species. Direct effects can include cutting, burning and use of herbicides on vegetation growing in the transmission line right-of-way or along roadsides. These practices are most common in habitats with tree and large shrub components which may interfere with overhead or underground lines or structures (EPRI 1995), or where visibility is restricted or the threat of vehicle related fires from roadsides may be great. Numerous researchers have studied right-of-way vegetation characteristics (Champlin 1973, Sorensen 1974, Vasek *et al.* 1975, Beley *et al.* 1982, Hessing and Johnson 1982, Loney and Hobbs, 1991, Luken *et al.* 1992, Brown 1994). Cleared forest or shrub communities are typically replaced by much simpler, early successional communities dominated by grasses, herbs and/or shrubs. Often, these species are weedy exotics able to quickly colonize the early successional environment of a cleared corridor (MacLellan and Stewart 1986). Herbicides are frequently used to maintain this early successional stage (USFWS 1979).

The indirect effects of corridor maintenance are numerous and can be more subtle. Once a roadway or corridor is established, aggressive exotic species may be introduced to the corridor by passing workers, motorists, wildlife and a variety of recreational users. Once present in the corridor, the weeds can invade adjacent native habitats (MacLellan and Stewart 1986) and compete successfully against rare species.

The objectives of this study are to:

1) identify and describe IPC's roads and transmission line corridors associated with the Hells Canyon Project,
2) identify and describe IPC's operational activities occurring along these corridors,
3) identify rare plant species known or expected to occur in the study area,
4) identify specific issues surrounding the potential for project operations to influence the presence of rare plant species,
5) inventory occurrences of rare plant species in the study area and the associated causal factors for the occurrence of each population,
6) assess the influence of project operations on the distribution of rare plant species, and
7) link project operational influences on rare plant species occurrences to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A summary of transmission line operations in corridors associated with the Hells Canyon Project has not been compiled. Location information, and general descriptive information of these corridors should be available in IPC files.

For the purpose of this study, rare plant species include federally listed and *candidate* species, BLM and USFS *species of special concern*, and ODA *threatened* and *endangered* species (OAR Ch. 603 (73)). The Idaho Native Plant Society, CDC and ONHP maintain lists with additional species. The number of rare plant species that may occur in the study area (roads and transmission lines) is over 160.

Methods

Study Area

The roadway area will include all lands impacted by cut/fill activities, or other disturbed areas, on IPC-owned roadways occurring in the Hells Canyon vicinity (generally within three miles of the Snake River; rim to rim area of Hells Canyon) and undisturbed areas out to a distance of about 50 meters on each side of the roadway centerline. Roadways will include unimproved and paved roads. The total miles of such roadways are unknown but anticipated to be approximately 50-75 miles in length. Examples of such roads include the paved Hells Canyon Road, between Oxbow and Hells Canyon Dams, and roads in the immediate vicinity of Oxbow Dam and Brownlee Dam.

The transmission line area will include all lands impacted by cut/fill activities, or other disturbed areas, associated with transmission towers and all roadways specifically constructed to access transmission towers. As a minimum, it will include a 100 m radius around towers and a 50 m buffer on each side of the centerline of all roadways. All lines to be relicensed with the Hells Canyon Project will be included.

Describing Operation/Maintenance Activities

Applicant operation/maintenance activity information will be described by IPC's Facilities Management. It will include a summary of types, extent, location, and timing of activities. Types of activities could include wheeled vehicle travel (i.e., pickup, ATV), helicopter travel, herbicide spraying, vegetation mowing, tree/shrub pruning, and road repair. The extent of activities will be summarized by hours/month and hours/year for each activity type. Location will be summarized by mile points along roads and transmission corridors for each activity type. Timing will be summarized by days of the week, weeks of the month, and months of the year, as appropriate, for each activity type.

Rare Plant Species Identification

Maps and accumulated data for all known Element Occurences in the study area will be obtained from the CDC, the ONHP, the Wallowa-Whitman National Forest and BLM of Idaho and Oregon (Boise District, Idaho; Vale and Baker Districts, Oregon). Appropriate agency personnel will be interviewed to find areas that were inventoried within the last five years but for which no rare plant species were found.

Issue Identification

The investigator will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area and to address the potential for project operations and maintenance activities to influence the occurrence of rare plant species.

Field Inventories

The investigator, in coordination with interested agencies and groups, will plan field inventory methodologies to search for rare plant species occurrences in the study area. Planning will include summarizing known significant habitat factors determining the distribution of the rare species. It is anticipated that the following conditions will apply. Most field data will be collected by IPC staff.

Prior to beginning field inventories available habitat information will be used in conjunction with GIS capabilities to identify areas with the highest likelihood of containing one or more rare plant species. Inventories for species will be prioritized by status (i.e., those species with the greatest protection requirements will have a higher inventory priority) and by focusing on areas most likely to have rare plant species. For example, an intensively farmed area bisected by a transmission line is not likely to have native vegetation remaining on site; such an area will not be the focus of inventories. Among the most appropriate locations, the sites in the immediate vicinity of utility poles and along maintenance road corridors will have the highest priority for inventory. The area within 100 m of a pole and 50 m on both sides of a road corridor will be inventoried. The full extent of the area to be inventoried as well as determining the species that will have the highest priority will be done in consultation with knowledgeable agency personnel.

Searches will take place during and soon after peak flowering to facilitate locating species of interest. When a rare plant occurrence is found, detailed edaphic, topographic and population data will be collected following the methods developed during consultation with appropriate agencies and groups.

A key component of the surveys will be an assessment of the type and degree of disturbance factors present within an occurrence. All disturbance vectors will be identified and their level (degree) of disturbance. Disturbance types may include alluvial (runoff water erosion), water fluctuation zone, livestock, mining, fire, road corridor activity, transmission corridor activity, industrial, agriculture, residential, off-road vehicle use, foot traffic, and recreation facility influences.

Analysis/Assessment

Data will be analyzed and assessed following the methods developed in consultation with interested agencies and groups.

Link to Protection, Mitigation or Enhancement Measures

Recommendations for protection, mitigation or enhancement measures to protect rare plant species from operational impacts will be based on the results of this study. Details and descriptions of all protection, mitigation or enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to implement protection, mitigation or enhancement measures.

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Deliverables

A project progress report will be completed by February of 1999 and 2000, summarizing search species, literature review, field methods, and survey results through the three field seasons. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All rare plant species data will be compiled in a digital format (ASCII).

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8.4. Historical and Archeological

8.4.1. Title: Archaeological Inventories-Hells Canyon Complex Transmission Lines

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to inventory archaeological sites along the primary transmission line corridors and associated access roads of the Hells Canyon Project. The proposed study will identify and make preliminary National Register evaluations of archaeological sites. The inventory will also identify the impacts on the National Register qualities of those sites. The nature, extent, and distribution of archaeological sites in the reservoir reaches are not fully known. A consultant will conduct field inventories of archaeological sites and identify impacts. This information will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation or enhancement of archaeological sites in conjunction with the development, protection, mitigation or enhancement of other resources.

Introduction

Relicensing-related archaeological inventories are mandated by law. FERC requires that relicensing applicants identify and describe archaeological sites in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of project operations on those resources (18 CFR §4.51 (f)(4)). This process is conducted by consultation with appropriate Native American tribes and the Idaho and Oregon State Historic Preservation Offices (SHPOs) and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended 1992 (36 CFR §800).

The objectives of this study will be to:

1) identify historic and Native American archaeological sites along the corridors and access roads of the Hells Canyon Project transmission lines;
2) evaluate the National Register quality of those sites on the basis of surface inventory data pursuant to 36 CFR §60.4; and
3) identify those sites adversely impacted by natural and human agents such as slopewash erosion, vandalism, road building/use, and recreational activities.

This information will provide baseline data for subsequent impact studies which will identify specific issues surrounding the potential for IPC's operations to adversely impact archaeological sites and link those adverse impacts on archaeological sites to appropriate protection, mitigation or enhancement measures. Both the proposed inventory and impact studies will be incorporated into cultural resource management and land management plans at a later stage in the relicensing process, pursuant to regulations.

State of Knowledge

The present distribution and nature of archaeological sites in the upland areas surrounding the Brownlee, Oxbow, and Hells Canyon Reservoirs are incompletely known. There have been several archaeological surveys and excavations in the Hells Canyon area (Caldwell and Mallory 1967, Jaehnig and Jaehnig 1993, Pavesic *et al.* 1964). A recent overview (Reid *et al.* 1991) has summarized major archaeological investigations in the Hells Canyon area.

However, the results of previous archaeological surveys (Shiner 1951) are not necessarily applicable to present conditions: the landscape has changed since these survey were conducted, obscuring some sites and possibly exposing others.

Methods

Study Area

The study area includes several hundred miles of transmission lines (described in Section III). The length and combined acreage of the access roads are presently unknown.

Determination of Inventory Area

Not all of the Hells Canyon area transmission line corridors need to be inventoried for archaeological sites. Some areas are too steep to survey; other areas will receive no impact. Therefore, the first step of the proposed study will be to select the areas to be surveyed. Information from the 1995 and 1996 botanical cover type mapping aerial surveys, GIS analysis, and other data will be used to determine the areas to be inventoried.

The inventory area will be stipulated in a Memorandum of Agreement (MOA) between FERC and the Oregon and Idaho SHPOs. IPC and the Advisory Council on Historic Preservation (ACHP) will be concurring parties to the MOA.

Contractor Selection

Consultants with expertise in historic and Native American archaeological inventories will be contracted to conduct this study. The IPC principal investigator will develop a Request for Quotations (RFQ) to solicit bids from interested consultants and administer ensuing contracts. By virtue of the above-mentioned MOA, interested agencies will assist in developing the RFQ. The Burns Paiute, Shoshone-Bannock, Shoshone-Paiute, Nez Perce, Colville, Umatilla, Yakima, and Warm Springs Tribes and Confederated Nations will be consulted prior to initiation of field work. Because of the magnitude of the project, it is anticipated that several contractors will be employed for the inventories.

Pre-field Archaeological Site Identification

The consultants will conduct a thorough review of available literature and archaeological site files to identify previous work that may be applicable to inventory the study area.

Field Inventories

The consultants will use standard archaeological inventory field methods and recording forms approved by the Idaho and Oregon SHPOs (Barner 1992, Idaho State Historic Preservation Office 1995, University of Utah *et al.* 1990, Oregon State Historic Preservation Office *n.d.*). The specific methods have been outlined in connection with the

Hagerman and C.J. Strike Reservoir transmission line inventories (Druss 1992) . For example, in areas with slopes less than 30 percent, survey transects are spaced 30 meters (98 feet) apart. On slopes of 30 percent or greater, a reconnaissance-level inventory will be conducted.

Analysis/Assessment

The consultant will analyze and assess the archaeological site data in order to provide estimates of site age, function, and cultural affiliation wherever possible given the limitations of surface inventory data. Analysis will also be directed at making National Register nominations.

Link to Protection, Mitigation, and Enhancement Measures

The proposed inventory will provide baseline archaeological site information, including data on existing impacts to National Register quality sites. As the IPC land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological baseline data will be used to assess new potential impacts from proposed new land uses. Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. Protection, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

It is anticipated that the scoping MOA will be developed during the winter of 1996/1997. This will be the basis for an RFQ which will be distributed to interested consultants in March 1997. The selected consultant will then review available literature, plan field inventory and data analysis methods, and conduct the study. This study is expected to require one field season, sometime between April 1997 and June 2001. A final report of results should be available within 18 months of the completion of the field work.

Cooperation

As mentioned above, the scoping MOA will be developed with the Idaho and Oregon SHPOs. Native Americans will be consulted.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in Anthropology and has 30 years of experience designing and implementing such studies. Dr. Druss has 20 years of experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience in archaeological inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, IMACS site forms for Idaho sites, ARCSITE (Barner 199) site forms for Oregon sites, and draft and final reports. Site forms and maps should be submitted in electronic form along with site maps within 6 months after the end of the field work. A draft report will be prepared within 12 months after the end of field work. A final report will be submitted within 6 months thereafter. IPC will prepare site location maps.

8.4.2.
Title: Archaeological Inventories-Brownlee, Oxbow, and Hells Canyon Reservoirs

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to inventory archaeological sites in the reservoir reaches of the Hells Canyon Project. The proposed study will identify and make preliminary National Register evaluations of archaeological sites. The inventory will also identify the impacts on the National Register qualities of those sites. The nature, extent, and distribution archaeological sites in the reservoir reaches are not fully known. A consultant will conduct field inventories of archaeological sites and identify impacts. This information will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation or enhancement of archaeological sites in conjunction with the development, protection, mitigation or enhancement of other resources.

Introduction

Relicensing-related archaeological inventories are mandated by law. FERC requires that relicensing applicants identify and describe archaeological sites in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of the project on those resources (18 CFR §4.51 (f)(4)). This process is conducted by consultation with appropriate Native American tribes and the Idaho and Oregon SHPOs and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended 1992 (36 CFR §800).

The objectives of this study will be to:

1) identify historic and Native American archaeological sites along the margins of the three reservoirs;
2) evaluate the National Register quality of those sites on the basis of surface inventory data pursuant to 36 CFR §60.4; and
3) identify those sites adversely impacted by natural and human agents such as slopewash erosion, reservoir fluctuations, vandalism, road building/use, and recreational activities.

This information will provide baseline data for subsequent impact studies which will identify specific issues surrounding the potential for IPC's operations to adversely impact archaeological sites and link IPC's adverse impacts on archaeological sites to appropriate protection, mitigation or enhancement measures. Both the proposed inventory and impact studies will be incorporated into cultural resource management and land management plans at a later stage in the relicensing process, pursuant to regulations.

State of Knowledge

The present extent of archaeological sites in the Brownlee, Oxbow, and Hells Canyon reservoirs is incompletely known. There have been several archaeological surveys and excavations in the Hells Canyon area (e.g. Caldwell and Mallory 1967, Jaehnig and Jaehnig 1993, Pavesic *et al.* 1964). A recent overview (Reid *et al.* 1991) has summarized major archaeological investigations in the Hells Canyon area.

However, the results of previous archaeological surveys (e.g. Shiner 1951) are not necessarily applicable to present conditions: the landscape has changed since these survey were conducted obscuring some sites and possibly exposing others. For example, archaeological reconnaissance during 1995 and 1996 has determined that several previously recorded sites in the normal Brownlee Reservoir drawdown zone have been deeply buried by sedimentation. However, this reconnaissance has also indicated that not all of the Brownlee shoreline is subject to heavy, site-obscuring sedimentation.

Methods

Study Area

The study area consists of three reservoir reaches; the approximately 55-mile long Brownlee reach from RM 339.2 to 284.6, the approximately 12-mile long Oxbow reach from RM 284.6 to 272.2, and the approximately 25-mile Hells Canyon reach from RM 272.2 to 247.0. The lateral extent of the study area will include all lands within approximately 100 m (330 feet) of each shoreline.

Determination of Inventory Area

Not all of the Hells Canyon area reservoir margins need to be inventoried for archaeological sites. Some areas are too steep to survey, other areas are heavily sedimented. Therefore, the first step of the proposed study will be to determine the areas to be surveyed. Information from the 1995 and 1996 reconnaissance surveys, GIS analysis, and other data will be used to determine the areas to be inventoried. The inventory area will be stipulated in an MOA between FERC and the Oregon and Idaho SHPOs. The Applicant and the ACHP will be concurring parties to the MOA.

Contractor Selection

Consultants with expertise in historic and Native American archaeological inventories will be contracted to conduct this study. The IPC principal investigator will develop an RFQ to solicit bids from interested consultants and administer ensuing contracts. By virtue of the above-mentioned MOA, interested agencies will assist in developing the RFQ. The Burns Paiute, Shoshone-Bannock, Shoshone-Paiute, Nez Perce, Colville, Umatilla, Yakima, and Warm Springs Tribes and Confederated Nations will be consulted prior to initiation of field work.

Pre-field Archaeological Site Identification

The consultant will conduct a thorough review of available literature and archaeological site files to identify previous work that may be applicable to inventory the study area.

Field Inventories

The consultant will use standard archaeological inventory field methods and recording forms approved by the Idaho and Oregon SHPOs (Barner 1992, Idaho SHPO 1995, University of Utah *et al.* 1990, Oregon SHPO *n.d.*). The specific methods have been outlined in connection with the Hagerman and C.J. Strike Reservoir inventories (Druss 1992) . For example, in areas with slopes less than 30 percent, within 0.1 mile of the reservoir shoreline, survey transects will be spaced 15 m (46.25 feet) apart. On slopes 30 percent or greater, a reconnaissance-level inventory will be conducted.

Archaeological site inventories will also be conducted in the normal drawdown zones as is practical given the extensive sedimentation observed during IPC's reconnaissance surveys.

Analysis/Assessment

The consultant will analyze and assess the archaeological site data in order to provide estimates of site age, function, and cultural affiliation wherever possible given the limitations of surface inventory data. Analysis will also be directed at making National Register nominations.

Link to Protection, Mitigation, and Enhancement Measures

The proposed inventory will provide baseline archaeological site information, including data on existing impacts to National Register quality sites. As the land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological baseline data will be used to assess new potential impacts from proposed new land uses. Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. protection, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

It is anticipated that the scoping MOA will be developed during winter 1996/1997. This will be the basis for an RFQ which will distributed to interested consultants in March 1997. The selected consultant will then review available literature, plan field inventory and data analysis methods, and conduct the study. This study is expected to require one field season, April through June, 1997. A draft report of results should be available by November 1997 with a final report delivered by April 1998.

Cooperation

As mentioned above, the scoping MOA will be developed with the Idaho and Oregon SHPOs. Native Americans will be consulted and may ask to assist in the inventories.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss who holds a Ph.D. in Anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has 20 years experience overseeing and administering contracts similar to the proposed study. An expert consultant, with extensive experience in archaeological inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, IMACS site forms for Idaho sites, ARCSITE (Barner 1992) site forms for Oregon sites, and draft and final reports. Site forms and maps should be submitted in electronic form along with site maps as soon as possible after the end of the field work, between September 1997 and September 1998. A final report is expected within 18 months of the completion of the field work. IPC will produce site location maps.

8.4.3.
Title: Archaeological Inventories-Below Hells Canyon Dam

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to update the inventory of archaeological sites in the free-flowing river reaches below Hells Canyon Dam. The proposed study will update existing site records and identify and make preliminary National Register evaluations of archaeological sites. The inventory will also identify the impacts on the National Register qualities of those sites. The nature, extent, and distribution of archaeological sites below Hells Canyon dam are generally well known. IPC will consult with the HCNRA, the Oregon and Idaho SHPOs, and interested tribes to determine the need for additional inventories. A consultant will conduct field inventories of archaeological sites and identify impacts. This information will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation or enhancement of archaeological sites in conjunction with the development, protection, mitigation or enhancement of other resources.

Introduction

Relicensing-related archaeological inventories are mandated by law. FERC requires that relicensing applicants identify and describe archaeological sites in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of project operations on those resources (18 CFR §4.51 (f)(4)). This process is conducted by consultation with appropriate Native American tribes and the Idaho and Oregon SHPOs and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended 1992 (36 CFR §800).

The objectives of this study will be to:

1) Update existing archaeological site records for the Oregon and Idaho sides of the Snake River from Hells Canyon Dam to the Salmon/Snake River confluence;
2) identify historic and Native American archaeological sites along the margins of the three reservoirs;
3) evaluate the National Register quality of those sites on the basis of surface inventory data pursuant to 36 CFR §60.4; and
4) identify those sites adversely impacted by natural and human agents such as slopewash erosion, river level fluctuations, vandalism, road building/use, and recreational activities.

This information will provide baseline data for subsequent impact studies which will identify specific issues surrounding the potential for project operations to adversely impact archaeological sites and link identified adverse impacts on archaeological sites to appropriate protection, mitigation or enhancement measures. Both the proposed inventory and impact studies will be incorporated into cultural resource management and land management plans at a later stage in the relicensing process, pursuant to regulations.

State of Knowledge

The present extent of archaeological sites below Hells Canyon dam is well known. The project area was nominated as a National Register District several years ago (King 1972). The District extends from Hells Canyon Dam 70 miles downstream, 10 miles below the Salmon/Snake River confluence. The District contains 152 historic sites, including homesteads and placer mines, and 384 Native American sites, including rockshelters and housepits.

Recent work below Hells Canyon Dam consists of housepit excavations at Tryon Creek (Leohardy and Thompson 1991) and at Pittsburg Landing (Reid *et al.* 1991*a*). A recent overview (Reid *et al.* 1991*b*) has summarized major archaeological investigations in the Hells Canyon area.

In general, archaeoalogists have identified several important archaeological research issues below Hells Canyon Dam including cultural chronology and paleoenvironments. Because the area below Hells Canyon Dam is so well known, the primary focus of the proposed study will be to update existing site records and record ongoing impacts.

Methods

Study Area

The study area consists of the free-flowing Snake River and lower tributary reaches from Hells Canyon Dam (RM 247.0) to the Salmon River/Snake River confluence (RM 188.2). The lateral extent of the study area will include all lands within approximately 330 feet of each shoreline.

Determination of Inventory Area

Because the area below Hells Canyon Dam is so well known, minimal survey is anticipated: much of the area has already been surveyed, and other areas are too steep for survey. The first step of the proposed study will be to select the areas to be surveyed. Information from existing site records, along with GIS analysis, and other data will be used to determine the areas to be inventoried. The inventory area will be stipulated in an MOA between FERC and the Oregon and Idaho SHPOs. IPC and the ACHP will be concurring parties to the MOA.

Contractor Selection

Consultants with expertise in historic and Native American archaeological inventories will be contracted to conduct this study. The IPC principal investigator will develop an RFQ to solicit bids from interested consultants and administer ensuing contracts. By virtue of the above-mentioned MOA, interested agencies will assist in developing the RFQ. The Burns Paiute, Shoshone-Bannock, Shoshone-Paiute, Nez Perce, Colville, Umatilla, Yakima, and Warm Springs Tribes and Confederated Nations will be consulted prior to initiation of field work.

Pre-field Archaeological Site Identification

The consultant will conduct a thorough review of available literature and archaeological site files to identify previous work that may be applicable to inventory the study area.

Field Inventories

The consultant will use standard archaeological inventory field methods and recording forms approved by the Idaho and Oregon SHPOs (Barner 1992, Idaho SHPO 1995, University of Utah *et al.* 1990, Oregon SHPO *n.d.*). The specific methods have been outlined in connection with the Hagerman and C.J. Strike Reservoir inventories (Druss 1992). For example, in areas with slopes less than 30 percent and within 0.1 mile of the reservoir shoreline, survey transects will be spaced 15 meters (49 feet) apart. On slopes 30 percent or greater, a reconnaissance-level inventory will be conducted.

Archaeological site inventories will also be conducted in the normal drawdown zones as practical, given the extensive sedimentation observed during IPC's reconnaissance surveys.

Analysis/Assessment

The consultant will analyze and assess the archaeological site data in order to provide estimates of site age, function, and cultural affiliation wherever possible, given the limitations of surface inventory data. Analysis will also be directed at making National Register nominations.

Link to Protective, Mitigation, and Enhancement Measures

The proposed inventory will provide baseline archaeological site information, including data on existing impacts to National Register quality sites. As the land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological baseline data will be used to assess new potential impacts from proposed new land uses.

Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. Protective, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

It is anticipated that the scoping MOA will be developed during the winter of 1996/1997. This will be the basis for an RFQ which will distributed to interested consultants in March 1997. The selected consultant will then review available literature, plan the field inventory and data analysis methods, and conduct the study. This study is expected to require one field season, to occur sometime between April 1997 and June 2001. A final report is expected within 18 months of the end of the field season.

Cooperation

As mentioned above, the scoping MOA will be developed with the Idaho and Oregon SHPOs. Native Americans will be consulted and may ask to assist in the inventories.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has 20 years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience in archaeological inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, IMACS site forms for Idaho sites, ARCSITE site forms for Oregon sites, and draft and final reports. Site forms and maps should be submitted in electronic form along with site maps as soon as possible after the end of the field work. A draft report will be prepared within 12 months of the end of the field work. A final report is expected within 6 months after the submission of the draft report. IPC will prepare site location maps.

8.4.4.
Title: Euro-Asian Oral History Study-Hells Canyon, Oxbow, and Brownlee Area

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to supplement existing historic literature by conducting an oral history study. The focus of the study will be the history and culture of the non-Native American (Euro-Asian) residents of the area prior to the impoundment of the Hells Canyon Project reservoirs in 1955. Taped interviews will be used to cover gaps in the existing literature.

Introduction

Relicensing-related cultural resources inventories are mandated by law. FERC requires that relicensing applicants identify and describe cultural resources in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of the project on those resources (18 CFR §4.51 (f)(4)).

An important aspect of Hells Canyon area cultural resources is the history of the non-Native Americans who inhabited the area prior to impoundment. Taped interviews with area residents will address such questions as 1) the establishment of local communities; 2) area ethnicity; 3) fauna and flora prior to 1955; 4) people's experiences with Native Americans; 5) early methods of irrigation; and 6) early economic conditions. These interviews may help to identify and evaluate the National Register significance of historic sites in the Hells Canyon area. Impact information may also be gained from the proposed studies.

State of Knowledge

Although there is a large body of accessible literature on the history of the Hells Canyon area (e.g. Carrey *et al*. 1979, Jordan 1954), there is still a need for additional information about several topics. According to oral historian Madeline Buckendorf, the Depression and post-World War II era is under-represented in the interview data, as is the area upstream from the HCNRA.

Many non-Native American ethnic groups have had a presence in the project area. These include Basque-, German-, Greek-, and Italian-Americans. A preliminary literature review will determine the extent to which these groups have been under-represented in area histories. Interviews will be obtained to fill in the gaps discovered by the literature review.

Methods

Study Area

The study area consists of the Brownlee, Oxbow, Hells Canyon Reservoirs and the area below Hells Canyon Dam (RM 247.0) downstream to the Salmon River/Snake River confluence (RM 188.2).

Determination of Inventory Area

The lateral extent of the study area will vary on a case-by-case basis to include all lands within ranches, farms, communities, and mines whose boundaries abut the original course of the unimpounded river. This will include the inundated townsite of Robinette, located below Brownlee Reservoir, as well as the Jordan Homestead, located below Hells Canyon Dam.

Contractor Selection

Consultants must have demonstrated expertise in gathering oral history data. The IPC principal investigator will develop an RFQ to solicit bids from interested consultants and administer ensuing contracts.

Pre-inventory Data Collection

The consultant will conduct a thorough review of available historic literature in order to identify information gaps. This work will be done prior to taping the interviews.

Oral History Interviews

The consultant will use standard oral history interview equipment and technique, including high-quality tape recorders, and standardized questionnaire forms. Interview questions include:

1) Why did people come to the area? From where? How and why were local communities established?
2) What was the ethnic makeup of the communities?
3) What flora and fauna were in the area before 1950?

4) What were people's experiences with local Native Americans?
5) What were the early methods of irrigation? What sources of drinking water, hydropower, and electricity were there?
6) What were the social activities? Who socialized with whom?

Analysis/Assessment

The consultant will analyze and assess the oral history data in order to address the interview questions mentioned above. Analysis will also be directed at assessing impacts to the National Register qualities of the recorded historic archaeological sites in the project area (see Torgeson King 1972).

Link to Protection, Mitigation and Enhancement Measures

The proposed inventory will provide baseline archaeological site information, including data on existing impacts to National Register quality sites. As the land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological and oral history baseline data will be used to assess new potential impacts from proposed new land uses. Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. Protection, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

A pilot study is currently nearing completion. If additional work is warranted, these studies will take place during 1997 and 1998, with a final report delivered by April 1998.

Cooperation

Local historical societies and the Idaho and Oregon State Historical Societies will cooperate with the study.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has two years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience in comparable inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, interview tapes, transcripts, and the final report. A draft report will be submitted by December 1997 with a final report submitted by April 1, 1998. IPC will prepare site location maps.

8.4.5.
Title: Native American Oral History Study-Hells Canyon, Oxbow, and Brownlee Area

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to supplement existing ethnohistoric literature by conducting an oral history study with Native American elders. The focus of the study will be those residents of the area prior to the impoundment of the Hells Canyon Project reservoirs in 1955. Taped interviews and site visits will be used to fill information gaps in the existing literature.

Introduction

Relicensing-related cultural resources inventories are mandated by law. FERC requires that relicensing applicants identify and describe cultural resources in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of the project on those resources (18 CFR §4.51 (f)(4)).

Cultural resources include traditional cultural properties (Parker and King *n.d.*). The identification and documentation of traditional cultural properties is an extremely *sensitive* and often explosive issue, sowing contention among tribes, agencies, developers, and the public (Jackson 1996). In order to avoid such problems, detailed anthropological studies must be undertaken with the assistance of tribal elders (Bouchard and Kennedy 1984, Myers 1996).

An important aspect of Hells Canyon area cultural resources are the traditional cultural properties utilized by the local Native Americans who inhabited the area prior to impoundment. Taped interviews with area residents will focus on the identification and evaluation of significance of area traditional cultural properties. These interviews may help to identify and evaluate the National Register significance of historic sites in the Hells Canyon area. Impact information may also be gained from the proposed studies.

State of Knowledge

Although there is some accessible literature on the ethnohistory of the Hells Canyon area (Sappington and Carley 1995, Spinden 1908), there is still a need for additional information about traditional cultural properties. Of particular importance are traditional cultural properties where plants were regularly gathered, and sacred sites in the Hells Canyon area. In addition, a standard culture element list will be compiled from the literature for the Hells Canyon area, if possible.

Methods

Study Area

The study area consists of the Brownlee, Oxbow, Hells Canyon Reservoirs and the area below Hells Canyon Dam (RM 247.0) downstream to the Salmon River/Snake River confluence (RM 188.2).

Determination of Inventory Area

The lateral extent of the study area will vary on a case-by-case basis to include all lands within ranches, farms, communities, and mines whose boundaries abut the original course of the unimpounded river. This will include the inundated townsite of Robinette, located below Brownlee Reservoir, as well as the Jordan Homestead, located below Hells Canyon Dam. Other areas possibly used by Native Americans will be inferred from the literature review. Primary data will come from the interviews.

Contractor Selection

Consultants with demonstrated expertise in gathering oral history data with Native Americans. The IPC principal investigator will develop an RFQ to solicit bids from interested consultants and administer ensuing contracts.

Pre-inventory Data Collection

The consultant will conduct a thorough review of available historic literature in order to identify information gaps. This work will be done prior to taping the interviews.

Oral History Interviews

The consultant will use standard oral history interview equipment and technique, including high-quality tape recorders, and standardized questionnaire forms. Interviews will be conducted with tribal elders, with an interpreter present, if necessary. Interview questions include:

1) Do you have knowledge about the study area?
2) Do you know anyone else who might have such knowledge?
3) Have you visited the study area yourself?
4) For what purpose?
5) Do any or your relatives visit these areas?
6) Do you know of any special use or purposes for places within the study area?
7) Do you know any stories, myths, legends, anecdotes, or place names relating to/describing any specific places within the study area?
8) Do you know any rituals and activities that took place at any specific places within the study area?
9) Do you know any of any religious activities or vision quests that took place at any specific places within the study area?
10) Do you know of any special meanings attached to any specific rock art sites within the study area?

Analysis/Assessment

The consultant will analyze and assess the oral history data in order to address the interview questions mentioned above. Analysis will also be directed at assessing impacts to the National Register qualities of the recorded ethnohistoric archaeological sites in the project area, including those which are currently included in the Hells Canyon Archaeological District (see Torgeson King 1972).

Link to Protective, Mitigation, and Enhancement Measures

The proposed inventory will identify baseline traditional cultural properties, as well as archaeological site information, including data on existing impacts to National Register quality sites. As the land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological and oral history baseline data will be used to assess new potential impacts from proposed new land uses. Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. Protection, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

A pilot study is currently underway. If additional work is warranted, these studies will take place sometime between 1997 and 2001, within 18 months after the end of the field work.

Cooperation

Native Americans on eight reservations are expected to cooperate in the study.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has four years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience in such inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, interview tapes, transcripts, and the final report. A draft report will be submitted within 12 months of the end of field work. A final report will be submitted within 6 months therafter. IPC will prepare any required site location maps.

8.4.6.
Title: Reconnaissance Inventory of Existing Project Structures: Brownlee, Oxbow, and Hells Canyon Dams

This is a descriptive study initiated to assist IPC in meeting the FERC requirement to describe cultural resources of the Hells Canyon Project and its vicinity. This study was not specifically developed as part of the collaborative process. However, the Collaborative Team has been informed of ongoing or planned descriptive studies to be conducted by IPC as part of the relicensing process.

Abstract

This investigation proposes to inventory and evaluate existing project structures at Brownlee, Oxbow, and Hells Canyon Dams. The proposed study will inventory, at the reconnaissance level, all Hells Canyon Complex dams, power houses, operators' cottages, and associated structures. The inventory will evaluate the National Register quality of these structures. The inventory will also identify the impacts to the National Register qualities of these structures. A consultant will conduct this study. This information will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation or enhancement of existing project structures in conjunction with the development, protection, mitigation or enhancement of other resources.

Introduction

Relicensing-related cultural resources inventories are mandated by law. FERC requires that relicensing applicants identify and describe cultural resources in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places (Register) and describe the impact of the project on those resources (18 CFR §4.51 (f)(4)). Cultural resources include existing project structures. These structures will be 50 years old shortly after the re-licensing of the Hells Canyon Complex and therefore eligible for consideration as Register properties.

The process of description, evaluation, and recommendation for nomination to the Register is conducted in consultation with the Idaho and Oregon State Historic Preservation Offices (SHPOs) and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended 1992 (36 CFR §800).

The objectives of this study will be to: 1) Describe existing dams, power plants, operators' housing, and associated structures at the Brownlee, Oxbow, and Hells Canyon hydroelectric projects; 2) evaluate the National Register quality of those structures on the basis of inventory data, including historic records and literature review, pursuant to 36 CFR §60.4; and 3) identify those structures adversely impacted by natural and human agents such as slopewash erosion, river level fluctuations, vandalism, road building/use, recreational activities, and IPC's operations.

State of Knowledge

There is extensive documentation of the Hells Canyon Project structures in IPC's records. However, the structures have not been described and evaluated in the context of the Section 106 process. And this must be done in connection with relicensing of the project at this time.

Methods

Study Area

The study area lies within the FERC-licensed project boundaries for the Brownlee, Oxbow and Hells Canyon hydroelectric projects. Transmission lines are not included in this study.

Contractor Selection

Consultants with expertise in historic research and documentation of historic hydroelectric structures will be contracted to conduct this study. The IPC principal investigator will develop an RFQ to solicit bids from interested consultants and administer ensuing contracts.

Pre-field IPC Records Review

The consultant will conduct a thorough review of available literature and records on file at IPC. These records may contain construction plans and other documents relevant to the study.

Field Inventories

The consultant will use standard reconnaissance methods listed in McCloskey (1993). The scope and methods of the proposed study will be the same as those for the Hagerman area and Shoshone Falls Project relicensing efforts (Stacy 1994, 1995).

Analysis/Assessment

Analysis of field data and records will aim toward a preliminary evaluation of the Register quality of the structures.

Link to Protection, Mitigation, and Enhancement Measures

The proposed inventory will provide baseline information on existing project structures, including data on existing impacts to National Register quality sites. As the land management plan is developed for other terrestrial, aquatic, and recreation resources, the archaeological baseline data will be used to assess new potential impacts from proposed new land uses. Once the full range of potential and actual impacts is known, further impact studies will be planned, if necessary. Protection, mitigation, and enhancement measures will be developed once the land management plan and impact studies are completed.

Timetable

This study is expected to require one field season, April through June, 1997. A draft report of results should be available by November 1997 with a final report delivered by April 1998.

Cooperation

No cooperators are identified.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has five years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience in historic structure inventory work will be sought to conduct the bulk of the study.

Deliverables

Inventory deliverables consist of site maps, IMACS site forms for Idaho sites (University of Utah *et al.* 1990), ARCSITE site forms for Oregon sites (Barner 1992), and draft and final reports. Site forms and maps should be submitted in electronic form along with site maps as soon as possible after the end of the field work, on or about September 1997. A draft report will be prepared by December 1997, and a final report due by April 1, 1998. IPC will prepare site location maps.

8.4.7.
Title: Effects of Reservoir Water Level Fluctuations on Cultural Resources

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of cultural resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural (and natural) resource inventories (FERC requirements).

T17. Impact identification (actual).

T18. Mitigation plans.

T21. Potential impacts to discover previously undiscovered archaeological properties due to fluctuation of reservoir levels and wave action.

T30. Long-term availability of baseline data collected, how will it be used?

T33. IPC land management practices effects on terrestrial resources.

T35. Potential impacts of project [construction]/maintenance activities on American Indian traditional use of sites and/or activities (e.g. will a long term draw-down affect fishing rights on the reservoir?)

(Please note: All of these issues are normally addressed during cultural resources inventories which locate, observe impacts, and set the stage for mitigation plans.)

Problem Statement

Operational

Fluctuating reservoir levels and flow regulation may be affecting cultural resources.

Desired Future Resource Goal

The general goal is to determine whether or not reservoir fluctuations have an adverse effect on cultural resources which are listed or eligible to be listed on the National Register of Historic Places. FERC requires that relicensing applicants identify and describe cultural resources in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of the project on those resources (18 CFR §4.51 (f)(4)). This process is conducted by consultation with appropriate Native American tribes and the Idaho and Oregon SHPOs and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended in 1992 (36 CFR §800). Specific agency statements in plans that support the general goal include: manage cultural resources in accordance with regulations (USDA 1990:S-43, II-113), and consider effects of activities on cultural resources; propose protection, mitigation (USDA 1990:IV-64ff).

Abstract

This investigation proposes to inventory cultural resources in the reservoir reaches of the Hells Canyon Project and to assess the influence of project operations on reservoir water level fluctuations. The study will also assess the effects of those fluctuations on the National Register qualities of those resources. A complete summary of reservoir water level fluctuations for the Hells

Canyon Complex has not been compiled for purposes of this study. The nature, extent, and distribution cultural resources in the reservoir reaches are not fully known. A consultant will conduct field inventories of cultural resources and assess the effects of water level fluctuations. The information gained will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation or enhancement of cultural resources in conjunction with the development, protection, mitigation or enhancement of other resources.

Introduction

Water level fluctuations resulting from project operations can negatively and positively influence cultural resources. Both short- and long-term reservoir water level fluctuations are considered. Proposed studies will also consider the timing, rates, magnitudes, and duration of reservoir water fluctuation as well as the characteristics of boat traffic and other recreational activities during the fluctuations.

The objectives of this study will be to:

1) characterize daily, monthly, and annual reservoir water level fluctuations for the Hells Canyon Complex,
2) distinguish between the water level fluctuations related to IPC's operations and those related to other purposes (i.e., fish flushes, flood control),
3) identify those cultural resources adversely impacted by reservoir fluctuations,
4) identify specific issues surrounding the potential for IPC's operations to adversely impact cultural resources,

5) link those adverse impacts on cultural resources to appropriate protection, mitigation or enhancement measures, and
6) characterize the types of recreational activities, such as boat traffic, which occur during the various types of fluctuations and their potential effects on impacts to shoreline cultural resources.

State of Knowledge

A complete summary of reservoir water level fluctuations for the Hells Canyon Project has not been compiled for purposes of this study. Historic headwater elevation data for the years 1982 through 1995 can be obtained from power plant log books at the Brownlee, Oxbow, and Hells Canyon Dams. These data are recorded by power plant operators off the headwater recorder at each dam. These daily measurements are most frequently recorded at the hours of 8:00, 16:00, 22:00 and 24:00.

Water levels vary greatly at the three Hells Canyon Complex reservoirs. Brownlee Reservoir is subject to annual water level fluctuations of approximately 43 feet. In contrast, Oxbow and Hells Canyon reservoirs are operated more as run-of-the-river facilities, and experience 5-foot annual fluctuations in water level.

The present extent of cultural resources in the Brownlee, Oxbow, and Hells Canyon Reservoirs is incompletely known. There have been several archaeological surveys and excavations in the Hells Canyon area (Caldwell and Mallory 1967, Jaehnig and Jaehnig 1993, Pavesic *et al.* 1964, and Shiner 1951). A recent overview (Reid *et al.* 1991) summarized major cultural resources investigations in the Hells Canyon area. However, the results of previous archaeological surveys (Shiner 1951) are not necessarily applicable to present conditions: the landscape has changed since these surveys were conducted, obscuring some sites and possibly exposing others. For example, archaeological reconnaissance during 1995 and 1996 has determined that several previously recorded sites in the normal Brownlee Reservoir drawdown zone have been deeply buried by sedimentation. This reconnaissance has also indicated that not all of the Brownlee shoreline is subject to heavy, site-obscuring sedimentation. The reconnaissance did not indicate extensive erosion of archaeological sites.

There is no detailed knowledge of the effects of water level fluctuations on Hells Canyon Complex cultural resources. However, as mentioned below, the effects of reservoir fluctuations on cultural resources have been studied in other areas. The proposed study will determine whether any of these effects are present in the Hells Canyon area.

Large-scale fluctuations, such as fishery-related drawdowns, impact archaeological sites. For example, several impacts to archaeological sites were observed during the biological drawdown test on Lower Granite Dam in March 1992 (COE *et al.* 1994).

Bank erosion resulting from wind and barge/boat traffic-generated waves was common (COE *et al.* 1994:4-79). In general, waves generated by river traffic and drawdowns are the greatest potential causes of bank erosion (COE Waterways Experiment Station 1989:I-11:1).

Other drawdown-related impacts included terracing and slumping of shorelines and increased vandalism on archaeological sites (COE *et al.* 1994:4-79, 80).

Methods

Study Area

The study area consists of three reservoir reaches: the approximately 55-mile-long Brownlee reach from RM 339.2 to 284.6, the approximately 12-mile-long Oxbow reach from RM 284.6 to 272.2, and the approximately 25-mile Hells Canyon reach from RM 272.2 to 247.0. The lateral extent of the study area will include all lands within approximately 100 m (330 feet) of each shoreline.

Describing Water Level Fluctuations

A summary of historic headwater elevation data for the years 1982 through 1995 will be summarized by the IPC Water Management Department to: characterize daily, monthly, and annual reservoir water level fluctuations for the Hells Canyon Complex, and distinguish between the water level fluctuations related to IPC operations and those related to other purposes (i.e., fish flushes, flood control).

Cultural Resources and Impacts Identification

Cultural resources and impacts will be identified in two stages. First (Stage I), a cultural resources inventory will be conducted in order to satisfy FERC's relicensing requirements. Preliminary water level fluctuation impacts will be identified during this inventory. This is normal procedure for a relicensing inventory (Rudolph *et al.* 1995).

Not all of the Hells Canyon area reservoir margins need to be inventoried for cultural resources. Some areas are too steep to survey, other areas are heavily sedimented.

Therefore, the first step of the proposed study will be to determine the areas to be surveyed. Information from the 1995 and 1996 reconnaissance surveys, GIS analysis, and other data will be used to determine the areas to be inventoried. This project is presently underway by IPC staff. The reconnaissance data will be used to determine the scope of cultural resources inventories in the three reservoirs in consultation with the Idaho and Oregon SHPOs. Agreement on the scope of work will be formalized in an MOA with the SHPOs, FERC, IPC, and the ACHP as signatories.

Because the cultural resources inventory must be conducted to meet FERC requirements, it contributes to, but is outside, the scope of the present water level fluctuation study. Based on IPC’s ongoing shoreline reconnaissance, it is not expected that the cultural resources component of this study will progress beyond the inventory phase. After the inventory, the Idaho and Oregon SHPOs will be consulted to determine the need for further study.

If water level fluctuation impacts are identified during the cultural resources inventory, and if the Oregon and Idaho SHPOs require, the second part of the study (Stage II) will be initiated. The second part of the study will be a geomorphological study of the effects of reservoir water level fluctuations on the cultural resources on and in the reservoir shore. This phase of the study will quantitatively determine the dynamics of reservoir water level fluctuation. The study will include, but not be limited to, a characterization of the type and degree of shoreline impact (i.e. bank erosion, slumping, terracing, etc.); the origin, magnitude, and duration of wave action; weather (principally wind direction and magnitude) conditions and their relationship to types of water level fluctuation; and the nature, timing, and effect of boat traffic during various fluctuation episodes (i.e., does wave action generated by water-skiing during the summer at full pool create more or less shoreline erosion than wave action created by fishermen during periods of maximum drawdown).

Contractor Selection

Consultant(s) with expertise in cultural resources, and, if the second phase of the study is initiated, in hydrology and/or geomorphology and statistical analysis will be contracted to conduct this study. The consultant(s) may utilize services of subcontractors to perform elements of the work. The IPC principal investigator will develop a RFP to solicit bids from interested consultants and administer ensuing contracts. Interested tribes, agencies and groups will assist in developing the RFP where appropriate. The COE Waterways Experiment Station, Vicksburg, will also be asked to assist in developing the RFP.

Issue Identification

If current literature reviews are inadequate, the consultant will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area and to address the potential for reservoir water level fluctuations to impact cultural resources.

Field Inventories

Stage I inventories will take place as a part of the FERC relicensing process and will contribute to this study. Stage II data collection will have to occur throughout the year. Changing weather and reservoir levels will be monitored during this time.

Analysis/Assessment

The consultant will analyze and assess the data following the methods developed in consultation with IPC, the COE Waterway Experiment Station, tribes, interested agencies and other groups, as appropriate.

Link to Protection, Mitigation, and Enhancement Measures

The consultant will recommend protection, mitigation or enhancement measures to protect cultural resources impacted by reservoir water level fluctuations, if caused by IPC operations. Details and descriptions of all protection, mitigation, and enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation, and enhancement measures.

Timetable

It is anticipated that an RFP for Stage II will be distributed to interested consultants after the Stage I cultural resources inventory and SHPO consultation is completed, in February 1999. The selected consultant will then review available literature, plan field inventory and data analysis methods, and conduct the study. This study is expected to require two field seasons, with the first season (1999) used as a pilot study year to test efficacy of methods and analysis techniques. A draft report of results should be available by November 2000 with a final report delivered by April 2001.

Cooperation

The following tasks will be conducted in consultation with interested agencies and groups:

1) determining the scope of Stage I inventory based upon reconnaissance data,
2) determining the need for Stage II studies, 3) developing the Stage II RFP for interested consultants,
3) planning Stage II field inventory and analysis methods,
4) reviewing draft report.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has 20 years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience with cultural resources and shoreline geomorphology will be sought to conduct the bulk of the study.

Deliverables

A project progress report for Stage II will be completed by the consultant by February 2000, summarizing field methods and survey results through the 1999 pilot season. A draft report will be prepared by November 2000, and a final report due by April 1, 2001.

8.4.8.
Title: Effects of River Water Level Fluctuations on Cultural Resources

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of cultural resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories (FERC requirements).

T4. Effects of flow changes below dams.

T9. Operational effects on both unimpounded and downstream areas.

T17. Impact identification (actual).

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (unimpounded and free-flowing reaches).

T31. Flooding/dewatering of terrestrial species, i.e., micro habitat.

T45. Water level fluctuations and riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statement and Study Questions

Operational

Fluctuating unimpounded levels and flow regulation activities may be affecting cultural resources.

1) What are the cultural resources from Hells Canyon Dam to the confluence of the Salmon River?
2) What are the flow fluctuations from Hells Canyon Dam to the confluence of the Salmon River?
3) What are the effects on cultural resources from Hells Canyon Dam to the confluence of the Salmon River caused by flow fluctuations by Hells Canyon Project operations?
4. How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goals

The general goal is to determine whether or not unimpounded river fluctuations below Hells Canyon Dam have an adverse effect on cultural resources which are listed or eligible to be listed on the National Register of Historic Places. FERC requires that relicensing applicants identify and describe cultural resources in the vicinity of the project which are listed or determined to be eligible for listing on the National Register of Historic Places and the impact of the project on those resources (18 CFR §4.51 (f)(4)). This process is conducted by consultation with appropriate Native American tribes and the Idaho and Oregon SHPOs and other agencies pursuant to Section 106 of the National Historic Preservation Act, as amended 1992 (36 CFR §800).

Specific agency statements in plans that support the general goal include:

- Manage cultural resources in accordance with regulations (USDA 1990:S-43, II-113).

- Consider effects of activities on cultural resources; propose protection, mitigation (USDA 1990:IV-64ff).
- Consider the continuing, cumulative effects on cultural resources of fluctuating flows on cultural resources (USFS 1994:IV-99ff).

Abstract

This investigation proposes to assess the influence of project operation-related water level fluctuations on known cultural resources in the unimpounded reaches of the Hells Canyon Complex. The study will assess the effects of those fluctuations on the National Register qualities of those resources.

Although there is evidence of erosion at archaeological sites below Hells Canyon, a complete summary of unimpounded water level fluctuations for the Hells Canyon Complex has not been compiled for purposes of this study. The nature, extent, and distribution cultural resources in the unimpounded reaches are not fully known. A consultant will conduct field inventories of water level fluctuation-caused damage to known cultural resources. This information will be incorporated into a cultural resource management plan which will be written in conjunction with the IPC land management plan for the Hells Canyon Project. The land management plan will present recommendations for appropriate protection, mitigation, or enhancement of cultural resources in conjunction with the development, protection, mitigation, or enhancement of other resources.

Introduction

Water level fluctuations resulting from project operations can negatively and positively influence cultural resources. Both short- and long-term unimpounded water level fluctuations are considered.

Proposed studies will also consider the timing, rates, magnitudes, and duration of unimpounded water fluctuation as well as the characteristics of boat traffic and other recreational activities during the fluctuations.

The objectives of this study will be to:

1) characterize daily, monthly, and annual unimpounded water level fluctuations for the Hells Canyon Complex,
2) distinguish between the water level fluctuations related to IPC operations and those related to other purposes (i.e., fish flushes, flood control),
3) identify those cultural resources adversely impacted by unimpounded fluctuations,
4) identify specific issues surrounding the potential for project operations to adversely impact cultural resources,
5) link those adverse impacts on cultural resources to appropriate protection, mitigation or enhancement measures, and
6) characterize the types of recreational activities, such as boat traffic, which occur during the various types of fluctuations and their potential effects on impacts to shoreline cultural resources.

State of Knowledge

A complete summary of river water level fluctuations below Hells Canyon Dam has not been compiled for purposes of this study. Historic tailwater elevation data, available for approximately 1988 through 1995, can be obtained from log books at Hells Canyon Dam. Additional data since the 1940s is available further downstream at several USGS gauging stations. No summary has been compiled to distinguish river water level fluctuations related to project operations from those related to other purposes (i.e., fish flushes mandated by the NMFS; COE flood control requirements).

The present extent of cultural resources below Hells Canyon Dam is generally well known. There is a National Register District (District) below Hells Canyon Dam (King 1972). The District extends from the dam 70 miles downstream to Cougar Rapids and consists of 152 historic and 384 prehistoric sites.

The general outline of the area's prehistory is known (Warren *et al.* 1968). There have been several archaeological excavations in the Hells Canyon area (e.g. Leonhardy and Thompson 1991; Reid, Cochran, *et al.* 1991). A recent overview (Reid, Hackenberger, *et al.* 1991*b*) summarized major cultural resources investigations in the Hells Canyon area.

Although erosion below Hells Canyon Dam has been investigated (Schmidt *et al.* 1995), there is no detailed knowledge of its effects on cultural resources. However, as mentioned below, the effects of unimpounded river fluctuations on cultural resources have been studied in other areas. The proposed and study will determine whether any of these effects are present in the Hells Canyon area.

Normal operations may affect archaeological sites. For example, monitoring of archaeological sites below Glen Canyon Dam has determined that arroyo cutting, bank slumpage, and site canyon erosion are probably related to dam operations (Burchette 1995:ii). In contrast, the rebuilding of sand bars, which occurred during the large experimental water release of Spring 1996 may protect archaeological sites.

Large-scale fluctuations, such as fishery-related drawdowns, impact archaeological sites. For example, several impacts to archaeological sites were observed during the biological drawdown test on Lower Granite Dam in March 1992. Bank erosion resulting from wind and barge/boat traffic-generated waves was common (COE *et al.* 1994:4-79). Other drawdown-related impacts included terracing and slumping of shorelines and increased vandalism on archaeological sites (COE *et al.* 1994:4-79, 80). In general, waves generated by river traffic and drawdowns are the greatest potential causes of bank erosion (COE Waterways Experiment Station 1989:I-11:1).

Methods

Study Area

The study area extends from Hells Canyon Dam (RM 247.0) to the Salmon River/Snake River confluence (RM 188.2). The lateral extent of the study area will include all lands within approximately 50 meters of each shoreline.

Describing Water Level Fluctuations

A summary of historic headwater elevation data for the years 1982 through 1995 will be summarized by the IPC Water Management Department to: characterize daily, monthly, and annual unimpounded water level fluctuations for the Hells Canyon Complex, and distinguish between the water level fluctuations related to IPC operations and those related to other purposes (i.e., fish flushes, flood control).

Cultural Resources and Impacts Identification

Cultural resources and impacts will be identified in two stages. First (Stage I), a cultural resources inventory will be conducted in order to satisfy FERC's relicensing requirements. Preliminary water level fluctuation impacts will be identified during this inventory. This is normal procedure for a relicensing inventory. Not all of the Hells Canyon area unimpounded margins needs to be inventoried for cultural resources. As mentioned above, there is already a National Register District below Hells Canyon, so the area has already been inventoried. However, much of the inventory data is more than 20 years old.

The first step of the proposed study will be to determine which areas to be re-inventoried. Site records and maps will be consulted in order to determined gaps in the existing inventory coverage. A Class II (sampling survey) will be designed to fill in those gaps and gather data on site types and impacts. The sample will be a stratified random sample using geomorphic locations and prehistoric and historic site types as sampling strata. The design will be developed in consultation with the Idaho and Oregon SHPOs, the tribes, and interested agencies. Agreement on the scope of work will be formalized in an MOA with the SHPOs, FERC, IPC, and the ACHP as signatories.

If water level fluctuation impacts are identified during the cultural resources inventory, and if the Oregon and Idaho SHPOs require, the second part of the study (Stage II) will be initiated.

The second part of the study will be a geomorphological study of the effects of unimpounded water level fluctuations on the cultural resources on and in the unimpounded river shore. This phase of the study will quantitatively determine the dynamics of unimpounded water level fluctuation. The study will include, but not be limited to, a characterization of the type and degree of shoreline impact (i.e. bank erosion, slumping, terracing, etc.); the origin, magnitude, and duration of wave action; weather (principally wind direction and magnitude) conditions and its relation to types of water level fluctuation; and the nature, timing, and effect of boat traffic during various fluctuation episodes.

Contractor Selection

Consultant(s) with expertise in cultural resources, and, if the second phase of the study is initiated, in hydrology and/or geomorphology and statistical analysis, will be contracted to conduct this study. The consultant(s) may utilize services of subcontractors to perform elements of the work. The IPC principal investigator will develop an RFP to solicit bids from interested consultants and administer ensuing contracts. Interested tribes, agencies, and groups will assist in developing the RFP where appropriate. The U.S. Army Engineer Waterways Experiment Station, Vicksburg, will also be asked to assist in developing the RFP.

Issue Identification

If current literature reviews are inadequate, the consultant will conduct a thorough review of available literature to identify previous work that may be applicable to inventory the study area and to address the potential for unimpounded water level fluctuations to impact cultural resources.

Analysis/Assessment

The consultant will analyze and assess the data following the methods developed in consultation with IPC, the COE Waterway Experiment Station, tribes, interested agencies and other groups, as appropriate.

Link to Protection, Mitigation, and Enhancement Measures

The consultant will recommend protection, mitigation or enhancement measures to protect cultural resources impacted by unimpounded water level fluctuations, if caused by project operations. Details and descriptions of all protection, mitigation, and enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation, and enhancement measures.

Timetable

It is anticipated that an RFP for Stage I will be distributed to interested consultants in February 1997. The selected consultant will then review available literature, plan field inventory and data analysis methods, and conduct the study. This study is expected to require one field season following the development of the sampling design during 1997. A draft report of results should be available by November 1997 with a final report delivered by April 1999. Stage II investigations will follow, after April 1999, and should take another two years.

Cooperation

The following tasks will be conducted in consultation with interested agencies and groups:

1) determining the scope of Stage I inventory based upon reconnaissance data,
2) determining the need for Stage II studies, 3) developing the Stage II RFP for interested consultants,
3) planning Stage II field inventory and analysis methods,
4) reviewing draft report.

Statement of Capabilities

The IPC principal investigator for the study will be Dr. Mark Druss, who holds a Ph.D. in anthropology and has 30 years of experience designing and implementing studies. Dr. Druss has 20 years experience overseeing and administering contracts similar to the proposed study. An expert consultant with extensive experience with cultural resources and shoreline geomorphology will be sought to conduct the bulk of the study.

Deliverables

A project progress report for Stage II will be completed by the consultant by February 2000, summarizing field methods and survey results through the 1999 pilot season. A draft report will be prepared by November 2000, and a final report due by April 1, 2001. All Stage II data will be provided in a digital format (ASCII) acceptable to IPC.

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8.5.
Other Terrestrial

8.5.1.
Title: Effects of Water Level Fluctuations on Soil Resources

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and concerned non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T1. Impacts of water level on reservoir habitats.

T2. Impacts of water level on riparian habitat downstream.

T3. Cultural and natural resource inventories (FERC requirements).

T4. Effects of flow changes below dams.

T9. Operational effects on both reservoir and downstream areas.

T17. Impact identification (actual).

T18. Mitigation plans.

T26. Effect of operations on the quantity and quality of riparian habitat (reservoir and free flowing reaches).

T28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off).

T33. IPC land management practices effects on terrestrial resources.

T40. Livestock grazing impacts in relation to current management plans (intermingled land in project areas).

T45. Water level fluctuations and riparian conditions.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Fluctuating reservoir levels, flow regulation activities, and land management practices may affect soil resources.

1) What are the soil resources affected by fluctuating reservoir levels, flow, and land management practices?
2) What is the present status of soil resources affected by fluctuating reservoir levels, flow, and land management practices?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize disturbance to soil resources that are adversely influenced by IPC operations. Specific agency plans that support the general goal include management of riparian areas to achieve a healthy and productive condition for long-term benefits and values (USDI 1990). Riparian and wetland habitat have a high priority for protection and improvement in accordance with state and national policy (USDI 1987).

Abstract

This study proposes to assess the influence of IPC operations on soil resources in the reservoir reaches of the Hells Canyon Complex and in the Snake River reach from Hells Canyon Dam to the confluence of the Salmon River. Existing descriptions of the soil types, occurrence, physical and chemical characteristics, erodability, and potential for mass soil movement with the study area will be summarized. Sand bars and gravel bars are not considered as soil resources in this study but are addressed in aquatic resources study proposals. A consultant and interested agencies and groups will assist in planning field inventories to assess the types, extent and distribution of soil erosion areas, and methods for assessing the influence of IPC operations on soil resources. A consultant will conduct most field work, analyze results, and recommend appropriate protection, mitigation or enhancement measures.

Introduction

Soil is here defined as the top layer of the land surface composed of small rock particles, organic matter, water and air. Soil is a major factor affecting plants, and plants provide the food and essential habitat for most animals.

Reservoir-related water level fluctuations resulting from project operations can negatively and positively influence soil resources. Large water-level fluctuations can result in undercutting of shoreline banks and accelerate sloughing and landslides of erosion-prone soils, especially when they occur on steep slopes (O’Neal and McDonnell 1995). Reservoir shorelines are young, compared to natural lakes, and are still moving toward a more stable equilibrium. As a result, reservoirs may have shoreline erosion problems (Allen and Wade 1991). Soils stability is greater along reservoirs with narrower fluctuations. This is due to less shoreline disturbance (i.e., physical impacts of waves, wetting/drying cycles), and to the soil binding capabilities of vegetation roots. Vegetation can increase in coverage and persistence along reservoirs with narrower fluctuations (Kryzanek *et al.* 1986, Wilcox and Meeker 1991).

Effects on shoreline habitat downstream of hydropower projects generally result from variable flow regimes. Shoreline erosion tends to increase with increasing alterations from the natural flow regime. Changes, however, can be both negative and positive for soils, their resulting vegetation communities and riparian-dependent wildlife species. For example, damming steep-walled-canyon rivers can reduce the frequency of catastrophic floods that erode soil resources and eliminate riparian vegetation. Large water-level fluctuations can result in undercutting of shoreline banks and accelerate sloughing and landslides of erosion-prone soils, especially when they occur on steep slopes (O'Neal and McDonnell 1995).

The objectives of this study are to:

1) identify specific issues related to the potential for project operations to influence soil erosion,
2) inventory bank erosion, sloughing and landslide areas that may be influenced by reservoir water-level fluctuations,
3) assess the influence of project operations on the erosion of soil resources, and
4) link those influences on soil resources to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A complete summary of reservoir water level fluctuations for the Hells Canyon Complex has not been compiled for purposes of this study. Historic headwater elevation data, available for approximately 1982 through 1995, can be obtained from power plant log books at the Brownlee, Oxbow, and Hells Canyon Dams. These data are recorded from the headwater recorder at each dam by power plant operators. These daily measurements are most frequently recorded at the hours of 8:00, 16:00, 22:00 and 24:00.

A complete summary of river water level fluctuations below Hells Canyon Dam has not been compiled for purpose of this study. Historic tailwater elevation data, available for approximately 1988 through 1995, can be obtained from log books at Hells Canyon Dam. Additional data since the 1940s is available further downstream at several USGS gauging stations.

Detailed knowledge of the nature, extent, and distribution of the soil resources in the vicinity of the Hells Canyon Complex is incomplete. Published soil survey information from the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, is not available for much of the study area. Several large landslides are present along Brownlee Reservoir. These are believed to have occurred during the late Pleistocene period (Crone and Schuster 1989). Locally, parts of some slides that reach the lower slopes along the Snake River were reactivated by the filling of Brownlee Reservoir in 1959 through 1963, and other parts were reactivated during the high-precipitation years of 1983 through 1984 (Crone and Schuster 1989). Field observations indicate that fewer bank erosion and sloughing sites are present on Brownlee, Oxbow, and Hells Canyon Reservoirs. No complete inventories of bank erosion, sloughing, and landslide areas have been conducted for the study area, and the ways and extent that soil erosion is influenced by project operations have not been investigated.

Methods

Study Area

The study area consists of three reservoir reaches and a downstream reach. The Brownlee Reservoir Reach extends for approximately 55 miles, from RM 339.2 to 284.6. The Oxbow Reservoir Reach will extend for approximately 12 miles, from RM 284.6 to 272.2. The Hells Canyon Reservoir Reach extends for approximatley 25 miles, from RM 272.2 to 247.0. The reach downstream of Hells Canyon Dam extends for approximately 59 miles, from RM 247.0 to 188.2. The lateral extent of the study area will include all lands within approximately 0.25 miles of each shoreline.

Contractor Selection

A consultant with expertise in soil surveys, geologic surveys, sediment transport, hydrology, and statistical analysis will be sought to conduct this study. The selected consultant may utilize services of other subcontractors to perform elements of the work. An IPC contract administrator with experience in geology and soil resources and contract administration will develop an RFP to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to:

1) describe the soil types, occurrence, physical and chemical characteristics, erodability, and potential for mass soil movement with the study area,
2) identify previous work that may be applicable for addressing potential IPC operation influences on soil resources in the reservoir reaches, and
3) to develop and identify research methodologies for investigating issues.

The literature review will follow a hierarchical structure starting with publications of national relevance, proceeding to the regional perspective, and ending with focus on the local level.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to assess the types, extent and distribution of areas subject to erosion.

Describing Water Level Fluctuations

A summary of available historic headwater and tailwater elevation data will be obtained from the IPC Water Management Department to: characterize daily, monthly, and annual reservoir water level fluctuations for each year of record for the Hells Canyon Complex, and distinguish between the water level fluctuations related to project operations and those related to other purposes. The summary may be limited by the data available.

Characterization of changes of water level will include: minimum and maximum elevation recorded; 50, 90, and 98 percent of all elevations; minimum and maximum daily, monthly, and yearly change; 50, 90, and 98 percent of maximum daily, monthly, and annual change. The number of samples recorded and other information will be presented in tables and figures to characterize these data. The IPC Water Management Department will provide a summary to identify river water level fluctuations related to operations versus those related to other purposes (i.e., fish flushes mandated by the NMF; COE flood control requirements).

Analysis/Assessment

The consultant will analyze and assess the data following the methods outlined in consultation with interested agencies and groups.

Link to Protection, Mitigation, And Enhancement Measures

The consultant will recommend protection, mitigation, and enhancement measures to minimize disturbance to soil resources that are adversely affected by project operations. Details and descriptions of all protection, mitigation, and enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation, and enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early 1998. This study is expected to require two field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. A progress report should be available by February 1999 with a final report delivered by April 2000.

Cooperation

A consultant will be used to conduct this study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) developing the RFP seeking interested consultants,
2) planning field inventory and analysis methods, and
3) reviewing progress and draft reports.

Statement of Capabilities

The IPC contract administrator will be Gary Holmstead, who holds a M.Sc. in Plant Ecology, a minor in Geology, and has 10 years of experience designing and implementing studies. Mr. Holmstead has developed RFPs, reviewed proposals, developed and administered contracts for many projects similar to the proposed study. An expert consultant, with extensive experienced with soil surveys, geologic surveys, sediment transport, hydrology, and statistical analysis, will be sought to conduct the study.

Deliverables

The consultant will deliver a project progress report by February 1999, summarizing literature review, field methods, and survey results through the 1998 pilot season. A draft of the final report will be prepared by February 2000, and a final report will be due by April 1, 2000. All inventory data collected by the consultant will be provided in a digital format (ASCII) acceptable to IPC.

8.5.2. Title: Effects of Road and Transmission Line Rights-of-Ways on Soil Resources

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and concerned non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T17. Impact identification (actual).

T18. Mitigation plans.

T19. Impacts associated with transmission line operation (R/W).

T28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off).

T33. IPC land management practices effects on terrestrial resources.

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Maintenance

Maintenance of transmission line facilities (including rights-of-way) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources within transmission line corridors?
2) What are the effects of transmission line maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Maintenance of roadways and other facilities (not transmission lines) may be affecting cultural/wildlife/botanical/soil resources.

1) What are the cultural/wildlife/botanical/soil resources in the study area?
2) What are the effects of roadways and other facility maintenance on cultural/wildlife/botanical/soil resources?
3) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to minimize disturbance to soil resources as a result of project operations. Specific agency plans that support the general goal include ensuring optimum populations and a natural abundance and diversity of wildlife resources on public lands, by restoring, maintaining, and enhancing habitat conditions through management plans and actions integrated with other uses of public lands through coordination with other programs, the states, by management initiatives, and through direct habitat improvement projects (USDI 1990).

Abstract

This study proposes to assess the influence of IPC operations on soil resources along roadways owned by IPC and along transmission line corridors associated with the Hells Canyon Project. Existing descriptions of the soil types, occurrence, physical and chemical characteristics, erodability, and potential for mass soil movement with the study area will be summarized. A consultant and interested agencies and groups will assist in planning field inventories to assess the types, extent and distribution of soil erosion areas, and methods for assessing the influence of operations on soil resources. A consultant will conduct most field work, analyze results and recommend appropriate protection, mitigation or enhancement measures.

Introduction

Direct factors resulting from operations along transmission line corridors and roadways may negatively affect soil resources. Direct effects can include compaction and disturbance to soil structure from wheeled vehicle traffic during maintenance activities (i.e., line monitoring surveys; cutting, burning, using herbicides on vegetation). When soil structure is damaged, or vegetation coverage is eliminated, soils are more susceptible to erosion.

The objectives of this study are to:

1) identify and describe roads and transmission line corridors associated with the Hells Canyon Project,
2) identify and describe activities occurring along these corridors,
3) identify specific issues related to the potential for operations to influence soil resources,
4) inventory erosion sites in the study area,

5) assess the influence of operations on the erosion of soil resources, and
6) link these influences on soil resources to appropriate protection, mitigation or enhancement measures.

State of Knowledge

A description of roads and transmission line corridors associated with the Hells Canyon Project has not yet been compiled for purposes of this study. Locational information and general descriptive information should be available in IPC files. No summary of the nature and extent of operational/maintenance activities has yet been compiled.

Detailed information regarding the nature, extent, and distribution of soil resources along roadway and transmission corridors is not available. Published soil survey information from the NRCS is available for much of the study area.

Methods

Study Area

The roadway areas to be studied will include all lands impacted by project operations on IPC-owned roadways occurring in the Hells Canyon vicinity (generally within three miles of the Snake River; rim-to-rim area of Hells Canyon) and undisturbed areas out to a distance of about 20 meters on each side of the roadway centerline. Roadways will include dirt and paved roads. The total length of such roadways is unknown but anticipated to be approximately 50 to 75 miles. Examples of such roads include the paved Hells Canyon

Road, between Oxbow and Hells Canyon Dams, and roads in the immediate vicinity of Oxbow Dam and Brownlee Dam.

The transmission line area will include all lands impacted by cut/fill activities, or other disturbed areas, associated with transmission towers and all roadways specifically constructed to access transmission towers. It will also include a 20-meter buffer surrounding disturbed areas. All lines to be relicensed with the Hells Canyon Project will be included. The total length of access roads is unknown.

Contractor Selection

Consultants with expertise in soil surveys, geologic surveys, sediment transport and statistical analysis will be sought to conduct this study. A single consultant will be selected. The selected consultant may utilize services of other subcontractors to perform elements of the work. An IPC contract administrator with experience in geology and soil resource, and contract administration, will develop an RFP to solicit bids from interested consultants and administer ensuing contracts. Interested agencies and groups will assist in developing the RFP.

Issue Identification

The consultant will conduct a thorough review of available literature to:

1) describe the soil types, occurrence, physical and chemical characteristics, erodability, and potential for mass soil movement with the study area,
2) identify previous work that may be applicable for addressing potential operational influences on soil resources along roads and transmission line corridors, and
3) develop and identify research methodologies for investigating issues.

The literature review will follow a hierarchical structure starting with publications of national relevance, proceeding to the regional perspective, and ending with a focus on the local level.

Field Inventories

The consultant and other interested agencies and groups will assist in planning field inventory methodologies to assess the types, extent and distribution of areas subject to erosion.

Describing Operation/Maintenance Activities

A description of operation/maintenance activities will be provided by the IPC Transmission Department. It will include, where available, a summary of the types, extent, location, and timing of activities. Types of activities could include: wheeled vehicle travel (i.e., pickup, ATV), helicopter travel, herbicide spraying, vegetation mowing, tree/shrub pruning, and road repair. The extent of activities will be summarized, where possible, by hours/month and hours/year for each activity type. It is anticipated that the location will be summarized by mile points along roads and transmission corridors or along specific sections of roads or transmission corridors for each activity type. Timing will be summarized by days of the week, weeks of the month, and months of the year, as appropriate, for each activity type.

Analysis/Assessment

The consultant will analyze and assess the data following the methods outlined in consultation with interested agencies and groups.

Link to Protection, Mitigation, and Enhancement Measures

The consultant will recommend protection, mitigation, and enhancement measures to minimize disturbance to soil resources that are adversely affected by project operations. Details and descriptions of all protection, mitigation, and enhancement measures or facilities will be provided, and will include figures and illustrations, location maps, and other necessary information to construct or implement protection, mitigation, and enhancement measures.

Timetable

It is anticipated that an RFP will be distributed to interested consultants in early 1998. This study is expected to require three field seasons, with the first season (1998) used as a pilot study year to test efficacy of methods and analysis techniques. Progress reports should be available by February 1999 and February 2000, with a final report delivered by April 1, 2001.

Cooperation

A consultant will be used to conduct this study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) developing the RFP for interested consultants,
2) planning field inventory and analysis methods, and
3) reviewing progress and draft reports.

Statement of Capabilities

IPC’s contract administrator will be Gary Holmstead, who holds a M.Sc. in Plant Ecology, a minor in Geology, and has 10 years of experience designing and implementing studies. Mr. Holmstead has developed RFPs, reviewed proposals, and developed and administered contracts for many projects similar to the proposed study. An expert consultant with extensive experience with soil surveys, geologic surveys, sediment transport, and statistical analysis will be sought to conduct the study.

Deliverables

The consultant will deliver a project progress report in February 1999, for 1998 activities, and in February 2000, for 1999 activities. These progress reports will summarize literature review (1999 report only), field methods, and survey results. A draft of the final report will be prepared by February 2001, and a final report will be due by April 1, 2001. All inventory data collected by the consultant will be provided in a digital format (ASCII) acceptable to IPC.

8.5.3.
Title: Influences of Land Management Practices on Terrestrial Resources on IPC-Owned Lands

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T12. Studies focus on Hells Canyon project impacts on wildlife versus focus on current conditions (impacts versus data only).

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T17. Impact identification (actual).

T18. Mitigation plans.

T33. IPC land management practices effects on terrestrial resources.

T40. Livestock grazing impacts in relation to current management plans.

T41. Do noxious weeds limit mitigation opportunity?

Problem Statements and Study Questions

Operational

Existing land use and land management practices affect cultural, wildlife and botanical resources.

1) What are the effects of land use practices (i.e., livestock grazing) on cultural, wildlife and botanical resources?
2) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to identify impacts on cultural, botanical, wildlife and soil resources, as a result of land management practices on IPC-owned lands, to promote healthy and productive conditions for long-term benefits and values.

Abstract

This study proposes to assess the effects that IPC-authorized land uses have had on cultural, botanical, wildlife and soil resources in the Hells Canyon vicinity. Land use will be identified on all IPC-owned lands in the Hells Canyon vicinity as part of land mangement plan development. Those lands not used solely for project operations, such as areas affected by water level fluctuations, industrial facilities, residences or parks will be addressed in this study. These lands will be inventoried to describe existing conditions of cultural, botanical, wildlife, and soil resources. Interested agencies and groups will assist in planning field methodologies to inventory terrestrial resources occurring on each property and in identifying techniques to assess the influence that IPC-authorized land uses (i.e., irrigated pasture, grazing, mining, public access, impromptu recreation)

have had on these resources. Most field work will be conducted by IPC staff. Recommendations will be made on how to change land management practices that have had a negative influence on cultural, botanical, wildlife and soil resources, and implement measures that will promote healthy and productive conditions for long-term benefits and values. These recommendations will be integrated with the IPC land management plan for the Hells Canyon Project. This study will also help identify potential protection, mitigation, and enhancement opportunities.

Introduction

Common land uses in the Hells Canyon vicinity are mining, agriculture, domestic livestock grazing, recreational, residences, other recreational uses, and resource conservation.

The objectives of this study are to:

1) identify specific issues related to land use impacts on cultural, botanical, wildlife and soil resources,
2) inventory the current condition of cultural, botanical, wildlife, and soil resources on IPC-owned lands,
3) assess the influence that IPC-authorized land use practices have had on cultural, botanical, wildlife, and soil resources, and
4) link the influence of these land use practices on cultural, botanical, wildlife, and soil resources to land management policies and appropriate protection, mitigation, or enhancement measures.

State of Knowledge

An inventory of land use occurring on IPC-owned lands is planned as part of land management plan development (Section 8.7.1.). Little information is available concerning the current condition of the lands with respect to cultural, botanical, and wildlife resources. No assessments have yet been made regarding the influence of IPC-authorized land use practices.

IPC is currently collecting substantial descriptive information on existing cultural, botanical, wildlife, and soil resources in the Hells Canyon vicinity to meet FERC requirements for relicensing and to provide baseline information for other environmental studies. The USFS and BLM have management responsibility for most of the lands in the Hells Canyon vicinity and have also conducted baseline studies on terrestrial resources. These data, supplemented by previous work conducted by other investigators, provide background information.

Methods

Study Area

This study will consider IPC-owned land within or adjacent to the project boundary, from the Highway 30N bridge at Weiser, Idaho (RM 351.2) to the confluence of the Salmon River (RM 188.2).

Identifying IPC Lands to be Considered in the Study

IPC's database includes ownership information. An inventory of land use in the study area will occur as part of the development of IPC's land management plan for the Hells Canyon Project.

Issue Identification

Interested agencies and groups will be consulted to help identify specific issues related to land use impacts on cultural, botanical, wildlife and soil resources. A thorough review of available literature will be conducted to identify previous work that may be applicable to inventory the existing conditions of cultural, botanical, wildlife, and soil resources in the study area, and to address the potential for IPC-authorized land use practices to negatively influence cultural, botanical, wildlife, and soil resources.

Field Inventories

Interested agencies and groups will be consulted to help plan field inventory methodologies to inventory the current condition of cultural, botanical, wildlife, and soil resources at each site. It is anticipated that the following types of data will be collected.

Cultural resource inventories will be conducted according to guidelines published by the Idaho and Oregon SHPOs. A Class III, or complete, intensive survey will be conducted for each site. Pedestrian surveys will be conducted at transect intervals no wider than 30 meters on slopes less than 30 percent. On slopes greater than 30 percent, a wider interval will be used, or areas will be inspected visually from a distance. Standard field mapping procedures will be followed; GPS location will be established for all site datums. For inventories in Idaho, the Intermountain Antiquities Computer System (IMACS) forms will be completed. IMACS site forms will be entered into ARCHEOCOMPUTE, the Idaho SHPO-mandated database system. For Oregon inventories, SHPO-approved site forms and the ARCSITE computer database will be used. Site location maps and site photographs will also be taken. All site data will be entered into the IPC GIS.

For botanical resources, the cover types and plant communities occurring at each site will be described. Each site will be mapped by cover type, based on the 26 vegetation, natural feature, and land use cover types used in past IPC relicensing studies. Detailed data on species composition, cover, woody species density and height, and vegetation structure will be collected for each plant community at each site. Where applicable, the degree of domestic grazing use will be estimated using established range utilization methods. Each site will be inventoried for *threatened*, *endangered* and *sensitive* species and noxious weeds. If such species are present, detailed demographic data will be collected for each population. Each site will be ranked using established indexes (following NRCS, USFS, BLM methods) for overall plant composition, abundance of seedlings and young plants, plant residues, plant vigor, condition of the soil surface, soil erosion condition class, bare soil, and ground cover. If present, detailed information on soil disturbance and soil erosional problems will be collected.

For wildlife resources, surveys will be conducted to develop wildlife species occurrences and distributions. Wildlife groups to be considered include:

1) nongame birds,
2) upland game birds,
3) nesting raptors,
4) mammalian carnivores,
5) waterfowl,

6) big game, and
7) *threatened*, *endangered*, and *sensitive* species.

Threatened, *endangered*, and *sensitive* species surveys will be emphasized. The presence of uncommon or sensitive habitats (e.g., wetlands) will also be recorded. Existing data will be used when possible, however, this will be augmented with additional field surveys when necessary.

For soil resources, a thorough review of available literature will be conducted to describe the soil types, occurrence, physical and chemical characteristics, erodability, and potential for mass soil movement with the study area. A field survey will be conducted to verify the information available from the literature and to more specifically assess the types, extent and distribution of erosional areas.

Analysis/Assessment

Data will be analyzed following the methods determined in consultation with interested agencies and groups. It is anticipated that the following types of analyses will occur.

For cultural resources, analysis of field inventory data will be directed toward completing the Oregon and Idaho electronic site form databases. Therefore, field data will be analyzed to address questions including site age; location; function; general environmental context; site condition; artifact quantity and type; and impacts from vandalism, construction, recreation, grazing, and natural forces. Inventory data will be shared, if necessary, with tribes and agencies according to establish protocols in order to protect the sites.

For botanical resources, the extent, representation and distribution of cover types present on a site will be compared with surrounding lands in the study area. The vegetative characteristics of each site will be compared with existing information on botanical resources in the study area on lands of similar edaphic and topographic conditions. This will provide a reference as to the relative abundance/condition of the cover types and plant communities present on IPC-owned lands, compared with that available in the study area. The degree of domestic grazing use will compared to that recommended by applicable USFS and BLM guidelines on lands of similar edaphic and topographic conditions. Rank scores for site condition indexes will be summarized for each site and compared to available information from surrounding areas.

For wildlife resources, the IPC GIS will be used to identify intersections between land uses and specific wildlife resources. Information identified from the literature review on known and potential impacts to wildlife species/habitat from land uses will be used to qualitatively evaluate the data. The potential impacts to wildlife resources will evaluated by wildlife group, for each land use and species/habitat overlap.

For soil resources, the data will be analyzed and assessed following the methods outlined in consultation with interested agencies and groups.

Link to Protection, Mitigation, and Enhancement Measures

Appropriate protection, mitigation or enhancement measures will be determined to promote healthy and productive conditions for long-term benefits and values for cultural, botanical, wildlife and soil resources.

Timetable

The land use inventory will occur in 1997. Methods to inventory and analyze site conditions and effects of land uses will be formally outlined in 1997. Efforts will be taken in 1997 and 1998 to test efficacy of methods and analysis techniques. Most site inventories are expected to occur late in the 1998 field season and during 1999. A progress report should be available by February 1999 with a final report delivered by April 2000.

Cooperation

This study will be closely coordinated with the development of a land management plan for the Hells Canyon Project. The services of a consultant may be used to assist with the study. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying specific issues (factors) related to the potential for IPC-authorized land use practices to negatively influence cultural, botanical, wildlife and soil resources,
2) planning field methodologies to inventory terrestrial resources occurring at each site and techniques to assess impacts, and
3) reviewing progress and draft reports.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct the study. The principal investigators will be selected from within the Terrestrial Section of the IPC's Environmental Department. These researchers work in coordination with IPC's Land Management Planner and two to four field assistants with B.Sc. degrees in natural resources, and one to three years of relevant field experience.

The facilities at IPC are well-suited to all phases of the proposed study. The company has available 4-wheel-drive vehicles, rafts, and jet- and propeller-powered boats for logistical support. Equipment and housing facilities to support field research are available. Data analysis will be conducted on the company's mainframe or personal computers using SAS. IPC's GIS will be used to aid in spatial data analysis and report preparation.

Deliverables

A project progress report will be completed by February 1999 summarizing the literature review, field methods, and survey results through the 1998 pilot season. A draft of the final report will be prepared by February 2000, and a final report will be due by April 1, 2000. All cultural, botanical, wildlife, and soil data will be provided in a digital format (ASCII).

8.5.4.
Title: Influences of Recreation Activities on Terrestrial Resources

This impact study description was proposed and developed in cooperation between IPC and the Terrestrial Resources Work Group of the Collaborative Team. This study was developed specifically to address concerns expressed by federal and state resource agencies and concerned non-governmental organizations. Further, this study will help IPC meet the FERC requirement to identify needs of terrestrial resources associated with the Hells Canyon Project, and develop means to minimize operational impacts on these resources.

Issues

T3. Cultural and natural resource inventories (FERC requirements).

T12. Studies focus on Hells Canyon project impacts on wildlife versus focus on current conditions (impacts versus data only).

T17. Impact identification (actual).

T18. Mitigation plans.

T32. Public access/recreational versus impact of new roads, public, wildlife species terrestrial habitat, winter ranges, etc., people use in former wildlife habitat.

T33. IPC land management practices effects on terrestrial resources.

T34. Potential effect of recreation on cultural, botanical, and wildlife resources (i.e., bald eagles, cultural sites, *threatened* and *endangered* plant species).

T41. Do noxious weeds limit mitigation opportunity?

T49. Hydro versus other uses (impacts).

Problem Statements and Study Questions

Operational

Existing land use and land management practices affect cultural, wildlife, and botanical resources.

1) What are the effects of recreational human presence on cultural, wildlife .and botanical resources?
2) How are results linked to protection, mitigation, and enhancement planning and implementation?

Desired Future Resource Goal

The general goal is to identify those recreational practices that may negatively affect cultural, botanical, wildlife, and soil resources and to identify potential measures that will promote healthy and productive conditions of these resources for long-term benefits and values.

Abstract

The influence of recreation activities on cultural, botanical, wildlife, and soil resources will be assessed by this study in two phases. During Phase I, existing information on recreation activities, cultural, botanical, wildlife, soil resources, and associated transmission lines occurring in the Hells Canyon vicinity will be compiled and entered into the GIS. Physiographic features such as topography, hydrology, roads, and trails, and land ownership will be included as thematic layers in the GIS (this is proposed as part of land management plan development). The GIS will be used to analyze spatial relationships between recreation activities and terrestrial resources, and to link descriptive attribute information about recreation activities and terrestrial resources to identify areas of potential conflict. An assessment will be made as to the nature of each conflict, any

negative influences on cultural, botanical, wildlife, and soil resources, and IPC's authority to control the recreation activity. If insufficient information is available to make these assessments for some sites, the need to conduct site specific studies or to collect missing data will be identified. Protection, mitigation or enhancement measures and/or land use policies may be recommended for recreation impacts. Phase II will involve conducting any additional studies determined necessary from Phase I.

Introduction

Common recreation activities in the Hells Canyon vicinity include camping at developed facilities and impromptu areas, boating, hunting, fishing, off-road vehicle (ORV) use, sight-seeing, shooting, and hiking.

The primary ecological impacts of recreation are

1) physical site alteration and disturbance of biota through trampling by recreationists and their equipment;
2) the removal and redistribution of materials by recreationists and their equipment;
3) disturbance of native animals by human presence;
4) importation of foreign substances (i.e., noxious weeds, food items for wildlife);
5) harvesting of animals and plants; and
6) pollution by human waste and foreign substances.

Effects of recreation on most levels of biological organization (i.e., genes, populations, communities, and ecosystems) have been documented. Where the impacts of recreation use are highly localized, the most significant ecological impacts are likely to be those that affect rare species and assemblages. The significance of a recreation activity is ultimately determined by characteristics of the activity and of the affected resource (Cole and Landres 1996).

To assess the influence that recreation activities have on terrestrial resources in the vicinity of the Hells Canyon Project, this study will be conducted in two phases. Specific objectives of Phase I are to:

1) compile existing information on the current condition of cultural, botanical, wildlife and soil resources in the study area,
2) compile existing information on the types and attributes of recreation activities in the study area,
3) consult with interested agencies and groups and conduct a literature search to identify specific issues surrounding the potential for recreation activities to negatively influence terrestrial resources, and to identify buffer zones needed to protect these resources,
4) conduct GIS analyses to identify areas of overlap between recreation activities and specific cultural, botanical, wildlife and soil resources,
5) assess IPC's authority to control specific recreation activities that may influence cultural, botanical, wildlife and soil resources,
6) link results to potential protection, mitigation or enhancement measures and land management policies, and
7) assess the need to conduct additional site specific studies.

The general objective of Phase II will be to investigate recreation activity influences on specific cultural, botanical, wildlife and soil resources as identified in Phase I. This may involve collecting more detailed site specific information. Specific methods used for investigation will be coordinated through consultation with interested agencies and groups. Each study will link results to potential protection, mitigation or enhancement measures for recreation impacts.

Two general considerations apply to this study. First, any wildlife behavioral issues in response to recreation activities are beyond the scope of this study. Second, this study will not address linkages between recreation carrying capacity and predicted resource impacts.

State of Knowledge

A complete description of the types of recreation activities occurring in the Hells Canyon vicinity and associated transmission lines has not been compiled for purposes of this study. IPC is currently collecting information on recreation activities occurring along the Snake River corridor in the Hells Canyon area from above Cobb Rapid (about RM 341) near Weiser, Idaho, downstream to just below Hells Canyon Dam (RM 247) (see recreation study proposals). The USFS maintains some data on recreational activities occurring in the HCNRA downstream from Hells Canyon Dam. The BLM also maintains some data on recreational activities occurring in the vicinity of Brownlee, Oxbow and Hells Canyon Reservoirs. These data will be compiled and analyzed.

A complete description of the existing cultural, botanical, wildlife, and soil resources occurring in the Hells Canyon vicinity and associated transmission lines has not been compiled. IPC is currently collecting descriptive information on existing cultural, botanical, wildlife, and soil resources occurring along the Snake River in the Hells Canyon area from Weiser, Idaho (RM 351.2), downstream to the confluence of the Salmon River (RM 188.2). The USFS and BLM have land management responsibility for most of the lands in the Hells Canyon vicinity and have also conducted baseline studies on terrestrial resources. These data can be compiled and analyzed.

Methods

Study Area

This study will consider all lands within approximately 3 miles of the Snake River (roughly from rim to rim in the canyon) or associated river arms on Brownlee Reservoir, from the Highway 30N bridge at Weiser, Idaho (RM 351.2) to the confluence of the Salmon River (RM 188.2) and includes transmission lines to be relicensed with the Hells Canyon Project.

Phase I - Describing Cultural, Botanical, Wildlife and Soil Resources

Existing information on cultural, botanical, wildlife and soil resources in the study area will be compiled. The key components of this information include the location of resources and associated descriptive attribute data. Each theme of data will be stored as a layer in the GIS.

Phase I - Describing Recreation Activities

Existing information on recreational use in the study area will be compiled (Section 8.6 contains recreation study proposals). Key components of this information include the location of each activity and associated descriptive attribute data. These data will be stored as a layer in the GIS.

Phase I - Agency Consultation/Literature Review

Interested agencies and groups will be consulted, and a thorough review of available literature will be conducted to help identify specific issues related to potential impacts of recreation activities on cultural, botanical, wildlife and soil resources. The literature review will follow a hierarchical structure starting with publications of national relevance, proceeding to the regional perspective, and ending with focus on the local level. This information will be used to assess the potential negative influence that recreation activities might have on cultural, botanical, wildlife, and soil resources.

Phase I - GIS Analysis/Assessment

Spatial data on recreation activities and cultural, botanical, wildlife, and soil resources will be analyzed using the GIS to identify areas of potential conflict. The GIS will be used to analyze spatial relationships between recreation activities and terrestrial resources. Each terrestrial resource will be assigned a buffer zone that is needed to protect the resource. Using the descriptive information available for each intersect area, the nature and significance of each conflict will be determined (see recommendations of Cole and Landres 1996). An assessment will be made regarding IPC’s authority to control the recreation activity. If insufficient information is available to make this assessment, additional site specific studies will be identified. The need for further study will be determined in consultation with interested agencies and groups.

Phase I - Link to Protection, Mitigation, and Enhancement Measures

If necessary, protection, mitigation, or enhancement measures will be determined. Emphasis will be placed on changing management of recreation activities that have negative influences on cultural, botanical, wildlife and soil resources. The goal will be to promote healthy and productive conditions for long-term benefits and values while continuing to provide recreational opportunities.

Phase II - Further Studies

Using the results of Phase I, additional studies may be conducted to investigate specific recreation activity influences on specific cultural, botanical, wildlife or soil resources that are affected by project operations. It is anticipated that any additional studies will focus on those recreation activities that IPC has authority to control. Methods used for Phase II studies will be coordinated through consultation with interested agencies and groups. Each study will link results to appropriate protection, mitigation or enhancement measures and land use policies.

Timetable

Phase I of this study is expected to require about two and a half years, from July 1997 to January 2000. A draft report is anticipated by November 1999, and a final report by January 2001.

Any Phase II studies will be conducted from January 2001 to December 2002. It is anticipated that some Phase II studies may be included as license articles and be conducted sometime during the period of the new license for Project No. 1971.

Cooperation

This study will be closely coordinated with recreation studies and IPC Land Management Plan development. Interested agencies and groups will be updated on study progress. The following tasks will be conducted in consultation with interested agencies and groups:

1) identifying specific issues related to the potential for recreation activities to negatively influence cultural, botanical, wildlife, and soil resources,
2) planning methods to assess conflicts using the GIS, and criteria to justify further studies to investigate site specific issues, and
3) reviewing the draft and final report.

Statement of Capabilities

IPC has the personnel and equipment necessary to conduct Phase I of the study. The company has available 4-wheel-drive vehicles, rafts, and jet and propeller-powered boats for logistical support. Equipment and housing facilities to conduct field research are available. Data analysis will be conducted on the company's GIS using ARC/INFO to conduct spatial data analysis and assist in report preparation.

Pending recommendations developed for Phase II, IPC's resources and capabilities to conduct additional data gathering efforts will be determined.

Deliverables

The principal investigators will have a draft report of Phase I by November 1999 and a final report by January 2001. Reports from Phase II studies will be provided in a timely manner. All recreation, cultural, botanical, wildlife and soil data will be provided in ARC/INFO format.

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8.6. Recreation

8.6.1. Title: A Review of Past Recreation Issues and Use in the Hells Canyon Complex

Issues

R2. Monitoring of use trends.

R4. Management of increasing use.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R16. Protection from loss of public access.

R27. Historic interpretation.

R28. Type and level of marketing used.

R30. Cooperative opportunities among concerned entities.

R31. Operation and maintenance costs of facilities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Current recreation use and users are stressing the physical and social environment in the Hells Canyon Complex.

Desired Future Resource Goals

The goals of this study include collecting, organizing, and reporting information (governmental, private, and IPC) about past recreational use and issues associated with the Hells Canyon Complex. This information, when combined with the results of recreational use studies to be conducted by IPC within the Hells Canyon Complex, will allow for the identification of important recreational use issues and trends in both location and activity-specific use levels. This information will enable IPC, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, to develop a plan to protect, mitigate, and enhance recreational resources associated with the hydroelectric projects within the Hells Canyon Complex.

Abstract

Recreational use at the Hells Canyon Complex has been documented by state and federal agencies and IPC over the last 50 years. Unfortunately, the majority of the information reported has been limited to a qualitative review. A literature (governmental, private, and IPC) review of available data will be undertaken by IPC and appropriate agencies. The study area will include the area identified as the Hells Canyon Complex.

Introduction

The Snake River Corridor from the upper end of Brownlee Reservoir through the HCNRA includes approximately 168 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. The land within this corridor is owned/controlled by numerous private and governmental entities. While IPC and other managing entities have had reason to collect some information concerning specific portions of the Hells Canyon Complex, no comprehensive recreational use or impact data has been collected. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

The USFS has quantifiable data on recreation use below Hells Canyon Dam from the late 1980s and qualitative data for an additional 25+ years. ODFW and the IDFG also have limited recreation data from creel and hunting surveys. More recently, IPC has been involved in quantifiable recreation studies since 1994 on the three reservoirs of the Hells Canyon Complex, but have only limited information for recreational use below Hells Canyon Dam.

Methods

A literature (governmental, private, and IPC) review of available data will be undertaken by IPC and appropriate agencies. The review process will cover the time period from the first project's construction through the present. Recreational use patterns prior to the dams' construction will be included as information is available. The study area will include the area identified as the Hells Canyon Complex. The intensity of the literature review will be determined by time, cost and data availability.

Timetable

The literature review will be completed during 1998.

Cooperation

IPC will implement the literature review with the assistance of the Recreation and Aesthetic Resources Work Group and concerned entities.

Statement of Capabilities

IPC will conduct the literature review with cooperating agencies and entities, who will provide copies or access to copies of data they deem to be of use to this study. A narrative will be completed on an IBM-compatible PC using Microsoft Word software. A GIS will be used for mapping recreation use.

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A narrative and GIS map.

8.6.2.
Title: A Description of Current and Potential Recreational Use and Users Associated with Reservoirs within the Hells Canyon Complex

Issues

R1. Identification of current and potential users.

R2. Monitoring of use trends.

R4. Management of increasing use.

R12. Fishing turnouts for bank angling.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R16. Protection from loss of public access.

R21. Identification of existing and potential facilities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Current recreation use and users are stressing the physical and social environment in the Hells Canyon Complex.

Desired Future Resource Goals

The goal of this study is to obtain information about current and potential (1997 through 2000) recreational use and users at reservoirs within the Hells Canyon Complex. This information, when combined with the results of a review of obtainable past information about recreational use within the Hells Canyon Complex, will provide for the identification of important recreational use issues and trends in both location and activity-specific use levels. This will enable IPC, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, to develop a plan to protect, mitigate and enhance recreational resources associated with the Hells Canyon Complex.

Abstract

IPC has documented recreational use, demographics and opinions of users at reservoirs within the Hells Canyon Complex since 1994. The data proposed to be collected will provide increased knowledge of use trends for these areas. Study objectives are to identify numbers, types and distribution of current reservoir-related recreational use in the Hells Canyon Complex and, where feasible, forecast trends of future use. IPC anticipates using a combination of sampling methodologies to obtain information from current, on-site recreational users and potential, off-site recreational users.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir to Hells Canyon Dam includes approximately 97 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. The land within this corridor is owned/controlled by numerous private and governmental entities. While IPC and other managing entities have had reason to collect some information concerning specific portions of the Hells Canyon Complex, no comprehensive recreational use or impact data has been collected. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

Since 1994, IPC has consistently documented numbers, types and distribution of recreational use as well as demographics and opinions of users for the Hells Canyon Complex from the headwaters of Brownlee Reservoir to the visitor center below Hells Canyon Dam. ODFW and IDFG also have limited recreation data from creel and hunting surveys.

Methods

Study design and survey methodologies to be employed will be developed by IPC in cooperation with appropriate agencies and entities and, if necessary, an independent consultant. Therefore, specifics on sampling design and methodologies are yet to be determined.

IPC anticipates using a combination of sampling methodologies to obtain information from current, on-site recreational users and potential, off-site recreational users. Sampling strategies will be tailored to fit the characteristics of the target group.

Timetable

Data collection is expected to begin during 1997 and continue through 2000. Reporting is anticipated to be finalized in 2001.

Cooperation

IPC will implement the study on current and potential recreational use with the assistance of the Recreation and Aesthetic Resources Work Group and concerned entities.

Statement of Capabilities

IPC will conduct on-site sampling via boat, vehicle or foot, depending on the terrain and weather. Off-site sampling, when used, may involve telephone and/or mail surveys and may be developed and conducted with the assistance of a private consultant. Data will be automated and analyzed using an IBM-compatible PC and appropriate software. A GIS will be used for mapping recreation use.

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS maps.

8.6.3.
Title: A Description of Current and Potential Recreational Use and Users Associated with the Snake River within the HCNRA

Issues

R1. Identification of current and potential users.

R2. Monitoring of use trends.

R4. Management of increasing use.

R12. Fishing turnouts for bank angling.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R16. Protection from loss of public access.

R21. Identification of existing and potential facilities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Current recreation users are stressing the physical and social environment in the Hells Canyon Complex.

Desired Future Resource Goals

The goal of this study is to obtain information about current and potential (1997 through 2000) recreational use and users on the Snake River within the HCNRA. This information, when combined with the results of a review of obtainable past information about recreational use within the HCNRA, will provide for the identification of important recreational use issues and trends in both location and activity-specific use levels. This will enable IPC, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, to develop a plan to protect, mitigate and enhance recreational resources associated with the Snake River within the HCNRA.

Abstract

The USFS has documented recreational use, demographics and opinions of recreationists within the HCNRA for several years. The data proposed to be collected will provide increased knowledge of use trends for these areas. Study objectives are to identify numbers, types and distribution of current river-related recreational use in the HCNRA and, where feasible, forecast trends of future use. IPC anticipates cooperating with the USFS in augmenting (if necessary) the information now being collected by the USFS in the HCNRA.

Introduction

The Snake River Corridor through the HCNRA includes approximately 71 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. The land and river within this corridor is managed by the USFS. This study is proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

Since 1994, IPC has consistently documented numbers, types and distribution of recreational use as well as demographics and opinions of users at the visitors' center below Hells Canyon Dam. The USFS is required to collect recreational use information within the HCNRA, and has done so since 1988.

Methods

Study design and survey methodologies to be employed will be developed by IPC in cooperation with appropriate agencies and entities and, if necessary, an independent consultant. Therefore, specifics on sampling design and methodologies are yet to be determined.

Timetable

Completion of this study is dependent upon results of evaluation of USFS information, consultation with same, and the possible decision to augment USFS information.

Cooperation

IPC will implement the study on current and potential recreational use with the assistance of the USFS, Recreation and Aesthetic Resources Work Group, and concerned entities.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS maps.

8.6.4.
Title: An Investigation into the Current and Potential Physical and Social Conflicts Associated with Recreational Use and Recreational Carrying Capacity of the Hells Canyon Complex

Issues

R3. Effects of attracting more use.

R4. Management of increasing use.

R5. Limits of acceptable change (LAC).

R6. Law enforcement.

R7. Traffic associated with use.

R8. Multiple-use conflicts.

R11. User expectations and desires relating to access.

R15. Seasonal closures of access areas.

R18. Improved property ownership identification.

R19. Impacts of recreation use on adjacent lands.

R20. Depletion of beaches below Hells Canyon dam.

R21. Identification of existing and potential facilities.

R22. User expectations and desires relating to facilities.

R23. “Improved” facilities versus dispersed sites.

R24. Boat mooring facilities.

R25. Sanitation.

R26. Commercial recreation service providers (i.e. concessionaires).

R27. Historic interpretation.

R30. Cooperative opportunities among concerned entities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Current recreation users are stressing the physical and social environment in the Hells Canyon Complex.

Desired Future Resource Goal

The goal of this study is to obtain information about current and potential (1998 through 2000) physical and social conflicts associated with recreational use and recreational carrying capacity within the Hells Canyon Complex. This information, when combined with the results of studies to ascertain trends in recreational issues and use, will enable IPC, managing agencies, and concerned entities to identify important physical and social conflicts associated with recreational use within the Hells Canyon Complex. IPC will, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, use the information obtained to develop a plan to protect, mitigate and enhance recreational resources associated with the Hells Canyon Complex which takes into consideration current and potential recreational use conflicts.

Abstract

Increasing use at many recreation sites in the Hells Canyon Complex may be resulting in congestion and crowding which threaten to impact the quality of the visitor experience. Recreation

planners have worked to develop and implement frameworks that address changing recreationists' wants and needs. Study objectives are to investigate limiting factors for increasing recreational use in the Hells Canyon Complex and identify targets for long-term management options.

IPC has documented opinions of reservoir-related recreational users within the Hells Canyon Complex since 1994. The information to be collected during this study will provide increased knowledge of recreational users' opinions as they relate to current and potential recreational use conflicts associated with reservoir use within the Hells Canyon Complex. IPC anticipates using a combination of sampling methodologies to obtain information from current, on-site recreational users and potential, off-site recreational users.

The only portion of the HCNRA which has been included in the 1994 to 1996 IPC survey area has been the visitor's center and boat ramp below Hells Canyon Dam. The USFS has use and opinion survey data from 1989 and 1992 studies of recreational users of the HCNRA and has developed management strategies which limit use in some areas during certain times of the year. IPC will coordinate studies within the HCNRA with the USFS and, if necessary to meet relicensing requirements, augment information already being collected by USFS personnel within the HCNRA.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir to the northern end of the HCNRA includes approximately 168 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. Increasing use at many recreation sites in the Hells Canyon

Complex may be resulting in congestion and crowding which threaten to impact the quality of the visitor experience. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

Recreation planners across the country have worked to develop and implement frameworks that address changing recreationists' wants and needs [e.g., Limits of Acceptable Change (LAC), Visitor Impact Management (VIM), Visitor Experience and Resource Protection (VERP), Carrying Capacity Assessment Process (CCAP), Quality Upgrading and Learning (QUAL) (Lime *et al.* 1995)]. These planning frameworks in general attempt to identify acceptable or tolerable limits of change to the natural and sociological environment. Established limits combined with a surveying effort designed to monitor recreation trends can be an effective management tool.

The USFS implemented an LAC process in 1990-1991 to be used as a decision-making tool in managing the Snake River within the HCNRA. The LAC plan considered the following:

1) launching and use of private and commercial floatcraft, powered boats and personal watercraft, aircraft use;
2) party size, length of stay, campsite reservations and use;
3) backpacking, horsepacking;
4) grazing; and
5) monitoring efforts.

The goal of the LAC process was to develop recommendations for the river recreation management plan.

IPC has collected opinion data from recreational users since 1994 on the three reservoirs of the Hells Canyon Complex. These studies indicated a need to examine such issues as sanitation, facility development, river access, resource degradation and crowding associated with recreational use at the Hells Canyon Complex.

Methods

Study design and survey methodologies to be employed will be developed by and in cooperation with IPC and appropriate agencies and entities and, if necessary, an independent consultant. Therefore, specifics on sampling design and methodologies are yet to be determined. IPC will coordinate studies within the HCNRA with the USFS and, if necessary to meet relicensing requirements, augment information already being collected by USFS personnel within the HCNRA.

IPC anticipates using a combination of sampling methodologies to obtain information from current, on-site recreational users and potential, off-site recreational users. Sampling strategies will be tailored to fit the characteristics of the target group.

Timetable

Data collection is expected to begin in conjunction with the opinion study in 1998 and continue through 2000. Reporting is anticipated to be finalized in 2001.

Cooperation

IPC will implement the study of current and potential physical and social conflicts with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, a private consultant.

Statement of Capabilities

IPC will conduct off-site sampling using telephone and/or mail surveys. This study may be developed and conducted with the assistance of a private consultant. Data will be automated and analyzed using an IBM-compatible PC and appropriate software. A GIS will be used to map recreation use.

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS mapping.

8.6.5.
Title: A Description of the Impacts of Reservoir Water Level Fluctuations Within the Hells Canyon Complex on Navigation, Recreational Opportunities, Amount of Recreational Use and Quality of Recreational Experience

Issues

R11. User expectations and desires relating to access.

R17. Providing access during changing reservoir levels.

R22. User expectations and desires relating to facilities.

R23. “Improved” facilities versus dispersed sites.

R24. Boat mooring facilities.

R26. Commercial recreation service providers (i.e. concessionaires).

R32. Scope of study area.

R34. Recommendations to other managing entities.

P1A. Water level fluctuations and impacts on fish, insects, crayfish and recreation (floating).

Witnessed stranded crayfish and rampant fluctuation during fish flush).

P13A. Manage rivers and reservoirs to mimic a natural hydrograph

- Minimize reservoir water fluctuations.

- Provide flows for salmon.

P13A. Predictable annual hydrograph to fish, wildlife and recreation in river and reservoirs.

P10T. Reservoir levels too low, Brownlee in particular.

P2R. Hazards to jet boats from low flows.

P5R. Reduced recreational opportunities due to river fluctuations affecting camp access.

P6R. Concern about recreational flows below Hells Canyon Dam. Will this be addressed (Flow fluctuations over 24 hours in particular)?

P9R. Boat ramps at all major access points remain usable, therefore allowing for maximum recreation use.

P15R. Keep the reservoir levels up.

P19R. Facilities near Richland aren't available because of drawdowns. Hurts the economy.

P21R. Large fluctuations of reservoir effects ability of getting into Brownlee - - when it's low, can't get in from the Oregon side.

P9R. Boat ramps at all major access points remain usable, therefore allowing for maximum recreation use.

P24R. Impacts of reservoir fluctuations on boating and local economies.

P25R. Reservoir level extreme drawdowns on Brownlee making it next to impossible to launch boats at flow levels.

P28R. Effect of fluctuating water levels (especially access to boat ramps) on guides (on reservoirs) and other small businesses.

P29R. Lack of water in Brownlee Reservoir.

P34R. Positive notification to downstream users (outfitters and private property owners) of expected flow operations and changes. Keep doing it!

P35R. Unsafe below 7,000 cfs.

P36R. Ramp problems for boaters because of daily fluctuation volumes.

P39R. Impacts of flow changes (daily) on recreation.

P41R. Impacts of flow fluctuations on recreational boating including safety, camping and fishing.

P44R. Flow regulation to mimic natural flows.

P5E. Spread “flush” flows through all dams.

Problem Statement

Project operations (reservoir water levels) impact recreation use in the Hells Canyon Complex and adjacent areas.

Desired Future Resource Goals

The goal of this study is to obtain information about the impacts of reservoir water level fluctuations within the Hells Canyon Complex on navigation, recreational opportunities, amount of recreational use and quality of recreational experience. This information will be used by IPC, in cooperation with managing agencies and concerned entities, to evaluate the impacts of both operations-induced reservoir water level fluctuations and those fluctuations caused by orders/requests from federal agencies. This evaluation will allow the development of mitigation, enhancement and protection measures which balance the sometimes conflicting needs associated with hydroelectric facilities.

Abstract

Information regarding the effects of reservoir water level fluctuations in the Hells Canyon Complex on recreational opportunities, amount of recreational use and quality of recreational experience is undocumented. The goal of this study is to obtain information about the impacts of reservoir water level fluctuations within the Hells Canyon Complex on navigation, recreational opportunities, amount of recreational use and quality of recreational experience. This will be accomplished by

analyzing recreational use trends obtained from the overall recreational use studies during periods of reservoir water level fluctuation, evaluation of recreational conditions at differing water levels and the solicitation of opinions and information from recreational users. This evaluation will allow the development of mitigation, enhancement and protection measures which balance the sometimes conflicting needs associated with hydroelectric facilities.

Introduction

As the result of requests from the NMFS and other agencies involved in salmon recovery efforts, annual water fluctuations in Brownlee Reservoir have occurred during peak recreational times more frequently than in any of the prior 30+ years of operation. IPC is also required to draw down Brownlee Reservoir for flood control purposes. The data proposed to be collected during this study will increase knowledge about the numbers and types of recreationists who are impacted by reservoir water level fluctuations and their concerns/comments about those impacts. Management of lands for public use often requires that tradeoffs be made between marketed commodities, such as hydroelectric power and non-marketed commodities, such as recreation. In this case, an additional factor may be salmon recovery efforts. The baseline information obtained in this study will facilitate an objective, decision-making process for potential protection, mitigation, and enhancement measures. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the dams within the Hells Canyon Complex.

State of Knowledge

Information on recreational impacts of reservoir water level fluctuations in the Hells Canyon Complex is incomplete. IPC recreational use studies and surveys, which have been conducted from 1994 through 1996, are ongoing in parts of the Hells Canyon Complex. User numbers, location, activities and some attitudinal information have been collected during this period. This information, along with any additional information provided by concerned entities, will be used as the baseline from which to design and implement this study.

Methods

Study design and survey methodology will be developed by IPC recreation staff in cooperation with the Recreation and Aesthetic Resources Work Group, appropriate agencies, and if necessary, a private consultant. Study design and information collected will be closely correlated with the economic impact, access and general recreational use studies which will be conducted during the same time period.

Timetable

Data collection will be coordinated with the timetable assigned to the other related studies.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years experience in planning and implementing fisheries and recreational use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years experience in planning and implementing recreational use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS analyses due in 2001.

8.6.6.
Title: A Description of the Impacts of Project-Induced River Water Level Fluctuations Within the HCNRA on Navigation, Recreational Opportunities, Amount of Recreational Use and Quality of Recreational Experience.

Issues

R11. User expectations and desires relating to access.

R17. Providing access during changing reservoir levels.

R20. Depletion of beaches below Hells Canyon dam.

R22. User expectations and desires relating to facilities.

R23. "Improved" facilities versus dispersed sites.

R24. Boat mooring facilities.

R26. Commercial recreation service providers (i.e. concessionaires).

R33. Use of instream flow data.

R32. Scope of study area.

R34. Recommendations to other managing entities.

P1A. Water level fluctuations and impacts on fish, insects, crayfish and recreation (floating).

Witnessed stranded crayfish and rampant fluctuation during fish flush.

P13A. Manage rivers and reservoirs to mimic a natural hydrograph

- Minimize reservoir water fluctuations.

- Provide flows for salmon.

P13A. Predictable annual hydrograph to fish, wildlife and recreation in river and reservoirs.

P10T. Reservoir levels too low, Brownlee in particular.

P2R. Hazards to jet boats from low flows.

P5R. Reduced recreational opportunities due to river fluctuations effecting camp access.

P6R. Concern about recreational flows below Hells Canyon Dam. Will this be addressed (Flow fluctuations over 24 hours in particular)?

P9R. Boat ramps at all major access points remain usable, therefore allowing for maximum recreation use.

P15R. Keep the reservoir levels up.

P19R. Facilities near Richland aren't available because of drawdowns. Hurts the economy.

P21R. Large fluctuations of reservoir effects ability of getting into Brownlee - - when it's low, can't get in from the Oregon side.

P9R. Boat ramps at all major access points remain usable, therefore allowing for maximum recreation use.

P24R. Impacts of reservoir fluctuations on boating and local economies.

P25R. Reservoir level extreme drawdowns on Brownlee making it next to impossible to launch boats at flow levels.

P28R. Effect of fluctuating water levels (especially access to boat ramps) on guides (on reservoirs) and other small businesses.

P29R. Lack of water in Brownlee Reservoir.

P34R. Positive notification to downstream users (outfitters and private property owners) of expected flow operations and changes. Keep doing it!

P35R. Unsafe below 7,000 cfs.

P36R. Ramp problems for boaters because of daily fluctuation volumes.

P39R. Impacts of flow changes (daily) on recreation.

P41R. Impacts of flow fluctuations on recreational boating including safety, camping and fishing.

P44R. Flow regulation to mimic natural flows.

P5E. Spread "flush" flows through all dams.

Problem Statement

Project operations (river flow fluctuations) impact recreation use in the Hells Canyon Complex and adjacent areas.

Desired Future Resource Goals

The goal of this study is to obtain information about the impacts of project-induced river water level fluctuations within the HCNRA on navigation, recreational opportunities, amount of recreational use and quality of recreational experience. This information will be used by IPC, in cooperation with managing agencies and concerned entities, to evaluate the impacts of both operations-induced river water level fluctuations and those fluctuations caused by orders/requests from federal agencies. This evaluation will allow the development of mitigation, enhancement and protection measures which balance the sometimes conflicting needs associated with hydroelectric facilities.

Abstract

Data regarding the effects of river flow fluctuations in the HCNRA on recreational opportunities, amount of recreational use, and quality of recreational experience is limited. IPC will analyze recreational use trends obtained from the overall recreational use studies during periods of river water level fluctuation, evaluate recreational conditions at differing water levels, and solicit

opinions and information from recreational users and managing agencies and entities. This information will be used by IPC, in cooperation with managing agencies and concerned entities, to evaluate the impacts of both operations-induced river water level fluctuations and those fluctuations caused by orders/requests from federal agencies.

Introduction

During portions of the year and dependent upon inflows, flow levels below Hells Canyon Dam vary on a daily basis to support production of power, flood control and salmon recovery efforts. Thus, fluctuation of flows in the Snake River below Hells Canyon Dam sometimes occurs during peak recreational times. Management of lands for public use often requires that tradeoffs be made between marketed commodities, such as hydroelectric power and non-marketed commodities, such as recreation (Rosenthal *et al.* 1984). The data collected during this study will increase knowledge about the numbers and types of recreationists who are impacted by river flow fluctuations and their concerns/comments about those impacts. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

Information about recreational impacts of river flow fluctuations in the HCNRA is incomplete. IPC recreational use studies and surveys, which have been conducted during 1994-1996, are ongoing in parts of the Hells Canyon Complex. Although user numbers, location, activities and some attitudinal information have been collected during this period, this information was only collected at one site of concern to this study. Use data and some attitudinal information has been collected at the boat ramp and associated areas immediately below Hells Canyon Dam. The USFS has collected recreational use information within the HCNRA since 1988 and has some information concerning the impacts of river flow fluctuations. This information, along with any additional information provided by concerned entities, will be used as the baseline from which to design and implement this study.

Methods

Study design and survey methodology will be developed by IPC recreation staff in cooperation with the Recreation and Aesthetic Resources Work Group, the USFS, appropriate agencies and entities and if necessary, a private consultant. Study design will concentrate on augmenting information already being collected by the USFS. Information collected will be closely correlated with the economic impact, access, and general recreational use studies which will be conducted during the same time period.

Timetable

Data collection will be coordinated with the timetable assigned to the other related studies.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years experience in planning and implementing fisheries and recreational use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years experience in planning and implementing recreational use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

Deliverables

A technical report will be due in 2001.

8.6.7.
Title: An Inventory of Existing Dispersed Recreational Access Sites Associated with the Reservoirs within the Hells Canyon Complex, Recreational Use at those Sites, and Attitudes about Dispersed Access

Issues

R1. Identification of current and potential users.

R2. Monitoring of use trends.

R4. Management of increasing use.

R10. Identification of existing and potential access sites.

R11. User expectations and desires relating to access.

R12. Fishing turnouts for bank angling.

R13. Upland access for hunting and other uses.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R18. Improved property ownership identification.

R19. Impacts of recreation use on adjacent lands.

R23. “Improved” facilities versus dispersed sites.

R24. Boat mooring facilities.

R25. Sanitation.

R27. Historic interpretation.

R29. Displacement of users due to changing fee structures.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Conflicts exist involving the amount and type of recreational use and private versus public access at dispersed water and land-based accesses.

Desired Future Resource Goal

The goal of this study is to compile an inventory of existing, dispersed recreational sites associated with reservoirs within the Hells Canyon Complex and the recreational use at these sites and attitudes about dispersed access. This information, when combined with information from concurrent studies about physical conflicts associated with recreational use, will enable IPC, in cooperation with managing agencies and concerned entities, to develop protection, mitigation and enhancement measures which takes into consideration current and potential recreational use associated with dispersed recreation sites.

Abstract

Recreational use at reservoirs within the Hells Canyon Complex appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. IPC will compile an inventory of existing dispersed recreational sites associated with reservoirs within the Hells Canyon Complex and recreational use and users' attitudes about those sites. The information collected during this study will provide managers with a comprehensive view of access associated with the reservoirs within the Hells Canyon Complex.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir to Hells Canyon Dam includes approximately 97 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. Increasing use at many recreation sites in the Hells Canyon Complex may be resulting in congestion and crowding which threaten to impact the quality of the visitor experience. The managing entities of access sites associated with the reservoirs within the Hells Canyon Complex have some data related to recreation access in their lands of responsibility. The information collected during this study will provide managers with a comprehensive view of access associated with the reservoirs. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

Comprehensive information concerning present and potential access facilities, conditions and rights-of-way is not available at this time. Although each individual managing agency/entity has some information, no attempt has been made to combine this information into a comprehensive package which includes land ownership, managing agency/entity, amount and type of recreational activity associated with the access and attitudinal information obtained from recreationists. This study will combine information from several sources to provide a comprehensive view of recreational access associated with reservoirs within the Hells Canyon Complex.

IPC has collected recreational use information on reservoirs associated with the Hells Canyon Complex since 1994. This will provide annual estimates of both amount and types of recreational activity by location.

Methods

IPC, in cooperation with the Recreation and Aesthetic Resources Work Group, other concerned entities and managing entities, will develop a plan to collect information (location, facilities, etc.) on access sites associated with reservoirs within the Hells Canyon Complex. This information will be joined with land ownership maps currently being developed by the IPC Real Property Management Department to provide a convenient, comprehensive way to display the results.

Dispersed water and land-based accesses will be recorded using a GPS and mapped using GIS software. Data concerning amount and type of dispersed recreational use at individual access sites associated with reservoirs within the Hells Canyon Complex will be gathered using on-site collection methods and converted into formats which can be analyzed with GIS software. Recreationists' attitudinal information will be gathered in conjunction with other opinion-based studies.

In addition, a comprehensive, relational database will be developed to provide itemized geographical and management-related information for dispersed access sites.

Timetable

GPS surveys and facilities evaluation of access sites/areas associated with reservoirs within the Hells Canyon Complex will be completed during 1998. Preliminary access and land ownership maps and relational data base will be available in 1998. Recreational use information will be collected as reported within the individual study plans.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group and concerned entities.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

Relational data base of collected access information. GIS analyses of pertinent data.

8.6.8.
An Inventory of Existing, River-Related Dispersed Recreational Access Sites Within the HCNRA, Recreational Use at those Sites, and Attitudes about Dispersed Access

Issues

R1. Identification of current and potential users.

R2. Monitoring of use trends.

R4. Management of increasing use.

R10. Identification of existing and potential access sites.

R11. User expectations and desires relating to access.

R12. Fishing turnouts for bank angling.

R13. Upland access for hunting and other uses.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R18. Improved property ownership identification.

R19. Impacts of recreation use on adjacent lands.

R23. “Improved” facilities versus dispersed sites.

R24. Boat mooring facilities.

R25. Sanitation.

R27. Historic interpretation.

R29. Displacement of users due to changing fee structures.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

Conflicts exist involving the amount and type of recreational use and private versus public access at dispersed water and land based accesses.

Desired Future Resource Goal

The goal of this study is to compile an inventory of existing dispersed recreational sites associated with the Snake River within the HCNRA and the recreational use at these sites and attitudes about dispersed access. This information, when combined with information from concurrent studies about physical conflicts associated with recreational use, will enable IPC, in cooperation with managing agencies and concerned entities, to develop protection, mitigation and enhancement measures which takes into consideration current and potential recreational use associated with dispersed recreation sites.

Abstract

This study will combine information from several sources to provide a comprehensive view of access associated with recreational river use in the HCNRA. IPC will, if necessary, cooperate with the USFS to augment the information already being collected by that agency.

Introduction

Information concerning present and potential access facilities, conditions, needs and rights-of-way has been collected by the USFS. IPC will, if necessary, cooperate with the USFS to augment this information. This study will combine information from several sources to provide a comprehensive view of access associated with recreational river use in the HCNRA. Management of lands for public recreation use often requires that tradeoffs be made among managing entities to maintain or improve recreation opportunities and activities and to resolve recreation-related conflicts. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the dams within the Hells Canyon Complex.

State of Knowledge

Information concerning present and potential access facilities, conditions, needs, and right-of-way has been collected by the USFS. Additionally, the USFS has collected recreational use and attitudinal information within the HCNRA since 1988.

Methods

Information concerning amount and type of recreational use and recreationists' attitudes at individual access sites associated with recreational river use within the HCNRA is presently being collected by the USFS. IPC will review USFS data and, in cooperation with the Recreation and Aesthetic Resources Work Group and managing entities, will develop a plan to augment (if necessary) the collection of information (location, facilities, etc.) on access sites/areas associated with recreational river use within the HCNRA.

Timetable

Commencing in 1997.

Cooperation

IPC will implement this study with the assistance of the USFS, Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

Deliverables

Determined by results of study and need for augmentation of USFS information.

8.6.9.
Title: An Evaluation of Current (1997-2000) and Potential Recreational Use at Major Developed Sites on Reservoirs within the Hells Canyon Complex

Issues

R1. Identification of current and potential users.

R2. Monitoring of use trends.

R4. Management of increasing use.

R10. Identification of existing and potential access sites.

R11. User expectations and desires relating to access.

R15. Seasonal closures of access areas.

R21. Identification of existing and potential facilities.

R22. User expectations and desires relating to facilities.

R23. "Improved" facilities versus dispersed sites.

R24. Boat mooring facilities.

R25. Sanitation.

R26. Commercial recreation service providers (i.e. concessionaires).

R30. Cooperative opportunities among concerned entities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

P10R. Hotel needs to be built at Brownlee Reservoir for bass tournaments.

P12R. IPC camping rates are way too high for retired people.

P16R. Camping fees keep going up. Prices are higher than anyone else ($300/mo. if you could stay a full month).

P17R. Need more primitive campgrounds - - not fond of camping on asphalt. Don't like having the water shut off in camp grounds on 10/15. Feel parks are too manicured, concrete curbs, dead spots, difficult to park the big rigs because of design of camp grounds.

P18R. Primitive camp grounds should be developed/provided. Cost should be free, based on the promises IPC made when the dam was built. Free sewer, power, water, etc.

P22R. Increasing recreational use fees (IPC parks).

Problem Statement

The present major developed recreation sites and facilities (land and water) may need expansion or enhancement in the future at the Hells Canyon Complex.

Desired Future Resource Goal

The goal of this study is to obtain information about current and potential (1997 through 2000) recreational use and users at major developed sites associated with reservoirs within the Hells Canyon Complex. This information, when combined with the results of a review of obtainable past information about recreational use at major developed sites associated with reservoirs within the Hells Canyon Complex, will provide for the identification of important recreational use issues and trends in both location and activity-specific use levels. This information will enable IPC, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, to develop a plan to protect, mitigate and enhance recreational resources at major developed sites associated with reservoirs within the Hells Canyon Complex.

Abstract

IPC has conducted recreational use studies on reservoirs within the Hells Canyon Recreation Complex since 1994. This has included the collection of some data at major developed sites. The data proposed to be gathered will, when combined with the data gathered since 1994, provide a basis for determining use trends and future needs. IPC anticipates continuing to conduct on-site surveys, combined with some use of mail and/or telephone surveys.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir through the HCNRA includes approximately 168 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. The major developed sites within this corridor are owned/managed by numerous private and governmental entities. While IPC and other managing entities have had reason to collect some information concerning specific portions of the Hells Canyon Complex, no comprehensive recreational use or impact data has been collected. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

IPC has data available from both recreational use surveys and fee envelopes from its four major campground/day-use parks. Reliable data from fee envelopes is limited to the 1995 and 1996 seasons. The information required from campers prior to 1995 was not adequate to ascertain overall use. This information will be examined to determine any changes or additions needed to IPC's present recreational use survey.

Data from Baker County, BLM, the Oregon Department of Parks and Recreation (ODPR), and private facilities will also be obtained during IPC studies.

Methods

A recreational use study will be designed by IPC in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities. This study will be conducted at major developed sites on reservoirs within the Hells Canyon Complex. The methodology and intensity of effort at each site will depend upon the needs identified by the ongoing consultation process, the availability of information from other sources and cost. The study area will include the following facilities:

IPC:

- Hells Canyon Park
- Carter's Landing
- Copperfield Park
- McCormick Park
- Woodhead Park

BLM:

- Steck Park
- Spring Recreation Area

ODPR:

Farewell Bend State Recreation Area

Baker County, Oregon:

Hewitt Park
Holcomb Park

Private Facilities:

Oasis Campground
Snake River RV Park
Mountain Man Resort and Marina

Timetable

The studies are expected to begin in early 1997 and continue through 2000.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreational use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State university and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS analyses will be due in 2001.

8.6.10.
Title: An Evaluation of Users' Attitudes about and Expectations of Major Developed Sites and Facilities Associated with Reservoirs within the Hells Canyon Complex

Issues

R4. Management of increasing use.

R10. Identification of existing and potential access sites.

R11. User expectations and desires relating to access.

R12. Fishing turnouts for bank angling.

R14. Wildlife viewing sites.

R15. Seasonal closures of access areas.

R21. Identification of existing and potential facilities.

R22. User expectations and desires relating to facilities.

R23. "Improved" facilities versus dispersed sites.

R24. Boat mooring facilities.

R25. Sanitation.

R26. Commercial recreation service providers (i.e. concessionaires).

R27. Historic interpretation.

R29. Displacement of users due to changing fee structures.

R30. Cooperative opportunities among concerned entities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

P10R. Hotel needs to be built at Brownlee Reservoir for bass tournaments.

P12R. IPC camping rates are way too high for retired people.

P16R. Camping fees keep going up. Prices are higher than anyone else ($300/mo. if you could stay a full month).

P17R. Need more primitive campgrounds - - not fond of camping on asphalt. Don't like having the water shut off in Cg's on 10/15. Feel parks are too manicured, concrete curbs, dead spots, difficult to park the big rigs because of design of camp grounds.

P18R. Primitive camp grounds should be developed/provided. Cost should be free, based on the promises IPC made when the dam was built. Free sewer, power, water, etc.

P22R. Increasing recreational use fees (IPC parks).

Problem Statement

The present major developed recreation sites and facilities (land and water) may need expansion or enhancement in the future at the Hells Canyon Complex.

Desired Future Resource Goal

The goal of this study is to gather information concerning users' attitudes about and expectations of major developed sites and facilities associated with reservoirs within the Hells Canyon Complex. This information, when combined with the information collected in concurrent studies concerning past, current, and potential recreational use at major developed sites associated with reservoirs within the Hells Canyon Complex will enable IPC, in cooperation with the Recreation and Aesthetic Resources Work Group and other concerned entities, to develop a plan to protect, mitigate and enhance recreational resources at major developed sites associated with reservoirs within the Hells Canyon Complex.

Abstract

IPC has conducted recreational use studies on reservoirs within the Hells Canyon Complex since 1994. During the course of these studies, IPC has solicited comments from recreationists who were interviewed. The data proposed to be gathered will, when combined with the data gathered since 1994, provide a basis for determining trends in user attitudes and expectations and future needs. IPC anticipates continuing to conduct on-site interviews, combined with some use of mail and/or telephone surveys.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir through the HCNRA includes approximately 168 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. Additionally, patterns of access and recreational use appear to be changing. The major developed sites within this corridor are owned/managed by numerous private and governmental entities. While IPC and other managing entities have had reason to collect some information concerning specific portions of the Hells Canyon Complex, no comprehensive recreational use, impact, or recreationists' opinion data has been collected. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

IPC has obtained recreationists' comments during recreational use surveys (1994 through 1996) conducted from Hells Canyon Dam upstream within the Hells Canyon Complex. It is unknown at this time what information may be available from other managing entities.

Methods

IPC will obtain other information concerning users' attitudes, expectations and potential responses to fee structure changes from other managing entities. A study will be conducted to determine users' attitudes about and expectations of major developed sites and facilities, as well as how use patterns may be affected by changes in fee structures. This study will employ on-site and, potentially, mail or telephone methodologies. The study area will include the following facilities:

IPC:

Hells Canyon Park
Carter's Landing
Copperfield Park
McCormick Park
Woodhead Park

BLM:

Steck Park
Spring Recreation Area

ODPR:

Farewell Bend State Recreation Area

Baker County, Oregon:

Hewitt Park

Holcomb Park

Private Facilities:

Oasis Campground

Snake River RV Park

Mountain Man Resort and Marina

Timetable

The studies are expected to begin in 1997 and continue through 2000.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreational use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State university and five years of experience in planning

and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS analyses will be due in 2001.

8.6.11.
Title: Description of Current Angling Use, Users and Angling Results at Reservoirs within the Hells Canyon Complex

Issues

R1. Identification of current and potential users.

R12. Fishing turnouts for bank angling.

R32. Scope of study area.

R34. Recommendations to other managing entities.

P27R. Fisheries below Hells Canyon Complex - Survey outfitters/users at Pittsburgh landing.

P21A. Warm water fishery is almost gone. Bass die-off from lowering reservoir when fish are on beds.

P45R. Catch rate affected by flow fluctuations.

P31R. Flow levels on river below Hells Canyon adversely affecting fishing.

P47R. Recorded flow information inaccurate or not timely.

Problem Statement

There is concern that current operations may be having a negative effect upon the recreational fishing opportunities. Therefore, data pertaining to angler effort, catch-rates, and harvest associated with the Hells Canyon Complex are needed to evaluate the situation.

Desired Future Resource Goals

The goals of this study are to identify amount, type, and distribution of current angling use and results associated with reservoirs within the Hells Canyon Complex and forecast trends of future use. This information, when combined with the fish inventories being collected by the Aquatics Section at IPC, will lead to a more comprehensive understanding by IPC fisheries biologists and other concerned entities of the fisheries associated with the reservoirs in the Hells Canyon Complex. This information will be used by IPC, in cooperation with the Aquatic Resources Work Group and other concerned entities, to develop comprehensive plans to protect, mitigate and enhance the fisheries resources associated with the reservoirs within the Hells Canyon Complex.

Abstract

IPC has documented angling use and results, demographics and opinions of anglers at reservoirs within the Hells Canyon Complex since 1994. The data proposed to be collected will provide increased knowledge of angling use trends and angling results for these areas. Study objectives are to identify numbers, types and distribution of current reservoir-related angling use and results within the Hells Canyon Complex. IPC anticipates using a combination of sampling methodologies to obtain information from current on-site anglers and potential off-site recreational users.

Introduction

The Snake River corridor from the upper end of Brownlee Reservoir through Hells Canyon Dam includes approximately 97 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. The majority of this recreational use in this area is associated with angling. Additionally, patterns of access and recreational use appear to be changing. Angling within this area is generally managed cooperatively by the States of Idaho and Oregon. Since 1994, IPC has consistently documented numbers, types and distribution of anglers as well as demographics and opinions of anglers within the Hells Canyon Complex from the headwaters of Brownlee Reservoir to the visitor center below Hells Canyon Dam. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

ODFW and the IDFG have collected some angling use and result data from creel and hunting surveys. IPC has been involved in quantifiable recreation studies since 1994 on the three reservoirs within the Hells Canyon Complex. Comprehensive creel data, including number and type of anglers and catch and harvest information, has been collected concurrent with these studies.

Methods

Study design and survey methodologies to be employed will be developed by IPC in cooperation with the Recreation and Aesthetic Resources Work Group and the Aquatic Resources Work Group, as well as other concerned entities. If necessary, an independent consultant will be included in the process. Therefore, specifics on sampling design and methodologies are yet to be determined.

IPC anticipates using on-site angler counts and interviews within the framework of a statistically sound, comprehensive sampling design to obtain angling use and results information.

Timetable

Data collection is expected to begin during 1997 and continue through 2000. Reporting is anticipated to be finalized in 2001.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group and concerned entities.

Statement of Capabilities

IPC will conduct on-site sampling via boat, vehicle or foot, depending on the terrain and weather. Off-site sampling when used, may involve telephone and/or mail surveys and may be developed and conducted with the assistance of a private consultant. Data will be automated and analyzed using an IBM-compatible PC and appropriate software. A GIS will be used for mapping reservoir-related angling use and results within the Hells Canyon Complex.

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning

and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS maps.

8.6.12.
Title: A Description of Angling Use Associated with the Snake River within the HCNRA

Issues

R1. Identification of current and potential users.

R32. Scope of study area.

R34. Recommendations to other managing entities.

P27R. Fisheries below Hells Canyon Complex - Survey outfitters/users at Pittsburgh landing.

P21A. Warm water fishery is almost gone. Bass die-off from lowering reservoir when fish are on beds.

P45R. Catch rate affected by flow fluctuations.

P31R. Flow levels on river below Hells Canyon adversely affecting fishing.

P47R. Recorded flow information inaccurate or not timely.

Problem Statement

There is concern that current operations may be having a negative effect upon the recreational fishing opportunities. Therefore, data pertaining to angler effort, catch-rates and harvest associated with the Hells Canyon Complex are needed to evaluate the situation.

Desired Future Resource Goals

The goal of this study is describe angling use associated with the Snake River within the HCNRA and forecast trends of future use. This information, when combined with the fish inventories being collected by the Aquatics Section at IPC, will lead to a more comprehensive understanding by IPC fisheries biologists and other concerned entities of the fisheries associated with the Snake River within the HCNRA. This information will be used by IPC, in cooperation with the Aquatic Resources Work Group and other concerned entities, to develop comprehensive plans to protect, mitigate and enhance the fisheries resources associated with the Snake River within the HCNRA.

Abstract

IPC has collected information about angling use within the Snake River immediately below Hells Canyon Dam since 1994. IPC will gather information concerning angling pressure within the remainder of the HCNRA from managing agencies and, if necessary, augment that information with information obtained from creel diaries, telephone surveys and/or mail surveys.

Introduction

The Snake River corridor through the HCNRA includes approximately 71 miles of river. Recreational use within the corridor appears to have increased dramatically during the last two decades. A large proportion of this recreational use in this area is associated with angling. Additionally, patterns of access and recreational use appear to be changing. Angling within this area is generally managed cooperatively by the States of Idaho and Oregon. This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the dams within the Hells Canyon Complex.

State of Knowledge

ODFW, IDFG, and USFS each gather some information concerning angling use within the HCNRA. IPC has collected information from anglers within a limited area within the HCNRA during 1994, 1995, and 1996.

Methods

IPC will, during 1997, conduct a comprehensive review of past information available, as well as any information presently being collected, concerning angling pressure within the HCNRA. The information gathered will be evaluated to determine if it is adequate for the purposes put forth in this proposal. If necessary, IPC will, in cooperation with the managing agencies, take steps to augment the available information through the use of creel diaries, telephone surveys and/or mail surveys.

Timetable

Literature review and subsequent report conducted during 1997. Timing of additional efforts will be determined by the results of the literature review.

Cooperation

IPC will implement this study with the assistance of the USFS, Recreation and Aesthetic Resources Work Group, and concerned entities.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

If necessary, any GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A literature review and, potentially, a technical report and GIS maps.

8.6.13.
Title: A Description of Hunting Pressure within the Hells Canyon Complex

Issues

R1. Identification of current and potential users.

R4. Management of increasing use.

R13. Upland access for hunting and other uses.

R22. User expectations and desires relating to facilities.

R32. Scope of study area.

R34. Recommendations to other managing entities.

Problem Statement

There is concern that current operations may be affecting hunting opportunities in the Hells Canyon Complex. Also, past and current management practices (including access opportunities) may be affecting hunting opportunities and harvest rates within the Hells Canyon Complex. Current information concerning hunting use within the Hells Canyon Complex is undocumented and incomplete.

Desired Future Resource Goals

Study goals are to identify the amount, type and distribution of upland game bird, waterfowl and big game hunting throughout the Hells Canyon Complex. Hunter's harvests will also be identified. This information, when combined with the wildlife surveys being conducted by the Terrestrial Section at IPC, will lead to a more comprehensive understanding by IPC biologists and other concerned entities of hunting associated with the Hells Canyon Complex. This information will be used by IPC, in cooperation with the Terrestrial Resources Work Group and other concerned entities, to develop comprehensive plans to protect, mitigate and enhance the wildlife resources associated with the Hells Canyon Complex.

Abstract

IPC has documented recreational use within the Hells Canyon Complex since 1994, but has gathered limited data relating to hunting. This study will identify numbers, types, harvests and distribution relating to current upland game bird, waterfowl and big game hunting in the Hells Canyon Complex. IPC anticipates using a two-step approach involving a literature review and, potentially, telephone or mail surveys of licensed hunters to obtain information.

Introduction

Since 1994, IPC has consistently documented numbers, types and distribution of recreational use as well as demographics and opinions of users for the Hells Canyon Complex from the headwaters of Brownlee Reservoir to the visitor center below Hells Canyon Dam. However, because of the limited accessibility of hunters while they are engaged in hunting activities on site, the data collected related to hunting has been limited. This study will provide additional, more comprehensive information on hunting use in the Hells Canyon Complex.

Currently, ODFW and IDFG collect harvest data from hunters each year at the end of a hunting season. If more detailed data is needed beyond the scope of that now collected by IPC and the managing agencies, IPC will consult with the Recreation and Aesthetic Resources Work Group and the managing agencies about developing a survey which will target licensed hunters who utilize the hunt zones within the Hells Canyon Complex.

This study is being proposed in response to direct requests from concerned entities and concerns expressed by attendees at a series of public meetings to discuss the relicensing of the Hells Canyon Project.

State of Knowledge

ODFW and the IDFG have general hunting data from annual harvest surveys.

Methods

A two-step process will be employed for this study. During step one, IPC will conduct a literature review of available agency hunting data. After reviewing available data, IPC will meet with Recreation and Aesthetic Resources Work Group members and concerned entities to discuss any additional data needs.

If necessary, step two will involve the design and implementation of a survey to obtain the desired data. The survey will be either in concert with the agencies' ongoing studies or as a separate study by the agencies or an independent consultant. Survey methodologies to be employed will be developed by IPC in cooperation with the Recreation and Aesthetic Resources Work Group and appropriate agencies. Potential methods include telephone and mail surveys of licensed hunters from Idaho and Oregon. Data will be presented in a GIS format.

Timetable

The literature review of available agency hunting data will be conducted in 1997 followed by the meeting with Recreation and Aesthetic Resources Work Group members and other agency personnel. If additional data is deemed necessary, IPC will expect to time survey execution to correspond with the respective hunting seasons. A target for study duration will be 1998 through 2000 with the possibility of two or fewer years of actual data collection as determined by the Recreation and Aesthetic Resources Work Group. Reporting is expected to be finalized in 2001.

Cooperation

IPC will implement this study with the assistance of the Recreation and Aesthetic Resources Work Group, concerned entities, and if necessary, an independent consultant.

Statement of Capabilities

Studies will be conducted under the supervision of Dwayne L. Wood. The principal investigators will be Marshall Brown and Lisa Grise. Mr. Brown has an M.Sc. in Warm Water Fisheries Management from Auburn University and nine years of experience in planning and implementing fisheries and recreation use surveys. Ms. Grise has an M.Sc. in Human Dimensions of Fisheries and Wildlife Management from Michigan State University and five years of experience in planning

and implementing recreation use surveys. The principal investigators will be assisted by a team of IPC recreation technicians and assistants.

GIS analyses will be conducted under the supervision of Frank Mynar. The principal analysts will be Chris Huck and Mike Butler. Mr. Huck has a B. S. in Geology from the University of Idaho and ten years of experience working with GIS. Mr. Butler has a B. S. in Geology from Boise State University and seven years of experience working with GIS.

Deliverables

A technical report and GIS maps.

8.6.14. Literature Cited

None.

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8.7.
Land Management

8.7.1.
Title: Land Management Plan

Issues

A6. Effects of IPC land management practices on aquatic resources.

A26. Effects on aquatic resources due to operation and maintenance of transmission lines.

A60. Determine effects of all land management practices on water quality and aquatics.

A67. Make sure all ongoing studies are folded into the database for relicensing (all agencies, not just IPC) to avoid duplication.

T13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control.

T32. Public access/recreational use impact of new roads, public, wildlife species terrestrial habitat, winter ranges, etc., people use in former wildlife habitat.

T33. IPC land management practices effects on terrestrial resource.

T40. Livestock grazing impacts in relation to current management plans.

T41. Do noxious weeds limit mitigation opportunity.

T49. Hydro versus other uses (impacts).

R4. Management of increasing use.

R6. Law enforcement.

R7. Traffic associated with use.

R8. Multiple-use conflicts.

R10. Identification of existing and potential access sites.

R13. Upland access for hunting and other uses.

R15. Seasonal closures of access areas.

R16. Protection from loss of public access.

R17. Providing access during changing reservoir levels.

R18. Improved property ownership identification.

R19. Impacts of recreation use on adjacent lands.

R34. Recommendations to other managing entities.

P17A. Fecal coliform levels immediately adjacent to dispersed recreation sites.

P20A. Paved road from Huntington to Richland.

P18T. Geologic/seismic activity.

P10R. Hotel needs to be built at Brownlee Reservoir for bass tournaments.

P15E. Possible IPC land acquisition downstream of the project to preserve open space (Asotin to Heller's Bar).

X10. Primary emphasis in Hells Canyon and along the Snake River should be restoration of native plants and wildlife; no additional commercial development or road building should occur.

X11. Stop all cattle and sheep grazing on public lands.

X27. Continue the parks.

X28. Manage dams for people, then fish, not the reverse.

Problem Statement and Study Questions

Land use and management actions affect water quality, aquatic resources, wildlife, botanical resources, cultural resources, aesthetics, recreation and project operations and maintenance.

1) What are existing land use and ownership patterns?
2) What are IPC's responsibilities and authority under FERC regulations to implement land management plans and policies?
3) How compatible are agency plans and policies with relicensing land management objectives?
4) What potential land management policies and actions will address impacts on water quality, aquatic resources, wildlife, botanical resources, cultural resources, aesthetics, recreation and project operations and maintenance?

Desired Future Resource Goal

IPC's land management plan for the Hells Canyon Project will ensure that proposed land uses are compatible with protection and enhancement of aquatic, terrestrial, cultural, aesthetic and recreation resources, the management plans and policies of affected agencies, efficient operation of project facilities, and that FERC requirements are met.

Abstract

Development of a comprehensive land management plan for the Hells Canyon Project is proposed. Although not required by the FERC at this stage of the relicensing process, IPC has elected to begin development of a land management plan as a proactive strategy for balancing resource values and effective management of land assets. Additionally, the land management plan will provide guidance for IPC use authorizations on project lands and waters, consistent with FERC requirements.

The land management plan will respond to issues raised by agencies, tribes, nongovernmental organizations and the public in the collaborative relicensing process. IPC's land management goals (IPC 1994, revised 1995), which were endorsed by resource agencies, provide the foundation for the land management plan. The goals address land use and access, public use and safety, terrestrial resources, aquatic resources, cultural resources, aesthetic resources, recreation resources and land management plan implementation.

Introduction

To date, IPC has developed and implemented a land management plan for its Upper Salmon Falls, Lower Salmon Falls, Bliss and Malad Projects (the Middle Snake River Land Management Plan) and has developed a draft land management plan for the Shoshone Falls Project (Shoshone Falls Land Management Plan). Additionally, IPC developed and implemented General Land Management Policies for all its FERC-licensed projects, including the Hells Canyon Project, in 1996.

The IPC General Land Management Policies contain policies, standards and guidelines for different land uses, that are consistent with the FERC land use article. Although these policies provide a good foundation for authorization of proposed land uses, a truly effective land management approach takes into account spatial attributes. The land management planning process integrates the development of land management policies, standards and guidelines with analysis of spatial data. For example, the Middle Snake River Land Management Plan established land use designations for project lands (protection, conservation, recreation, agriculture/grazing, utility facilities, and special management area), based on the highest resource values and the requirements of agencies with authority. Only proposed land uses that are compatible with the intent and requirements of the designations are allowed. A similar approach may be used for the Hells Canyon land management planning process.

The land management planning process provides the basic land use and ownership information that is needed for aquatic, terrestrial and recreation relicensing studies and analysis. This information is also needed for the Report on Land Management and Aesthetics in the new license application (FERC 1990).

The objectives of the land management planning process are to:

1) inventory and evaluate existing land use and ownership,
2) inventory and evaluate current land management plans, policies and actions,
3) integrate land management goals, objectives, policies and specific actions with identified impacts on resources resource protection and enhancement objectives (in a manner consistent with FERC requirements),
4) integrate information from collaborative process Work Groups and IPC staff about land use impacts on water quality, aquatic resources, wildlife, botanical resources, cultural resources, aesthetics, recreation, and project operations and maintenance to develop land management policies and actions that respond to identified impacts,
5) through a comprehensive resource analysis methodology, provide a way of identifying resource management opportunities and constraints, for developing protection, mitigation, and enhancement proposals and for balancing aquatic, terrestrial, cultural, aesthetic and recreation resources values,
6) provide a comprehensive land management policy framework for aquatic, terrestrial, cultural, aesthetic and recreation protection, mitigation, and enhancement proposals,
7) provide for the effective management of Company-owned real estate and facilities, and land acquisition and disposal issues, consistent with long-term relicensing objectives and IPC's overall financial objectives,
8) consider land acquisition and disposal issues,
9) provide a framework for continued coordination and cooperation between IPC, agencies, tribes, nongovernmental organizations,

10) engage stakeholders in development and implementation of the land management plan,
11) provide a way of monitoring the effectiveness of the land management plan, and
12) develop and maintain a comprehensive GIS database.

State of Knowledge

The FERC land use license article for the Hells Canyon Project gives IPC authority to grant permission for certain uses of project lands and waters and to convey certain interests in project lands, without prior FERC approval. It also describes other land uses that may be allowed and the requirements for agency consultation and prior FERC approval. This article provides guidance for development of the land management plan and the specific actions needed to implement the land use article. (IPC's General Land Management Policies are based on this article.)

In the Manual of Standard Special Articles (FERC 1992), the FERC outlines some of the articles that may be included in a new license. In addition to the standard use authorization provision, the it suggests that FERC will include a provision regarding establishment of a shoreline buffer zone when significant development pressure exists. IPC's ongoing review of FERC orders pertaining to land use provides a basis for understanding of current FERC practices and helps further define the scope of the land management plan.

IPC has conducted a preliminary survey of plans and policies. Idaho agencies with authority in land management matters include the SHPO, the Idaho Department of Lands, the IDFG, the IDPR, the Department of Health and Welfare DEQ, and the Southwest District Health Department. Oregon agencies include the SHPO, the Oregon Division of State Lands, the Marine Board, ODFW, ODPR, and the Department of Environmental Quality. Federal agencies with jurisdiction include the COE, the USFWS, the USFS, and the BLM. Baker, Malheur and Wallowa Counties have jurisdiction in Oregon, and Adams and Washington Counties have jurisdiction in Idaho.

IPC took aerial photographs of the Hells Canyon Project and adjacent lands in 1993, and then superimposed ownership and project boundary information. In addition to these maps, IPC is building a GIS database that includes land use, land ownership and other resource information (from other relicensing studies) that is useful for land management planning.

IPC is working with the USFS and the BLM to obtain digital data from the Columbia Basin EIS project.

IPC leases some of the project lands that it owns for grazing or recreational uses. It also administers a FERC-approved permitting program for private boat docks. Some project lands are owned privately, or by the state or federal government. In these areas, IPC's authority to control land use is very limited.

Methods

The steps in the planning process are:

1) Identify issues and goals,
2) Describe current conditions,
    a) Inventory and evaluate existing land use and ownership,
    b) Inventory and evaluate current land management plans, policies and actions
3) Incorporate descriptive and impact-related data from environmental studies (GIS database)
4) Conduct resource analyses (synthesis and interpretation of information),

5) Adjust goals and objectives, as needed,
6) Develop land management alternatives,
7) Select preferred alternative
8) Prepare draft land management plan,
9) Implement plan, and
10) Monitor, evaluate and update plan.

The USFS recommends a process that is compatible with their Watershed Analysis efforts. Relicensing study areas are described on a study-by-study basis in this consultation package and are generally narrower in scope than Watershed Analysis would suggest. The scope of relicensing studies is defined by the FERC's jurisdiction as exercised pursuant to the Federal Power Act, which focuses on areas affected by project operations. Nevertheless, the similarities between IPC's land management planning process and the methodology described in the Federal Guide for Watershed Analysis (Regional Interagency Executive Committee and the Intergovernmental Advisory Committee 1995) should facilitate data sharing and analysis as mutually desired. Resource work groups will develop more detailed study descriptions in 1997 which will involve refinement of study area boundaries and data collection methodologies. The FERC's decision on cumulative effects analysis will also further define the scope of relicensing studies.

Agencies with jurisdiction (federal, state and local), tribes, nongovernmental organizations and the public are expected to be active participants in the planning process via the collaborative process. Work Groups will be the primary participants in the resource analysis and development of alternatives. The Collaborative Team will be involved at milestones in the planning process, such as the selection of a preferred alternative. Collaborative Team-sponsored meetings or special meetings will be held to involve the public in the planning process.

GIS technology will be used to store and map existing and proposed land use, land ownership, resource data from other relicensing studies, to conduct resource analyses and to develop land management alternatives.

The study area for existing land use and ownership surveys will extend from canyon rim to rim, encompassing portions of direct tributaries, and from Weiser to the northern boundary of the HCNRA. General ownership categories (federal, state, county, private, IPC) and protected areas will be mapped at this scale using GIS.

Specific land ownership will be identified within and immediately adjacent to the project boundary. Structures, roads and road classifications will be mapped within and immediately adjacent to the project boundary to the extent this information is available from the USGS and aerial photographs.

The inventory of existing land use and ownership will include easements and use authorization agreements (such as leases and permits). Use authorizations by IPC, the BLM, the USFS, and state agencies will be considered.

The inventory of land management plans, policies and actions will include protected areas, land use designations and zoning, and the FERC Revised List of Comprehensive Plans (FERC 1996).

Timetable

Development of the GIS database is underway. The existing land use inventory will begin in 1997 and will be updated periodically. As soon as baseline resource data from the other relicensing studies is available, it will be included in the GIS. Not all of the detailed study information is needed for land management planning analyses, so resource analyses could begin as early as 1999 and should be completed by the end of 2001. This will allow two years of analysis and development of land management alternatives before selection of specific protection, mitigation, and enhancement measures and completion of the draft new license application in late 2001.

Cooperation

Counties and agencies that administer project lands and the adjacent lands, and the owners of adjacent lands will be the primary cooperators. Other agencies with jurisdiction, tribes, nongovernmental organizations and the public are also expected to be active participants via the collaborative process.

Statement of Capabilities

Responsibility for the land management planning process will be IPC's, coordinated by its Land Management Planner. Real Estate Specialists will assist with the land use and ownership inventory. Consultants may be used for inventories, meeting facilitation and document preparation tasks. IPC will provide the GIS services.

Deliverables

1) A detailed schedule and work program for the land management planning process that interfaces with other studies.
2) An inventory and evaluation of existing land use and land ownership in narrative form (for inclusion in the land management plan and new license application); GIS maps of existing land use and land ownership.
3) An inventory and evaluation of existing land management plans, policies and actions in narrative form; GIS maps of zoning, land use designations and protected areas.
4) A useable GIS database for analysis purposes, to support development of land management alternatives and protection, mitigation and enhancement measures.
5) A Hells Canyon Land Management Plan with goals, objectives, policies, specific actions, land use designations (if applicable) and an implementation plan; use of GIS maps and other graphics where appropriate.
6) Tabular data, charts and graphs, as appropriate.

8.7.2. Literature Cited

Federal Energy Regulatory Commission. 1990. Hydroelectric project relicensing handbook. FERC, Office of Hydropower Relicensing, Washington, D.C. 164pp.

Federal Energy Regulatory Commission. 1990. Manual of standard special articles. Paper No. DPR-4. FERC, Office of Hydropower Relicensing, Washington, D.C. 83pp.

Federal Energy Regulatory Commission. July 26, 1996. Revised list of comprehensive plans. FERC, Office of Hydropower Relicensing, Washington, D.C. 67pp.

Regional Interagency Executive Committee and the Intergovernmental Advisory Committee. 1995. Federal guide for watershed analysis. Regional Ecosystem Office, Portland, Oreg. 26pp.

8.8. Aesthetics

8.8.1. Title: An Evaluation of the Aesthetic Resources of Hells Canyon

Issues

R35. Appearance of project facilities, including transmission lines.

R36. Views from recreation facilities, heavily used dispersed sites, travel routes and scenic overlooks.

R37. Effects of project operations on aesthetic quality.

R38. Effects of land management practices on aesthetic quality.

R39. Effects of transportation facilities on aesthetic quality (dust, proposed facilities).

R40. Costs and other constraints related to potential protection, mitigation, and enhancement measures.

Problem Statements

The FERC requires IPC to provide a graphic visual picture of the existing project and the surrounding landscape to serve as a baseline for evaluating any project modifications (FERC 1990). Project facilities, viewed from public use areas such as recreation facilities, heavily used dispersed recreation sites, travel routes and scenic overlooks, affect the aesthetic character of the area.

1) What are the existing conditions for aesthetic resources, including existing development and use of project lands and the scenic quality of the surrounding landscape?
2) What is the sensitivity of aesthetic quality to any proposed modifications to project facilities from identified viewer locations?
3) How visually compatible are proposed project modifications, including linear features such as transmission lines, penstocks and canals, with the surrounding landscape?

4) What are the aesthetic impacts of modifications of project facilities and associated transmission lines?
5) What are alternative ways to enhance the aesthetic quality of the project facilities to minimize the visual contrast of the project with the surrounding landscape?
6) What are potential protection, mitigation, and enhancement measures?
7) The FERC asks applicants to provide a narrated color video cassette tape recording and/or color photographs of the exterior of all project facilities and of the range of streamflows below the dam. The video and photographs should show the overall land character using both large and small scale views, proposed construction sites, and proposed minimum flow levels compared to seasonal flows from the same vantage point.

Project operations affect reservoir levels and flows below Hells Canyon Dam, thereby affecting the visual character of the reservoir shorelines and the river below Hells Canyon Dam.

1) What are the aesthetic impacts of fluctuations in reservoir levels?
2) What are the aesthetic impacts related to altered flows below Hells Canyon Dam?
3) What are potential protection, mitigation, and enhancement measures?

The land management practices of IPC and other land owners/managers may affect aesthetic quality. Land use conflicts, dispersed recreation use, noise, odor, water quality and other developments have the potential to affect aesthetic quality.

1) What are the aesthetic impacts associated with the following land management issues:
   a) conflicting land uses, for example, grazing impacts on the aesthetic quality of recreation sites,
   b) dispersed recreation use, for example the effects of poor sanitation on aesthetic quality of recreation sites,
   c) noise,
   d) water quality (macrophytes),
   e) weeds,
   f) house docks and other structures authorized (or not authorized) by IPC and agencies with jurisdiction,
   g) appearance of recreation facilities,

2) What plans and policies exist related to aesthetic resources for lands within and adjacent to the project?
3) What are potential protection, mitigation, and enhancement measures or land management policies, standards and guidelines related to land management/aesthetics issues?

Dust associated with the existing Steck Park Road, Cambridge Road, Brownlee Road and the road to McCormick Park may affect aesthetic quality. (In the case of transportation facilities proposed by the applicant, the FERC requires a description of measures to ensure that the development blends, to the extent possible, with the surrounding environment.)

1) Does the general public perceive that dust associated with these roads impacts visual quality?
2) What are land management policies, standards and guidelines related to the dust problem?
3) What measures can be taken to ensure that the proposed transportation facility blends, to the extent possible, with the surrounding environment?

The cost of protection, mitigation, and enhancement measures affects the economic viability of the project. (The FERC requires applicants to provide an analysis of costs and other constraints related to aesthetic resources protection.)

What are the constraints related to aesthetic resources protection, mitigation and enhancement?

Desired Future Resource Goal

The overall goal is to minimize the negative impacts of fluctuating water levels associated with the Hells Canyon Project on aesthetic resources.

Abstract

Past studies have examined aesthetic impacts from varying flows on streams. However, site-specific information relative to Hells Canyon has not been documented. Information is needed to determine aesthetic impacts from fluctuations of reservoir levels and flows below Hells Canyon Dam. This information will be linked to the identification of potential protection, mitigation, and enhancement recommendations.

Introduction

Portions of the Snake River in Hells Canyon are part of the National Wild and Scenic River system. Below the dam, the river is within HCNRA. The 31.5 miles from the dam to Pittsburgh landing is classified *wild* and the 36.0 miles from Pittsburgh landing to the northern boundary of the Wallowa-Whitman National Forest are classified *scenic*. The Act establishing wild and scenic rivers requires protection of aesthetic values among others [Public Laws 90-542 and 99-590, Section 10(a)]. Fluctuating reservoir levels can effect aesthetic values. The objective of this study is to assess impacts from fluctuating reservoir levels and project-induced flows below Hells Canyon Dam.

Assessment of river flows should occur from key viewing areas along trails, at camps, and other concentrated recreation areas. The change in water character at major falls and rapids should be documented and public perception of these changes determined. Perception of the aesthetic quality of the reservoir at various operating levels should be determined from key viewpoints around the perimeter of the reservoir, superior viewing positions to the reservoir, and viewers on the reservoir.

State of the Knowledge

Aesthetics studies conducted in the Hells Canyon Project area include agency inventory of the landscape aesthetic values, *sensitive* viewers and their viewsheds, and agency visual management objectives. Two national forests have completed these inventories, the Payette and the Wallowa-Whitman. Information available will include variety classes, *sensitive* viewpoint and viewsheds, and Visual Quality Objectives (VQOs). The BLM has completed a similar visual inventory for lands under its jurisdiction. This information will include scenic quality classes, *sensitive* viewpoints and viewsheds, and Visual Resource Management classes (VRM). This information is available for national forest and public lands, and will not include private lands.

Assessment of visual impacts in the project area is limited to evaluation of projects proposed on federal lands, determining if the project is compatible with visual resource management objectives. Assessment of flow and reservoir levels from an aesthetic perspective has not occurred in the project area.

Methods

Study design and methodology will be developed by an independent consultant, in cooperation with the Recreation and Aesthetic Resources Work Group and other appropriate entities. Input will be solicited directly from all land management authorities (federal, state, county) located within the study boundary.

Timetable

It is anticipated that an RFP will be developed in mid-to late 1997. The RFP will be circulated to potential consultants in the fall of 1997 and a consultant selected by December 31, 1997. The study is anticipated to be conducted in 1998 and, if necessary, carry over into 1999. The final report is expected to be available in early 2000.

Cooperation

The RFP will be developed in cooperation with a sub-group of the Recreation and Aesthetic Resources Work Group. Appropriate land management agencies, tribes and public interest groups will be consulted.

Statement of Capabilities

A consultant with demonstrated skills in conducting aesthetic evaluations will be selected to conduct this study.

Deliverables

Several copies of a draft review report, one camera-ready final report, video and photographic documentation.

8.8.2. Literature Cited

Federal Energy Regulatory Commission. 1990. Hydroelectric project relicensing hand book. FERC, Office of Hydropower Relicensing, Washington, D.C.

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IX.
Studies Discussed by the Collaborative Team that are not Proposed at this Time

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IX
STUDIES DISCUSSED BY THE COLLABORATIVE TEAM THAT ARE NOT PROPOSED BY IPC AT THIS TIME

The descriptions of proposed studies in the preceding Section VIII. of the Formal Consultation Package were developed by IPC, agencies, tribes and nongovernmental organizations, with public input, as part of the collaborative process for relicensing consultation. They generally represent a consensus of collaborative process participants to date, with the exception of a proposal for pre-construction studies. (IPC understands that agencies may have further comments on some of the study proposals during the official comment period following distribution of the Formal Consultation Package. The study proposals will be refined in 1997 with input from agencies, tribes, nongovernmental organizations and the public.) The following study is distinguished from those preceding this section on the basis that it is not proposed here as a consensus product of the Collaborative Team, but rather is only included in order to gain broader public and agency review and comment.

The Joint Proposal for Study of Wildlife Habitat Inundated by the Hells Canyon Complex (Appendix VIII.D) was prepared by the United States Fish and Wildlife Service, the Idaho Department of Fish and Game and the Oregon Department of Fish and Wildlife. It asserts that this study provides an essential context in which to address actions necessary to meet today's wildlife needs, and that knowing what was lost in the past is a key to determining what might be needed in the future.

When the current license expires, the project will have been operated, under the auspices of federal law and according to and in compliance with, the regulatory scheme and Commission (FERC) authority delegated by that law as it has been amended over time for 50 years. The project exists today because the original licensing decision-makers determined that the project was in the public interest, subject to the many constraints and requirements provided in that license.

In a relicensing proceeding, great effort is made to assure scientifically objective results, which can be relied upon, regardless of perspective, as a scientific basis for ultimate decisions about appropriate natural resource protection, mitigation, and enhancement measures to be imposed upon a licensee during the next license term. IPC's position is that any study which attempts to reconstruct an environmental baseline developed from available data, speculation, and anecdotal information dating back 50 years, to a time when neither science, history, nor media were focused upon or sufficiently developed to reliably and comprehensively record such information in the Hells Canyon area, is inconsistent with common standards of objectivity and fairness.

In a relicensing proceeding, neither the Federal Power Act, the federal regulations implementing that act, nor the federal Commission administering them require assessment of pre-project, pre-construction, or pre-impoundment conditions. The Commission has clearly stated that the basis for assessment of project impacts in a relicensing proceeding is the existing environmental conditions in the project area.

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X.
Economic Considerations

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X. ECONOMIC CONSIDERATIONS

X.
ECONOMIC CONSIDERATIONS

10.1. Background

Though FERC regulations do not require economic studies as part of the formal consultation package, IPC feels it is important to include discussions of economic considerations as part of the collaborative process. IPC must also perform comprehensive economic analyses to determine the cost-effectiveness of its projects in light of proposed protection, mitigation, and enhancement measures.

The role of the Economics Work Group, as defined in the collaborative process document, is to:

> ***"work with the Collaborative Team and the Resource Work Groups to integrate economic considerations into their discussions. The Economics Work Group is charged with considering the economic values associated with relicensing such as aquatics, fish and wildlife cultural and aesthetic values, as well as developmental values such as power generation, irrigation, and flood control. The function of the Economics Work Group is not to constrain discussions by the Team or the Resource Work Groups, but to provide data and expertise on economic issues for consideration in the relicensing process."***

The Economics Work Group of the Collaborative Team, therefore, was formed to address the valuation of economic, socio-economic, and environmental impacts related to the Hells Canyon Project. The information generated from these types of studies will be used to help the Collaborative Team comprehensively assess impacts to IPC, ratepayers, affected economies, and the environment.

In October of 1996, the Economics Work Group convened to address economic aspects of study issues developed by the Resource Work Groups and issues identified at Collaborative Team-sponsored public meetings regarding the Hells Canyon Complex (please refer to Appendix VIIIC for a list of the identified issues). In November and December, the economic work group developed problem statements, research questions, and goals related to these issues. They are preliminary attempts to capture analysis that may need to be performed to address the questions raised by the Resource Work Groups and the public.

Because of the short timeframe in which these problem statements, research questions, and goals were developed and because of lack of thorough evaluation, including cost, benefit, and feasibility analyses, they are not currently proposed as studies by IPC in Section VIII of this consultation package. However, IPC will consider them, once they are fully developed, as part of the comprehensive analysis requested by the Collaborative Team. During the next year, the Economics Work Group will fully develop these descriptions and, in coordination with IPC, perform the related feasibility analyses.

10.2. Problem Statements, Research Questions and Goals

The following section includes problems statements, research questions, and goals developed by the Economics Work Group.

10.2.1. Title: Removal or Decommissioning of Hells Canyon Complex *Dams*

Problem Statement

Dam removal or decommissioning result in direct economic costs that need to be quantified.

1) What is the direct economic cost of removing one or more Hells Canyon Complex dams?
2) What is the direct economic cost of decommissioning one or more Hells Canyon Complex dams?
3) What are the alternatives for replacement power?
4) What is the replacement cost of lost power associated with dam removal or decommissioning?
5) What are the reliability impacts of dam removal or decommissioning?

Goal

The general purpose of this study is to identify and, where possible, quantify all power and non-power values associated with dam removal and decommissioning.

Timeline

FERC requires information regarding replacement power and the value of the current projects to be included in new license applications for existing facilities. This analysis will be performed to support the development of the new license application.

10.2.2.
Tit/e: Current Operating Constraints for the Hells Canyon Complex

Problem Statement

Voluntary and mandatory operating constraints at the Hells Canyon Complex result in economic and environmental impacts that need to be quantified.

1) What are the current operating constraints?
2) What additional costs and quantified benefits are associated with the constraints?
3) What are the costs and quantified benefits associated with natural flow constraints?
4) What are the costs and quantified benefits of operating constraints associated with Endangered Species Act listings?

Goals

To identify and quantify the economic and environmental costs and benefits of current legal, regulatory, and voluntary operating constraints.

Identify and quantify changes to those constraints that may result from regulatory mandates.

Timeline

Information on current operating constraints already exists and will be made available as needed. Other information will be developed to evaluate impacts of other operating constraints to support the efforts of other Work Groups and the development of the new license application.

10.2.3.
Title: Socio-economic and Environmental Impacts Related to the Hells Canyon Complex

Problem Statement

Hells Canyon Complex operations result in local, state, and regional socio-economic impacts that need to be identified and quantified.

1) What are the regions of influence, including economic sectors?
2) What are the current socio-economic impacts within the identified regions?
3) What are the changes in socio-economic impacts within the identified regions resulting from modified operations?

What are the operational alternatives?

1) What are the changes in socio-economic impacts within the identified regions resulting from dam removal?
2) What are the changes in socio-economic impacts within the identified regions resulting from decommissioning?
3) What are the changes in environmental impacts associated with the questions listed above? Environmental impacts will be commensurate with those identified in the Aquatic and Terrestrial Resource, and Recreation and Aesthetics Resource Work Groups.

Goals

Identify regions of influence and baseline socio-economic conditions resulting from current operations.

Identify changes in socio-economic and environmental conditions resulting from modified operations, dam removal, or decommissioning.

Timeline

Aspects of this analysis will be completed to support the efforts of other Work Groups and the development of the new license application.

10.2.4.
Title: Effect of Relicensing on Power Rates

Problem Statement

Power rates may be affected by relicensing and these changes and effects need to be quantified.

1) What are the relicensing costs associated with the Hells Canyon Complex?
2) How much of an increase in rates can be attributed to these costs?
3) How much of an increase are ratepayers willing to pay for relicensing costs associated with the Hells Canyon Complex?

Goal

Identify and quantify the economic costs associated with relicensing the Hells Canyon Complex and their impacts on power rates.

Timeline

These impacts will be quantified once further information is developed on the cost of relicensing the projects.

10.2.5.
Title: Fish Passage at the Hells Canyon Complex

Problem Statement

Fish passage through Hells Canyon Complex dams for resident migratory and anadromous fish results in economic and environmental impacts that need to be identified and quantified.

1) What are the fish passage alternatives for anadromous and migratory resident fish identified by the Aquatic Resources Work Group?
2) What are the associated costs and quantified benefits of these alternatives?

Goal

Evaluate the costs and benefits of the fish passage alternatives, as identified by the Aquatic Resources Work Group.

Timeline

This analysis will begin once fish passage alternatives are identified.

10.2.6.
Title: Deregulation Impacts

Problem Statement

Deregulation may result in changes to power rates. These economic impacts need to be identified and quantified.

1) What are the effects of deregulation on relicensing and, subsequently, rates?

Goal

Identify and quantify the economic issues associated with deregulation and their subsequent impact on relicensing and power rates.

Timeline

The future impacts of deregulation are currently unknown and there remains some uncertainty of what it will look like in Idaho and elsewhere. Therefore, the analysis will be performed once the extent of and timeframe for deregulation is more fully known.

Hells Canyon Formal Consultation Package

XI. Tables

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Table 6-2 (C O E designation)

BROWNLEE FLOOD CONTROL REQUIREMENTS

THE DALLES FORECAST APR - AUG. MAF	BROWNLEE FORECAST APR - JUL. MAF	SPACE REQUIRED, 1000 AF 28-Feb	31-Mar	15-Apr	30-Apr
<60	<2.5	0	0	0	0
	>2.5 <3	100	50	0	0
	>3	200	100	50	0
>60 <70	<2.5	0	0	0	0
	>2.5 <3	100	50	0	0
	>3 <4	200	100	50	0
	>4	300	200	100	0
>70 <80	<2.5	200	100	0	0
	>2.5 <3	200	150	50	0
	>3 <5	300	200	100	50
	>5	400	350	250	150
>80 <90	<2.5	200	100	0	0
	>2.5 <3	200	150	50	0
	>3 <4	300	250	150	100
	>4 <5	300	350	400	400
	>5	400	450	500	500
>90 <100	<2.5	200	100	50	0
	>2.5 <3	200	150	100	50
	>3 <4	300	300	250	200
	>4 <5	300	350	400	400
	>5 <6	400	450	500	500
	>6	400	500	550	600
>100 <110	<2.5	200	100	50	0
	>2.5 <3	300	200	150	100
	>3 <4	400	400	350	300
	>4 <5	400	450	500	500
	>5 <6	400	500	550	600
	>6	400	500	600	700
>110 <120	<2.5	200	100	50	0
	>2.5 <3	300	250	200	150
	>3 <4	400	400	400	400
	>4 <5	400	500	550	650
	>5 <6	400	650	750	850
	>6	500	750	850	980
>120 <130	<3	300	300	250	200
	>3 <4	400	500	550	600
	>4 <5	500	750	800	850
	>5	500	750	850	980
>130 <140	<3	500	400	300	200
	>3	500	750	850	980
>140 <150	<3	500	550	600	600
	>3	500	750	850	980
>160	ALL	500	750	850	980

Revised from 2 Feb 83 Table7/16/87 DDS

Table 5-1 Beneficial use categories to be protected for segments of the Snake River within the study area as identified by the State of Oregon.

Beneficial Use Categories	RM 459-335	RM 335-285	RM 285-274	RM 274-249	RM 249-180
Public Water	*	*	*	*	*
Private Water	*	*	*	*	*
Industrial Water	*	*	*	*	*
Irrigation	*	*	*	*	*
Livestock	*	*	*	*	*
Salmonid Spawning	*	*	*	*	*
Salmonid Rearing	*	*	*	*	*
Resident Fish and Aquatic Life	*	*	*	*	*
Wildlife and Hunting	*	*	*	*	*
Fishing	*	*	*	*	*
Boating	*	*	*	*	*
Contact Recreation	*	*	*	*	*
Aesthetics	*	*	*	*	*
Hydropower		*	*	*	*
Anadromous Fish Passage					*
Commercial Navigation and Transport					*

Table 5-2 Beneficial use categories to be protected for segments of the Snake River within the study area as identified by the State of Idaho.

Beneficial Use Categories	RM 458-335	RM 335-285	RM 285-274	RM 274-249	RM 249-180
Domestic Water Supply	*	*	*	*	*
Agricultural Water Supply	*	*	*	*	*
Cold-Water Biota	*	*	*	*	*
Warm-					
Water Biota					
Salmonid Spawning	F	*	*	*	*
Primary Contact Recreation	*	*	*	*	*
Secondary Contact Recreation	*	*	*	*	*

Table 5-3 Species list of historic and present day fish species found in the Hells Canyon Study Area.

Class	Family	Common Name	Scientific Name	Status[1]
Crustacea				
	Astacidae			
		crayfish	*Pacifastacus leniusculus*	N
			P. gambeli	N
			P. connectens	N
Osteichthyes				
	Petromyzontidae			
		Pacific lamprey	*Entosphenus tridentatus*	N,A
	Acipenseridae			
		white sturgeon	*Acipenser transmontanus*	N
	Salmonidae			
		redband trout	*Oncoryhnchus mykiss*	N
		rainbow trout	*O. mykiss*	N,I
		steelhead trout	*O. mykiss*	[2]N,A
		chinook salmon	*O. tschawytscha*	[3]N,A
		sockeye salmon	*O. nerka*	[3]N,A
		coho salmon	*O. kisutch*	[4]N,A
		mountain whitefish	*Prosopium williamsoni*	N
		bull trout	*Salvelinus confluentus*	[2]N
		brook trout	*S. fontinalis*	I

Table 5-3 *(Continued)*

Class	Family	Common Name	Scientific Name	Status[1]
Osteichthyes (cont.)	*Cyprinidae*			
		peamouth	*Mylocheilus caurinus*	N
		northern squawfish	*Ptychocheilus oregonensis*	N
		chiselmouth	*Acrocheilus alutaceus*	N
		redside shiner	*Richardsonius balteatus*	N
		speckled dace	*Rhinichthys osculus*	N
		longnose dace	*R. cataractae*	N
		leopard dace	*R. falcatus*	N
		common carp	*Cyprinus carpio*	I
	Catostomidae			
		bridgelip sucker	*Catostomus columbianus*	N
		largescale sucker	*C. macrocheilus*	N
	Ictaluridae			
		channel catfish	*Ictalurus punctatus*	I
		blue catfish	*I. furcatus*	I
		brown bullhead	*I. nebulosus*	I
		black bullhead	*I. melas*	I
		tadpole madtom	*Noturus gyrinus*	I
		flathead catfish	*Pylodictis olivaris*	I
	Centrarchidae			
		smallmouth bass	*Micropterus dolomieu*	I
		largemouth bass	*M. salmoides*	I

Table 5-3 *(Continued)*

Class	Family	Common Name	Scientific Name	Status[1]
Osteichthyes (cont.)	*Centrarchidae (cont.)*	*pumpkin seed*	*Lepomis gulosus*	I
		bluegill	*L. macrochirus*	I
		warmouth	*Chaenobryttus gulosus*	I
		black crappie	*Pomoxis nigromaculatus*	I
		white crappie	*P. annularis*	I
	Percidae			
		yellow perch	*Perca flavescens*	I
	Cottidae			
		mottled sculpin	*Cottus bairdi*	N
		shorthead sculpin	*C. confusus*	N

1 N-Native, I- Introduced, A-Anadromous

2 candidate under ESA

3 endangered listing under ESA

4 declared extinct under ESA

Table 5-4 History of dam construction on the mainstem Columbia and Snake rivers and selected tributaries.

Drainage	River	Dam	Year of Construction
Columbia River	mainstem	Bonneville	1937
		Grand Coulee	1941
		McNary	1954
		The Dalles	1957
		Priest Rapids	1961
		John Day	1968
Snake River	mainstem	Swan Falls	1901
		Diversion Dam	1908
		Warm Springs	1919
		Crane Creek	1920
		Black Canyon	1923
		Owyhee	1928
		Thief Valley	1919
		Unity	1936
		C.J. Strike	1952
		Brownlee	1958
		Oxbow	1961
		Ice Harbor	1962
		Hells Canyon	1967
		Lower Monumental	1969
		Little Goose	1970
		Lower Granite	1975

Table 5-5 Winter waterfowl surveys along the Snake River - Salmon River confluence to Upper Brownlee Reservoir, January 1974 and 1975.

	Merganser		Goldeneye		Bufflehead		Mallard Duck		Unknown		Canada Goose		Grebes		Great Blue Heron		Σ	
Study Section	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Salmon River to Pittsburgh	8	2	0	0	0	0	0	0	0	0	38	0	0	0	0	0	46	2
Pittsburgh to Hells Canyon Dam	574	2	0	333	0	0	0	0	0	0	0	0	0	0	0	0	574	235
Hells Canyon Reservoir	30	65	0	0	0	0	9	0	4	0	0	0	1	0	1	0	45	65
Oxbow Reservoir	78	90	0	257	0	0	18	0	0	0	0	0	0	0	0	0	96	347
Brownlee Reservoir	212	290	0	306	5	10	150	143	2	0	275	30	0	0	0	1	644	780
Σ	902	449	0	896	5	10	177	143	6	0	313	30	1	0	1	1	1405	1429

Table 5-6 Small and medium-sized mammals, including bats, occurring in the Blue Mountains Province, Oregon[1)]

Common Name	Scientific Name	Abundance[2)]
Small mammals		
Preble's shrew	*Sorex preblei*	D
Vagrant shrew	*Sorex vagrans*	W
Montane shrew	*Sorex monticolus*	D
Water shrew	*Sorex palustris*	D
Coast mole	*Scapanus orarius*	W
Pika	*Ochotona princeps*	D
Least chipmunk	*Tamias minimus*	D
Yellow-pine chipmunk	*Tamias amoenus*	W
Belding's ground squirrel	*Spermophilus beldingi*	D
Columbian ground squirrel	*Spermophilus columbianus*	D
Golden-mantled ground squirrel	*Spermophilus lateralis*	W
Fox squirrel	*Sciurus niger*	L
Red squirrel	*Tamaisciurus douglassii*	D
Northern flying squirrel	*Glaucomys sabrinus*	W
Northern pocket gopher	*Thomomys talpoides*	W
Little pocket mouse	*Perognathus longimembris*	D
Great Basin pocket mouse	*Perognathus parvus*	D
Ord's kangaroo rat	*Dipodoumys ordii*	D
Western harvest mouse	*Reithrodontomys megalotis*	D
Deer mouse	*Peromyscus maniculatus*	D
Bushy-tailed woodrat	*Neotoma cinerea*	W
Southern red-backed vole	*Clethrionomys gapperi*	W
Heather vole	*Phenacomys intermedius*	D
Montane vole	*Microtus canicaudus*	W
Long-tailed vole	*Microtus longicaudus*	W
Water vole	*Microtus richardsoni*	W
Sagebrush vole	*Lagurus curtatus*	D

Table 5-6 ***(Continued)***

Common Name	Scientific Name	Abundance[2)]
House mouse	*Mus musculus*	D
Western jumping mouse	*Zapus princeps*	W
Medium-sized Mammals		
Pygmy rabbit	*Brachylagus idahoensis*	D
Nuttall's cottontail	*Sylvilagus nuttallii*	W
Snowshoe hare	*Lepus americanus*	D
White-tailed jackrabbit	*Lepus townsendii*	D
Black-tailed jackrabbit	*Lepus californicus*	D
Yellow-bellied marmot	*Mormota flaviventris*	D
Porcupine	*Erethizon dorsatum*	W
Bats		
Little brown myotis	*Myotis lucifugus*	W
Long-eared myotis	*M. evotis*	W
Fringed myotis	*M. thysanodes*	W
Long-legged myotis	*M. volans*	W
California myotis	*M. californicus*	W
Small-footed myotis	*M. leibii*	W
Silver-haired bat	*Lasionycteris noctivagans*	W
Western pipistrelle	*Pipistrellus hesperus*	D
Big brown bat	*Eptesicus fiuscus*	W
Hoary bat	*Lasiurus cinereus*	W
Townsend's big eared bat	*Plecotus townsendii*	D
Pallid bat	*Antrzous pallidus*	D
Yuma myotis	*Myotis yumanensis*	D

[1)]Based on Marshall (1986)
[2)]W = widespread; D= discontinuous distribution; L= local population

Table 5-7 **Herptiles known to occur, expected, and possibly to be found in the Hells Canyon Study Area in Oregon and Idaho.**

Common Name	Scientific Name	Oregon[1]	Idaho Distribution[2]	Idaho Found[3]	Idaho Expected[4]
Amphibians					
Long-toed salamander	*Ambystoma macrodactylum*	W	A,W	-	
Tiger salamander	*Ambystoma tigrinum*	-	-	-	+
Pacific giant salamander	*Dicamptodon ensatus*	-	A	-	
Western toad	*Bufo boreas*	D	A	W	
Woodhouse's toad	*Bufo woodhousei*	-	A,W	D	
Great Basin spadefoot	*Scaphiopus intermontanus*	D	A,W	D	
Pacific treefrog	*Hyla regilla*	W	-	D	
Striped chorus frog	*Pseudacris triseriata*	-	A,W	-	
Tailed frog	*Ascaphus truei*	D	A,W	-	
Bullfrog	*Rana catesbeiana*	D	W	L	
Northern leopard frog	*Rana pipiens*	-	A,W	-	+
Spotted frog	*Rana pretiosa*	W	A,W	-	
Lizards					
Side-blotched lizard	*Uta stansburiana*	-	-	L	
Mojave black-collared lizard	*Crotaphytes bicinctores*	-	-	-	+
Western whiptail	*Cnemidophorus tigris*	L	W	L	
Longnose leopard lizard	*Gambelia wislizenii*	-	W	L	
Sagebrush lizard	*Sceloporus graciosus*	D	W	L	
Western fence lizard	*Sceloporus occidentalis*	D	W	D	
Western skink	*Eumeces skiltonianus*	D	W	W	

Table 5-7 *(Continued)*

Common Name	Scientific Name	Oregon[1]	Idaho Distribution[2]	Idaho Found[3]	Idaho Expected[4]
<u>Snakes</u>					
Rubber boa	*Charina bottae*	D	-	-	+
Racer	*Coluber constrictor*	W	W	W	
Gopher snake	*Pituophis melanoleucus*	D	A,W	W	
Western terrestrial garter snake	*Thamnophis elegans*	W	A,W	D	
Common garter snake	*Thamnophis sirtalis*	-	A,W	D	
Striped whipsnake	*Masticophis taeniatus*	-	-	-	+
Western rattlesnake	*Crotalus viridis*	W	A,W	W	
Western ground snake	*Sonara semiannulata*	-	-	-	+
Ringneck snake	*Diadophis punctatus*	-	-	-	+
Longnose snake	*Rhinocheilus lecontei*	-	-	-	+
Night snake	*Hypsiglena torquata*	-	-	L	+

[1]Based on Marshall (1986) W=widespread; D= discontinuous population; L=local population

[2]Based on Nussbaum et al. (1983) and Groves and Peterson (1992) A=Adams County; W=Washington County

[3]Collected in the project area by Asherin and Claar (1976)

[4]Expected in the project area by Asherin and Claar (1986)

Table 5-8 State and Federal listed, proposed, candidate, and sensitive species known, or suspected to occur, in the Hells Canyon Study Area.

Taxon	IDNHP[1] Status	IDFG[2] Status	USFS[2] Region1	USFS[2] Region4	USBLM[2] Status	USFWS[3] Status	ORNHP[1] Status	ORFW[4] Status
Amphibians								
Spotted Frog *Rana pretiosa*						C	2	SC
Reptiles								
Western ground snake *Sonora semiannulata*	G5/S3	SSC			S		3	SP
Birds								
Common loon *Gavia immer*	G5/S1	SSC	S	S				
Horned grebe *Podiceps auritus*							4	SP
Ring-necked duck *Aythya collaris*							4	
Harlequin duck *Histrionicus histrionicus*	G5/S1	SSC	S	S			2	SP
Franklin's gull *Larus pipixcan*							2	SP
American white pelican *Pelecanus erythrorhynchos*	G3/S1	SSC					2	SV
Great egret *Casmerodius albus*	G5/S1	SSC					3	
Snowy egret *Egretta thula*							4	SV
White-faced ibis *Plegadis chihi*	G5/S2				S		4	SV
Greater sandhill crane *Grus canadensis tabida*							4	SV
Upland Sandpiper *Bartramia longicauda*	G5/S1	SSC						

Table 5-8 *(Continued)*

Taxon	IDNHP[1] Status	IDFG[2] Status	USFS[2] Region1	USFS[2] Region4	USBLM[2] Status	USFWS[3] Status	ORNHP[1] Status	ORFW[4] Status
Birds *(continued)*								
Greater yellowlegs *Tringa melanoleuca*							2	
Long-billed curlew *Numenius americanus*	G5/S3				3		4	
Western sage grouse *Centrocercus urophasianus*							3	SV
Columbian sharp-tailed grouse *Tympanuchus phasianellus*	G5/S2			S	S			
Spruce grouse *Dendragapus canadensis*							3	SU
Mountain quail *Oreortyx pictus*	G5/SE	SSC		S	S			
Northern goshawk *Accipiter gentilis*							3	SC
Ferruginous hawk *Buteo regalis*	G4/S3	SSC	S	S			3	SC
Swainson's hawk *Buteo swainsoni*	G4/S4				S		3	SV
Merlin *Falco columbarius*	G4/S1	SSC			S		2	
Peregrine falcon *Falco peregrinus*	G3/S1	T/E				LE	1	LE
Bald eagle *Haliaeetus leucocephalus*	G3/S3	T/E				LE	1	LT
Yellow-billed cuckoo *Coccyzus americanus*	G5/S3	SSC					2	SC
Northern saw-whet owl *Aegolius acadicus*							4	
Boreal owl *Aegolius funereus*							3	

Table 5-8 *(Continued)*

Taxon	IDNHP[1] Status	IDFG[2] Status	USFS[2] Region1	USFS[2] Region4	USBLM[2] Status	USFWS[3] Status	ORNHP[1] Status	ORFW[4] Status
Birds *(continued)*								
Burrowing owl *Athene cunicularia*	G5/S4				S		3	SC
Northern pygmy owl *Glaucidium gnoma*	G5/S3	SSC					3	SU
Flammulated owl *Otus flammeolus*							4	SC
Great gray owl *Strix nebulosa*	G5/S2	SSC					4	SV
Barred owl *Strix varia*	G5/S3	SSC						
Black-chinned hummingbird *Archilochus alexandri*							3	
Broad-tailed hummingbird *Selasphorus platycercus*							3	
Pileated woodpecker *Dryocopus pileatus*							4	SC
Lewis woodpecker *Melanerpes lewis*							3	SC
White-headed woodpecker *Picoides albolarvatus*	G5/S1	SSC					4	SC
Black-backed woodpecker *Picoides arcticus*							4	SC
Three-toed woodpecker *Picoides tridactylus*	G5/S3	SSC		S			4	SC
Williamson's sapsucker *Sphyrapicus thyroideus*							4	SU
Water pipet *Anthus spinoletta*							4	
Bank swallow *Riparia riparia*							3	SU

Table 5-8 *(Continued)*

Taxon	IDNHP[1] Status	IDFG[2] Status	USFS[2] Region1	USFS[2] Region4	USBLM[2] Status	USFWS[3] Status	ORNHP[1] Status	ORFW[4] Status
Birds *(continued)*								
Pygmy nuthatch *Sitta pygmaea*	G5/S3	SSC					4	SV
Veery *Catharus fuscescens*							4	
Gray catbird *Dumetella carolinensis*							4	
Loggerhead shrike *Lanius ludovicianus*							3	
Mountain bluebird *Sialia currucoides*							4	
Western bluebird *Sialia mexicana*							4	SV
American redstart *Setophaga ruticilla*							4	
Black rosy finch *Leucosticte arctoa atrata*							3	SP
Wallowa rosy finch *Leucosticte arctoa tephrocotis*							2	
Bobolink *Dolichonyx oryzivorus*							3	SV
Pine grosbeak *Pinicola enucleator*							3	
Mammals								
Preble's shrew *Sorex preblei*	G4/S1	SSC		S	S		4	
Townsend's big-eared bat *Plecotus townsendii*	G4/S2	SSC	S	S			2	SC
Spotted bat *Euderma maculatum*	G4/S4	SSC		S	S		2	

Table 5-8 *(Continued)*

Taxon	IDNHP[1] Status	IDFG[2] Status	USFS[2] Region1	USFS[2] Region4	USBLM[2] Status	USFWS[3] Status	ORNHP[1] Status	ORFW[4] Status
Mammals *(continued)*								
Fringed myotis *Myotis thysanodes*	G5/S1	SSC		W				
California myotis *Myotis Californius*	G5/S1	SSC						
Western pipistrelle *Pipistrelus hesperus*	G5/S1	SSC						
Idaho ground squirrel *Spermophilus brunneus*	G2/S2	SSC		S	S	C		
Northern flying squirrel *Glaueomys sabrinus*	G3/S3	SSC						
Pygmy rabbit *Brachylagus idahoensis*							3	SU
White-tailed jackrabbit *Lepus townsendii*							4	SV
Gray wolf *Canis lupus*	G4/S1	T/E				LE	2	LE
Fisher *Martes pennanti*	G5/S1	SSC		S	S		2	SC
Kit fox *Vulpes macrotis*	G5/SH	SSC						
River otter *Lutra canadensis*	G5/S4				S			
California wolverine *Gulo gulo luteus*	G4/S2	SSC	S	S	S		2	LT
Lynx *Lynx canadensis*	G4/SU	SSC		S				
Rocky Mt. bighorn sheep *Ovis canadensis canadensis*							4	
Beartooth copper butterfly *Lycaena phlaeas arctodon*							3	

Table 5-8 *(Continued)*

Taxon	IDNHP[1)] Status	IDFG[2)] Status	USFS[2)] Region1	USFS[2)] Region4	USBLM[2)] Status	USFWS[3)] Status	ORNHP[1)] Status	ORFW[4)] Status
Invertebrates								
Wallowa snowfield carabid beetle							4	
Nebria labontei								
Wallowa Mt. carabid beetle							4	
Nebria wallowae								
Peck's skipper butterfly							2	
Polites coras								

1)Heritage program ranks — G=global rank indicator; T=trinomial rank indicator; S=state rank indicator; 1=critically imperiled; 2=imperiled because of rarity; 3=very rare and local throughout its range or found locally; 4=apparently secure; and 5=demonstrably secure

2)IDFG, FS, and BLM ranks — SSC=species of special concern; T/E= threatened/endangered; S=sensitive

3)USFWS (Federal) status — LE=listed endangered; LT=listed threatened; C1-C3=candidate species

4)ORFW status — C=critical; V=vulnerable; P=peripheral or naturally rare; U=undetermined status

Table 5-9 List of special status plant species potentially occurring in the Hells Canyon area (Tier 1).

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Achnatherum wallowaensis	Wallowa ricegrass					1	
Adiantum aleuticum (subalpine ecotype)	western maidenhair fern		S		G5T2QS2		
Agrostis humilis	mountain bentgrass					3	
Allium aaseae	Aase's onion	SOC		S	G3S3		
Allium brandegii	Brandegee's onion		S	S		3	
Allium campanulatum	Sierra onion		S	S		4	
Allium geyeri var. *geyeri*	Geyer's onion		S	S		2	
Allium lemmonii	Lemmon's onion					4	
Allium macrum	rock onion					4	
Allium madidum	swamp onion		S		G3S2	4	
Allium tolmiei var. *persimile*	Tolmie's onion				G3S3		
Allium tolmiei var. *platyphyllum*	Tolmie's onion					3	
Allium validum	swamp onion		S		G4S3		
Antennaria aromatica	aromatic pussytoes	SOC	S			4	
Arabis davidsonii	Davidson's rockcress					3	
Arabis hastatula	Hells Canyon rockcress					3	
Arenaria rossii	Ross sandwort					2	
Artemisia arbuscula ssp. *thermopola*	cleft-leaf sagebrush					3	
Asclepias cryptoceras	pallid milkweed					4	
Astragalus atratus var. *owhyeensis*	Owyhee milk-vetch			S		4	

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Astragalus mulfordiae	Mulford's milkvetch	SOC		S	G2S2	1	LE
Astragalus robbinsii var. *alpiniformis*	Wallowa milkvetch					4	
Astragalus vallaris	Snake Canyon milkvetch				G5S2		
Balsamorhiza hookeri var. *idahoensis*	Hooker's balsamroot					3	
Bolandra oregana	Oregon bolandra		S	S		1	C
Botrychium spp.	grapefern						
Bupleurum americanum	bupleurum					2	
Calochortus macrocarpus var. *maculosus*	sagebrush mariposa		S		G4T2S2	3	
Calochortus nitidus	broad-fruit mariposa	SOC	S		G3S3		
Camassia cusickii	Cusick's camas				G4S2		
Camissonia palmeri	Palmer's evening primrose				G3S1	3	
Carex atrata var. *atrosquama*	blackened sedge					2	
Carex backii	Back's sedge					2	
Carex capillaris	capillary sedge					4	
Carex concinna	low northern sedge		S	S		4	
Carex haydeniana	Hayden's sedge					4	
Carex hystricina	porcupine sedge					2	
Carex norvegica ssp. *norvegica*	Scandinavian sedge					2	
Carex nova	new sedge					2	
Carex praeceptorum	teacher's sedge					3	
Carex praticola	meadow sedge					3	

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Carex pyrenaica	Pyrenaean sedge					3	
Carex saxatilis var. *major*	russet sedge					2	
Castilleja flava var. *rustica*	rural paintbrush					3	
Castilleja fraterna	fraternal paintbrush	SOC	S			1	
Castilleja glandulifera	glandular paintbrush					4	
Castilleja viscidula	sticky paintbrush					3	
Caulanthus pilosus	hairy wild cabbage					4	
Cheilanthes feei	Fee's lipfern		S	S		2	
Chrysothamnus nauseosus ssp. *nanus*	dwarf gray rabbitbrush				G5T4S2		
Cicuta bulbifera	bulb-bearing water hemlock		S	S	G5S2	2-ex	
Claytonia umbellata	umbellate spring-beauty					4	
Clematis columbiana var. *columbiana*	rock clematis					3	
Collomia macrocalyx	bristle-flowered collomia					4	
Corydalis caseana var. *cusickii*	Case's corydalis					3	
Crepis bakeri ssp. *idahoensis*	Idaho hawksbeard				G4T2S2		
Crepis modocensis var. *modocensis*	low hawksbeard					3	
Cryptantha propria	Malheur cryptantha				G4S1	4	
Cryptantha rostellata	beaked cryptantha					2	
Crypthantha simulans	pine woods cryptantha				G4SH	3	
Cryptantha interrupta	Snake River cryptantha					3	

Table 5-9 ***(Continued)***

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Cyperus schweinitzii	Schweinitz flatsedge					3	
Cuscuta denticulata	tooth-sepal dodder				G4S1		
Cypripedium fasciculatum	clustered lady's slipper		S	S	G3S3	1	
Cypripedium montanum	mountain lady's slipper					4	
Dimeresia howellii	dimeresia				G4S2		
Draba lemmonii var. *cyclomorpha*	Lemmon's draba					4	
Dryopteris filix-mas	male fern		S	S		2	
Eatonella nivea	white eatonella				G4S3		
Eburophyton austiniae	phantom orchid				G4S3		
Elantine brachysperma	short-seeded waterwort					3	
Epilobium latifolium	red willow-herb					4	
Epipactis gigantea	chatterbox orchid				G4S3		
Erigeron disparipilus	white cushion erigeron					2	
Erigeron engelmannii var. *davisii*	Engelmann's daisy		S	S		2	
Eriogonum ochrocephalum ssp. *calcareum*	ochre-flowered buckwheat				G4?T4SH	3	
Eriogonum scopulorum	cliff buckwheat					4	
Eritrichium nanum var. *elongatum*	pale alpine forget-me-not					4	
Festuca brachyphylla	alpine fescue					3	
Frasera albicaulis var. *idahoensis*	Idaho frasera					3	
Geum rossii var. *turbinatum*	slender-stemmed avens					2	
Gilia sinistra ssp. *Sinistra*	sinister gilia					3	

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Glyptopleura marginata	white-margined wax plant				G4S3		
Hackelia cronquistii	Cronquist's stickseed	SOC			G2S1	1	LT
Hackelia patens var. *patens*	spreading stickseed					3	
Halimolobos perplexa var. *perplexa*	puzzling halimolobos		S		G4T3S3		
Haplopappus hirtus var. *sonchifolius*	sticky goldenweed				G4T3S1		
Haplopappus radiatus	Snake River goldenweed	SOC	S	S	G3S3	1	LE
Heliotropium curassavicum	salt heliotrope					3	
Heuchera grossularifolia var. *grossularifolia*	gooseberry-leaved alumroot					4	
Hulsea algida	alpine hulsea					4	
Kobresia simpliciuscula	simple kobresia		S		G5S1	2	
Leptodactylon pungens ssp. *hazeliae*	Hazel's prickly phlox		S	S	G5T2S2	1	C
Lewisia columbiana var. *wallowensis*	Columbia lewisia					4	
Listera borealis	northern twayblade		S			2	
Lloydia serotina	alpine lily					3	
Lomatium cusickii	Cusick's lomatium					4	
Lomatium dissectum var. *dissectum*	fern-leaved desert parsley				G5T5S3		
Lomatium rollinsii	Rollins' lomatium					4	
Lomatium salmoniflorum	Salmon River lomatium		S		G3S2	2-ex	
Lupinus cusickii	Cusick's lupine	SOC				1	LE
Lycopodium annotinum	stiff club-moss					4	

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Machaerocarpus californicus	fringed waterplantain				G4S2		
Mimulus clivicola	bank monkeyflower		S		G4S3	2	
Mimulus hymenophyllus	membrane-leaved monkeyflower		S		G1S1	1	C
Mimulus pathless ssp. *pathless*	stalked-leaved monkeyflower		S		G3S1	1	LT
Mimulus washingtonensis ssp. *ampliatus*	spacious monkeyflower		S		G2T1S1		
Minuartia austromontana	southern mountain sandwort					3	
Mirabilis macfarlanei	Macfarlane's four-o'clock	T	S	S	G2S2	1	LE
Myriophyllum sibiricum	Siberian water milfoil					3	
Pediocactus simpsonii var. *robustior*	hedgehog cactus				G4T4S3	4	
Pellaea bridgesii	Bridge's cliffbrake		S			2	
Penstemon seorsus	short-lobe beardtongue				G4?S2	3	
Penstemon spatulatus	Wallowa penstemon					4	
Peraphyllum ramosissimum	squaw apple				G4S2		
Phacelia lyallii	Lyall's phacelia				G3S2		
Phacelia minutissima	least phacelia		S	S	G3S2	1	C
Pentagramma triangularis ssp. *triangularis*	gold-back fern				G5T5S1		
Pinus albicaulis	whitebark pine				G4S4		
Plantanthera obtusata	small northern bog-orchid		S		G4G5S1	2	
Plantanthera orbiculata	round-leaved bog-orchid					3	
Polemonium viscosum	skunk polemonium					4	

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Polystichum kruckebergii	Kruckberg's sword fern		S		G4S1	4	
Potomogeton filiformis	slender-leaved pondweed					3	
Primula cusickiana	Wallowa primrose		S	S	G4S3	2	
Ranunculus oresterus	Blue Mt. buttercup		S	S		4	
Ribes cereum var. *colubrinum*	wax currant					4	
Ribes oxyacanthoides ssp. *irriguum*	inland black gooseberry		S			4	
Ribes wolfii	Wolf's currant		S		G4S2		
Rubus bartonianus	bartonberry		S	S	G2S2	1	C
Salix brachycarpa var. *brachycarpa*	short-fruited willow					4	
Salix farriae	Farr's willow		S		G4S1	2	
Salix wolfii	Wolf's willow					3	
Scutellaria nana var. *nana*	dwarf skullcap				G4T4S2		
Sedum borschii	Borsch's stonecrop				G3S2		
Selaginella watsonii	Watson's selaginella					4	
Senecio porteri	Porter's butterweed		S			2-ex	
Silene scaposa var. *scaposa*	scapose catchfly		S	S		4	
Silene spauldingii	Spalding's silene	SOC	S		G2S1	1	LE
Stanleya confertiflora	Oregon prince's plume				G4G5S1	3	
Stanleya viridiflora	green prince's plume				G4S1		
Thalictrum alpinum var. *hebetum*	alpine meadowrue					2	
Teucrium canadense var. *occidentale*	American wood sage				G5T4S1		

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Thelypodium howellii ssp. *howellii*	Howell's thelypody					2	
Thelypodium howellii ssp. *spectabilis*	Howell's spectacular thelypody	C	S			1	LE
Thelypodium laciniatum var. *streptanthoides*	thick-leaved thelepody				G5T4QS2		
Trifolium douglasii	Douglas' clover					1	
Trifolium plumosum var. *amplifolium*	plumed clover				G3T2S2		
Trollius laxus var. *albiflorus*	American globeflower		S	S		2	
Viola canadensis var. *rugulosa*	western Canadian violet					3	
<u>Lichens</u>							
Aspicilia fruticulosa	rim lichen				G?S1		
Cladonia transcendens	reindeer lichen				G5S2?		
Collema curtisporium	short-spored lichen				G1S1		
Collema furfuraceum	scurfy jelly lichen				G5S1		
Lobaria hallii	Hall's lungwort				G4S1		
Lobaria linita	smeared lungwort				G4S1	2	
Lobaria scrobiculata	pored lungwort				G3G4S1		
Physcia semipinnata	dot lichen				G5S1		
Texosporium sacti-jacobi	wovenspore lichen	SOC			G2?S2	3	
Thamnolia vermicularis	worm lichen				G?S1		
<u>Mosses and Liverworts</u>							
Buxbaumia aphilla	leafless bug-on-a-stick				G2G3SH		
Buxbaumia piperi	Piper's bug-on-a-stick				G4S1		

Table 5-9 *(Continued)*

Latin Binomial	Common Name	FWS[1]	FS[2]	BLM[3]	Idaho Rank[4]	Oregon Rank[5]	State of Oregon[6]
Barbilophozia lycopodioides	liverwort					3	
Crumia latifolia	moss					2	
Preissia quadrata	liverwort					3	
Tortula mucronifolia	moss					2	
Ulota megalospora	large-spored ulota				G?S2?		

[1]FWS (U.S. Fish and Wildlife Service):

E= Listed Endangered
T= Listed Threatened
C=Candidate (U.S. Fish & Wildlife Service has sufficient data to support listing as endangered or threatened)
SOC=species of Concern (Species for which the U.S. Fish and Wildlife Service has insufficient data to support listing endangered or threatened)

[2]FS (U.S. Forest Service; includes ranks from Regions 1, 4 or 6)

[3]BLM (Bureau of Land Management)

S=sensitive
W=Watch; species that need status monitored
R=Review; species that need more data to determine status

[4]Idaho Ranks (determined by Conservation Data Center, Idaho Dept. of Fish and Game):

G=Global rank indicator; based on rangewide status1=Critically Imperiled
T=Trinomial rank indicator; status of infraspecific taxa
S=state rank indicator; based on status within Idaho2=Imperiled
3=Rare
4=Not Rare
5=Widespread

[5]Oregon Ranks (determined by Oregon Natural Heritage Program)

1=threatened with extinction
2=threatened with extirpation
3=more information needed
4=rare, but currently secure

[6]State of Oregon (Oregon Department of Agriculture)

LE=Listed Endangered
LT=Listed Threatened
C=Candidate (Native plant species that need further study to determine their conservation status)

Table 5-10 Plant communities thought to be rare in the Hells Canyon study area and their ranks as assigned by the Idaho Conservation Data Center and Oregon Natural Heritage Program.

Plant Community Type, Association or Habitat Type

Common name	Scientific Name	Rank[a]	Rank[a]
sand dropseed/Sandberg's bluegrass[1,2]	*Sporobolus cryptandrus/Poa sandbergii*	G2?S1?	G4S3
bluebunch wheatgrass/Wyeth's buckwheat[2]	*Agropyron spicatum/Eriogonum wyethii*	G2?S1	G4SU
antelope bitterbrush/bluebunch wheatgrass[2]	*Purshia tridentata/Agropyron spicatum*	G3?S1?	G3S1
western juniper/Idaho fescue-bluebunch wheatgrass[2]	*Juniperus occidentalis/Festuca idahoensis-Agropyron spicatum*	G3?S2	G3S2
buckwheat/Oregon bladderpod[2]	*Eriogonum spp./Physaria oregana*	G2?S2?	G2S3
stiff sagebrush/Sandberg's bluegrass[1,3]	*Artemisia rigida/Poa sandbergii*	G4S2?	G4S3
netleaf hackberry/bluebunch wheatgrass[3]	*Celtis reticulata/Agropyron spicatum*	G2?S1	G3S3
grand fir/pacific yew/queen's cup[2]	*Abies grandis/Taxus brevifolia/Clintonia uniflora*	G2?S2?	G2S2
grand fir/goldthread[2]	*Abies grandis/Coptis occidentalis*	G2?S2?	G2S1
grand fir/mountain maple/ninebark[1]	*Abies grandis/Acer glabrum/Physocarpus malvaceus*	G3S2	G3S3
ponderosa pine/Idaho fescue[2]	*Pinus ponderosa/Festuca idahoensis*	G3S2	G4S2
ponderosa pine/antelope bitterbrush/bluebunch wheatgrass[2]	*Pinus ponderosa/Purshia tridentata/Agropyron spicatum*	G3S2	G3S3

[1] community type

[2] plant association

[3] habitat type

a Ranks: G = global S = state, 1 = very rare, 2 = uncommon, 3 = common, 4=abundant

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1965

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	23246	60729	44835	24761	57971	34493	25859	12471	13114	18788	16533	15145
2	19227	54810	43602	22162	60253	32241	23104	13081	10649	14354	16245	16522
3	21252	51682	43082	25611	57218	32580	22279	12531	10752	15619	16143	17725
4	21598	49266	43082	23091	54139	31952	22235	12042	12723	13850	16834	16940
5	20466	48390	42519	23817	54057	33526	23506	13521	16002	14441	16018	18471
6	20795	48037	40303	24902	51882	31314	21546	13174	13682	14741	15545	17826
7	24587	47196	43015	25342	48267	32133	25264	12840	10863	15697	16921	16120
8	23723	48271	42274	26623	43392	29124	19782	12809	15703	15493	16138	19486
9	22455	46567	43783	27528	43917	30128	20603	13323	16007	13805	14870	21150
10	22993	48081	42301	29543	43631	29446	19499	13728	13487	15526	16019	21041
11	20750	45287	43070	29188	43408	30322	18415	12318	12981	15446	17536	22045
12	20699	43793	41230	29215	42673	31373	17832	13867	17967	14485	16018	21936
13	21606	42226	42691	32218	44250	34135	14783	13985	15393	14132	16361	21114
14	22737	40313	41615	36494	39957	31921	14915	15183	13975	15678	18422	20534
15	22769	40469	41831	37060	36851	31950	15225	14205	15068	16572	21820	21276
16	22210	40334	37416	38653	41416	32408	12524	15386	15871	15836	17292	19872
17	23190	40206	39999	43312	36588	33082	12230	14669	11836	15037	13432	20781
18	23682	39735	39401	44666	36611	33780	12162	14762	17251	17057	18052	20823
19	24194	40685	38219	45199	34965	31657	12222	19583	14532	15491	16689	20216
20	22274	39530	37903	48107	33732	34335	11223	15202	13827	16754	17752	20007
21	24823	42797	32622	58686	33990	32860	12817	13777	17057	14440	16997	21367
22	25187	38291	29753	60840	31832	31224	11548	16332	14737	17439	18561	20025
23	26015	39207	29859	59076	33998	31784	12768	17471	15549	15659	17162	20917
24	28083	40485	30017	57033	37424	31385	12182	15997	15701	15965	16850	21626
25	32468	39454	28228	54431	34956	30668	12702	14258	15602	16217	16988	21156
26	30823	41326	29571	54588	33885	31940	10336	13659	18327	17349	17390	19952
27	29203	42688	27759	53629	34328	29418	13750	13417	14443	16792	17035	21365
28	33378	46566	27389	53879	35320	31546	12483	14235	14869	16642	17270	21279
29	43588	---	25941	53531	34395	27861	13209	17573	15133	15884	16468	19415
30	63571	---	23437	55466	36457	25397	10608	12235	14094	15349	16473	20108
31	66646	---	22922	---	38055	---	12712	13243	---	16362	---	19731

Table 6-1.1

Table 6-1.2

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1966

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	19629	19242	16931	17631	12005	13013	9113	10541	11887	11464	14106	13039
2	20099	21052	18606	17766	8656	14147	8142	9802	11692	12375	12249	15097
3	17792	20472	17853	19093	10988	13347	9864	10443	10335	12144	14065	12918
4	18843	18853	18139	20037	12318	12390	9205	9791	11294	13343	13830	16056
5	18851	19048	19300	18001	11715	12812	10141	9331	10916	12686	12691	16327
6	20402	19686	18171	17981	13338	12715	8813	9235	12504	12883	13294	15575
7	20183	17632	19589	16967	15950	12179	9281	9195	10596	13039	13763	14340
8	21634	18919	19346	17744	14740	11501	7958	10596	12201	12443	13204	13748
9	23161	20658	21779	16820	14693	11365	9738	10147	11649	12603	13809	14428
10	19959	18693	23423	18546	14718	12524	7891	9535	11139	14227	13318	12092
11	21786	19394	22317	17049	14708	12163	8374	9443	11600	13371	13456	13470
12	19781	20877	19874	16210	12693	12825	10049	9090	11399	13221	14266	13897
13	21047	19841	16845	15233	13278	11174	9503	10677	11073	10940	16878	13515
14	19474	19288	19421	16730	13564	10972	9061	9691	10864	13421	11960	14424
15	21179	18563	17576	13695	13701	12145	8435	9854	11966	13459	13375	15081
16	21276	19273	19189	15047	12406	10517	8913	7843	12981	13972	14465	14137
17	22803	19459	16905	12101	13580	10148	9026	11567	12176	14690	13982	13316
18	21673	18911	17798	15618	12420	9622	10419	10042	13149	13042	14025	13575
19	20384	19291	15976	13531	10475	11599	10172	9180	13293	13604	13215	13015
20	23050	20766	16416	12574	11607	8908	9298	9601	12174	13446	12519	13774
21	21900	18666	17271	10142	11283	10099	9634	10915	12527	12720	14180	13196
22	22330	18414	20975	11027	12625	8244	10039	9334	12124	12906	14991	13412
23	19784	19604	18198	11284	13121	8979	9208	8710	11680	13228	11895	13473
24	18945	18386	17224	11675	12188	8820	8825	10058	11302	14462	13218	12648
25	20127	19696	16907	12486	11914	9916	9648	9398	11710	14352	12454	12166
26	22446	20243	16320	10584	11422	10414	8993	10608	11738	13083	12404	12754
27	20961	19038	15937	11998	11466	8823	9456	10035	12390	13690	13082	12147
28	20921	18925	16721	9975	12346	9308	10240	10468	12439	13797	13960	12590
29	20017	---	15602	10961	14545	9566	9660	12056	10389	14403	13719	12771
30	18972	---	14814	10401	12538	8597	10564	9999	12994	14213	13298	13378
31	20497	---	15318	---	14545	---	8223	10551	---	12532	---	12534

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1967

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	13452	20439	12753	10393	9679	24363	20138	8461	12133	13124	15288	15900
2	12318	17839	12785	12809	12850	22251	19515	10960	9623	17413	15890	14685
3	13192	16639	12514	11074	13188	22000	14824	9868	11124	15927	14782	15252
4	12185	15967	13627	11265	10377	21909	22631	9423	11207	18871	15548	16047
5	11990	12824	11936	13134	12617	22892	14980	9824	12106	15985	16552	16158
6	12951	13830	11188	13078	11451	21723	14288	10619	10794	18739	15242	14648
7	12867	14667	11076	13248	12384	28036	14169	9155	12491	10968	15499	16553
8	11838	14374	11869	13467	12252	23400	14304	9775	10470	15014	16900	14742
9	12588	12867	11376	14034	14955	26235	13421	9829	12888	15180	15595	15751
10	12523	13589	11602	14358	17895	26150	13742	10370	12509	17600	15147	16565
11	12724	12925	12751	14968	18865	24865	12968	10415	12999	10484	16618	17791
12	13084	13633	11958	16054	18943	24945	13538	10581	13690	13422	16860	15722
13	11668	13463	11376	12241	18095	24285	12937	11371	14436	17464	14488	16168
14	12035	12204	13396	13633	16686	23176	12170	10327	14190	15043	16200	15717
15	12643	11269	13361	12351	15214	20461	9161	8675	14191	14008	16687	15464
16	13000	13365	12492	13571	17647	24191	12856	11101	14084	14535	14893	13960
17	13654	13738	14066	12638	16962	23456	9677	9030	13350	12807	16342	15527
18	11953	11375	16371	9844	18543	23338	10007	10483	14885	14159	15534	16345
19	13025	12380	10384	11016	21172	23965	8512	9739	13590	14248	14846	18795
20	12243	12102	12665	11273	20276	26364	9979	11228	13442	15347	14926	16940
21	14529	12828	12236	12318	22954	33312	11285	8644	11928	14192	16894	16574
22	16325	12516	14641	13139	22744	35322	8863	9131	11988	15460	14570	17930
23	15032	11444	14260	11927	25097	34522	11551	9788	12094	14056	15011	16572
24	12658	12204	13010	9385	26075	33474	9690	10038	14638	16563	15246	14721
25	15843	11768	13462	10140	26892	28781	10094	10202	11042	13996	16801	14914
26	14200	11679	14547	12710	24822	29954	10709	12411	13911	13251	16101	16413
27	14894	12813	13975	11470	22829	24152	10880	10095	11454	13324	13977	16349
28	16558	12275	12737	12346	21778	22788	9317	8686	12861	14649	15686	16450
29	22508	---	14191	14754	20843	21975	9668	10164	11954	14981	14676	17240
30	31968	---	14480	12017	20797	20566	10277	11296	12907	15281	14539	18094
31	21899	---	12331	---	21862	---	10557	10387	---	17243	---	16680

Table 6-1.3

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1968

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	18087	13327	22169	11438	10847	12848	8800	8935	12610	15465	19341	15400
2	18221	13080	22889	13533	9282	15007	9475	7537	11817	7959	12259	17300
3	16255	14647	21332	13879	9780	14345	9085	9206	9040	14400	14700	12757
4	16689	16573	18204	7305	9318	13933	8690	10042	10658	13200	19341	18000
5	15329	14890	18896	15949	11674	14853	9684	9282	11073	13000	16400	13059
6	19491	16099	19293	15619	9518	14830	9895	10590	12808	13300	16800	16900
7	14220	16263	20656	12803	11255	13629	9745	9236	13044	14000	16700	18200
8	10435	15604	19796	12198	10781	15920	8477	10099	10449	13100	14959	16400
9	14876	15139	20451	13757	9917	15653	8688	7846	12045	14300	17100	14700
10	15332	12482	17937	10788	9299	17756	10532	10313	10949	14400	19641	16700
11	16234	17211	13141	12095	10710	15465	8082	9618	11899	13900	12159	12357
12	15575	18197	13447	12329	11117	14837	8802	10197	12899	11800	15900	16900
13	17387	15942	14174	11097	11842	15587	8056	12211	11236	17341	17300	17600
14	16290	14790	10271	11911	14174	16703	9798	11195	10751	14500	20341	14100
15	14936	19841	12535	11152	10742	13650	8486	13190	12816	13700	18700	18643
16	15890	15208	14730	13198	11586	11768	9023	15615	11549	15400	18600	17200
17	15531	15008	13711	9662	10397	12479	9529	14153	13306	13900	17500	17400
18	16234	15475	11354	11078	12222	15894	9118	13395	11042	17500	12759	19600
19	17001	21466	11862	8305	11397	14503	8836	18500	11595	13600	19900	16557
20	17002	30382	13107	8930	12798	18194	8841	17137	12205	17100	11557	17859
21	18696	33469	12640	12105	15134	21270	8170	20688	13161	16000	16100	17317
22	13600	35111	12478	8414	15270	18579	10448	23632	14103	10859	13700	12776
23	14454	31532	12109	9972	15091	16005	8885	15384	15909	16300	20543	15617
24	14264	34529	13101	10264	14033	11343	7925	11082	13385	16500	12900	14358
25	15321	30811	12011	9256	13140	11350	8793	18777	10939	13700	17100	25942
26	13726	26573	12704	8554	14292	9088	9998	18947	16510	15500	14800	15158
27	13872	25685	13290	8980	15160	9438	7803	11153	11741	15000	15800	20157
28	14627	26738	13068	9940	12527	8019	9912	14697	14155	14800	19341	16359
29	15425	19790	12868	9442	12694	8570	9190	13305	12105	15700	11959	15316
30	14469	---	12626	8229	13415	9555	8941	14492	14761	13400	14800	22559
31	16873	---	14363	---	12654	---	10652	12453	---	13100	---	16617

Table 6-1.4

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1969

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	15716	24700	24267	42496	38521	23183	15900	11000	14900	12991	13800	12672
2	20959	23559	34641	48079	38208	23983	13800	9740	11459	16300	14204	12263
3	14917	26058	23592	51016	33446	18842	14100	13322	11457	11996	13592	12466
4	16117	19958	29270	50988	32250	18141	12100	10200	13400	14610	13687	13775
5	19500	21059	30116	50396	30384	21785	14600	6458	12700	15729	14406	14183
6	19659	28300	26780	45900	33321	26724	8330	13600	10900	14503	14294	12383
7	15757	25300	23442	53974	31554	23824	10400	7459	13413	15897	12588	13400
8	24400	20000	25888	47471	33362	23105	10600	9960	12557	17894	14100	15391
9	20158	22058	29051	46688	33654	28283	14800	9160	15100	15184	15200	11655
10	20960	27642	30375	44388	34675	24400	9559	15041	12900	17087	12171	13671
11	22058	19758	27729	38345	32659	24300	10600	11700	13100	15884	11379	14570
12	17516	29542	25168	43251	31554	28841	8900	9120	8159	15487	15104	11871
13	22359	26600	25795	42233	30525	17159	12681	13800	12341	14288	13789	12588
14	25241	30641	26197	42849	37475	29400	12149	8559	16343	16304	14487	14400
15	28442	24400	24479	42967	30721	22257	12800	13100	12800	14488	12396	13483
16	29642	31642	25601	39859	35450	23059	10200	7757	14500	15400	12500	15775
17	25582	29958	28116	38896	30625	20500	9620	8660	13900	13808	13488	11976
18	20742	22076	26104	34183	29221	10057	9630	12600	14300	14108	12887	12183
19	27084	30015	35709	33412	32932	11400	10700	8259	8557	15721	14288	13103
20	25442	22134	27429	33984	32133	15843	8160	13700	16443	13400	13596	14321
21	32941	30059	27317	33091	31825	16541	10200	11500	10200	15204	12378	14933
22	39242	28058	32504	32291	26083	14413	10200	7557	19841	14796	13392	15300
23	37283	26916	35322	36221	29484	12900	10200	11200	15200	14083	13600	16204
24	34443	27176	34591	42183	28582	20641	13441	7750	14800	14088	12792	14421
25	27600	31217	32158	42400	24084	19100	8540	10600	12159	14396	15596	14412
26	28900	28229	35137	45686	24883	18700	5400	11100	17600	16416	12492	14000
27	32241	29743	35884	42946	29326	18800	15642	8510	16100	15206	12396	14693
28	28400	26616	34471	38399	29525	19200	9220	13053	13700	12300	12578	12986
29	28600	---	43304	38621	23083	20300	10900	9800	14400	14204	12279	13379
30	24959	---	43104	39633	23594	15300	9750	12771	14400	15020	14296	14076
31	20057	---	47288	---	26925	---	7658	16524	---	15517	---	12362

Table 6-1.5

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1970

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	14184	22082	14653	16780	18375	32720	32659	11095	12688	14647	19223	21716
2	13253	21376	15697	15146	22589	34833	32342	10597	11192	15104	17400	18196
3	11943	21366	18766	12633	21709	36414	28646	11200	11475	13492	18400	20696
4	14750	23955	17066	15214	21504	35066	30025	13100	12712	16004	14077	18596
5	10425	14737	17916	15229	22819	36051	32190	11492	14633	15396	14882	20104
6	12443	17239	16699	16324	29148	35173	29780	10594	15237	13175	16783	17804
7	15454	18450	17338	16218	26650	32267	16295	8870	16000	14796	12806	25029
8	12746	16441	20704	13807	26779	32533	17995	13821	15984	14992	15511	29779
9	11350	17483	13986	16540	26732	31321	13200	8284	16691	13900	17504	25155
10	12555	18805	20527	17577	30614	29804	16817	10494	14980	15020	17604	32036
11	16574	17700	18392	18778	31426	27254	12088	11300	13170	15525	17710	22788
12	13171	22217	17999	22858	31544	26984	12600	11309	14789	16304	18700	22977
13	14696	26742	18300	25844	32022	25800	10895	8445	16587	16500	18303	19136
14	22842	25258	20585	19764	31009	27683	14517	14508	12696	15709	17379	17930
15	23880	18946	18705	21785	26018	29192	13183	10145	13392	19020	14879	20849
16	22442	22935	18950	16994	28696	34187	9884	12112	15596	16500	22481	20251
17	26979	21028	20798	19826	33080	39638	11192	10800	13808	17700	16133	17443
18	26995	23129	19148	21401	38753	39637	9087	11703	14808	17096	18054	17741
19	29626	21309	19654	27554	32254	38900	12913	9784	13308	15800	16245	20770
20	36040	20804	17798	26159	38321	35508	12203	10603	18842	17410	17351	18355
21	28697	20512	18050	21573	33121	38417	8958	12112	16097	19200	16343	19159
22	37137	20622	18201	19901	32704	39789	11405	11100	16591	18700	23700	20369
23	41609	18712	17791	18347	38396	34694	9795	11209	18180	18387	10000	18160
24	43475	21732	16387	19940	36745	36050	9935	14916	15783	17779	16875	16645
25	45062	19111	17015	18130	51967	29633	13408	11980	14079	19292	20325	17253
26	35950	16226	16907	14612	44404	27009	10000	7575	18200	15588	24183	18388
27	38929	18800	16261	16280	43016	21895	10992	11305	12400	17708	19634	18888
28	42571	13775	20086	17315	42766	29495	10355	10195	17706	19304	20057	21083
29	31413	---	15244	12615	42495	30275	13308	10700	15400	14904	21567	20070
30	30327	---	19352	15353	39779	30067	11292	12250	14694	16513	20818	20679
31	25275	---	17596	---	39554	---	11595	12703	---	16225	---	19384

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1971

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	20596	29208	25380	47607	51920	44552	48192	7680	11866	17350	25660	25756
2	19888	33096	26245	50290	57492	41178	47491	12908	11871	17015	23141	25950
3	18879	39096	22201	51018	55698	42487	46196	9885	14396	18285	26894	25808
4	19858	38608	22721	55414	56902	36762	44496	10395	13496	20915	26028	25921
5	17350	34188	23213	55228	60829	41305	40479	10997	12800	23341	25843	25200
6	17271	36400	22301	52059	57421	42411	38896	10200	15096	24150	26546	25581
7	16271	29124	23991	53572	58073	44725	30696	10503	13492	22513	27266	26143
8	15875	32760	26382	55549	58003	42404	27358	12805	14191	23815	24748	25399
9	21305	30520	23195	57542	59156	47349	26042	11200	14192	23807	26714	24009
10	20108	30125	26592	60751	61603	47738	23005	11095	14588	23186	26838	24448
11	23232	33064	25316	55852	63467	43309	18288	11605	13991	23116	26249	23597
12	21200	31849	29212	65515	61451	39990	21012	11495	14109	25181	25866	25237
13	21300	32343	30973	58320	63265	38163	14688	10592	13675	23936	24952	24888
14	22505	33753	31141	55802	64139	39457	18912	10497	12187	24198	23767	24691
15	25116	40268	29493	54088	64057	38060	10375	9886	15089	23659	22358	24515
16	32558	33834	27125	56502	59376	37457	13803	11800	13075	23209	20810	23394
17	42513	37042	26784	54323	59563	36537	14022	10125	12878	23685	20774	23408
18	49646	36937	26498	54435	57546	37746	13608	11395	13996	24355	22560	22445
19	63575	36024	29679	55078	53626	39037	13005	10295	14408	24972	25015	22825
20	62999	38643	26013	54341	50709	38841	12903	11497	14692	25526	25107	23562
21	61317	30815	29312	56147	47397	38930	13109	11603	14688	25845	25551	24837
22	56845	35827	33786	58031	48495	38313	12191	10669	14387	25729	25788	24260
23	47900	34120	33083	53024	45176	32321	11984	13003	14288	26000	25414	26938
24	46989	32004	37168	52139	47992	40653	14203	10389	14092	26009	25366	27217
25	41138	34914	44300	55143	52538	39906	10488	11208	13696	25423	24272	26183
26	39245	31200	52741	52117	48147	39487	10288	13105	15924	25424	25580	27122
27	40475	28360	61109	57549	44621	47488	12109	12395	15800	25956	26232	25609
28	43392	25193	54508	55217	45900	51800	11500	11100	15000	25820	28560	22350
29	27584	---	53923	55480	46878	50616	11600	9738	15300	26464	30608	24286
30	37188	---	54441	56883	51032	52221	12403	15212	17121	27827	29200	23874
31	34000	---	45418	---	43421	---	12700	11497	---	27939	---	21526

Table 6-1.7

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1972

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	24254	30368	59128	48436	36238	39769	23301	11457	12187	17936	21897	21952
2	24295	30114	57473	47299	35341	36272	22170	11245	12904	17794	22788	19373
3	24503	29485	54725	46351	34447	35603	19458	11813	12375	18474	22347	19505
4	26576	29481	55651	47822	35133	34681	17727	11442	13652	17705	23706	23749
5	24266	29052	62799	50390	37050	32204	16063	11323	13023	18102	24173	23745
6	23314	29949	59290	52755	37781	30873	12955	11368	14467	18285	24657	21536
7	22840	29093	56474	51892	37720	32143	13694	11631	14595	19569	25083	21917
8	22075	29401	56616	50588	37574	35642	11531	11687	16171	21008	24712	22095
9	22195	30352	57977	48720	39101	40606	12364	11234	14059	23546	23692	18598
10	23833	29588	57889	47801	37324	47467	11726	11415	15409	25477	23693	17720
11	22687	30463	61778	48055	35703	54871	11550	11091	14806	25125	25545	19213
12	23200	31707	64596	48189	33222	52081	11234	11219	16029	24425	22802	18285
13	21724	31764	68419	46964	34321	48443	11515	10982	17239	26070	20435	18417
14	22958	33332	69013	47882	33309	45829	10713	11781	17523	25572	21155	17947
15	24884	32975	64556	47723	34951	45092	10852	12567	17770	24823	23145	18535
16	25129	33447	60104	46435	39123	46597	10802	11975	17184	24686	22782	18771
17	23600	35198	58080	47768	41262	43825	10943	12141	16780	25707	24359	20049
18	25557	35168	57475	48107	44482	43456	10444	12809	16176	24956	23218	22320
19	29721	35073	59851	46695	38242	42000	10049	12707	17260	24622	23167	24200
20	37177	37211	59017	46018	35103	39272	10779	12534	16857	25428	23845	25461
21	55476	38830	55494	43955	34525	37078	11154	13665	15880	26437	23725	27793
22	52297	39943	53502	43091	35218	33252	11308	12734	16262	26002	23124	33591
23	43201	41368	53172	42308	39074	32095	11548	13175	16010	25059	23265	37213
24	40582	39858	53733	40246	39678	30912	11868	13338	16099	24720	22306	35726
25	41834	38368	53832	39352	37185	30250	12310	12812	15801	24312	22965	32078
26	39869	37874	52574	38547	33298	28614	11205	13172	17728	23700	22357	29165
27	35905	38250	52509	39567	34888	27107	11975	13120	16174	22264	22681	27790
28	35605	43844	51943	37947	36600	25790	11012	13385	17837	18649	23338	28169
29	32767	56468	49250	37671	37497	23076	11280	13010	17710	15637	21895	27076
30	30396	---	47840	38276	38405	25088	11382	12104	17133	16302	21656	26003
31	31593	---	46787	---	40413	---	12064	13258	---	19566	---	25700

Table 6-1.8

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1973

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	25281	21265	27644	16306	17125	15475	9132	10296	11660	16924	13630	22190
2	24038	22913	29611	16424	16545	14625	9373	10387	11754	15270	14333	23667
3	24162	23295	27618	16868	18462	14351	9568	10472	12828	15848	14789	21590
4	22519	22632	26791	18295	16616	14227	8820	10571	13837	14623	13939	19910
5	22785	22539	25583	19073	16267	13550	9714	10487	14100	13834	15262	19093
6	22023	23523	25133	18909	16003	13220	9177	11084	13589	14451	15616	19220
7	20568	23781	25516	18940	16578	13484	9394	10897	13191	14041	16186	20445
8	19769	24030	25258	21319	15391	11713	8894	10916	13220	14691	17700	22828
9	21262	23299	24748	22778	15091	13016	10043	10239	13175	14754	17334	20818
10	23686	24116	24226	21551	14691	11519	9265	10773	13473	14637	17762	20732
11	21866	24575	25287	20743	13588	13078	8924	10640	13284	15240	20517	20418
12	21228	25773	24004	19990	13655	12277	8357	10070	12626	15626	21327	20666
13	22264	25740	22197	21976	13102	11065	9008	10883	13281	15733	22424	19581
14	26307	25719	21983	22387	14409	10726	9434	10681	12771	15259	21982	20209
15	27879	25623	21756	25460	15029	11943	9255	9657	12521	15385	22640	18595
16	33932	24833	21381	25123	16045	12416	9843	9880	13126	14379	24359	18982
17	43174	23350	20565	26976	16903	13168	9500	9884	13168	13745	23581	20953
18	33024	23393	22036	29750	16912	14154	9296	9769	13963	15134	21539	28214
19	31027	23203	21610	26950	17426	13984	9146	9740	14347	13971	20950	23661
20	29780	22085	22027	26646	16944	12751	9791	10399	13640	13734	19422	22076
21	27327	21360	23908	23089	15385	12852	9493	10245	14600	13613	18420	21848
22	27196	21519	22468	22145	15742	11637	11314	10571	14900	13390	17508	19775
23	25450	20955	21395	21953	15415	11471	11770	10249	15340	14392	18246	24591
24	24880	20869	21406	20623	16287	10882	11783	10371	14859	14015	18677	22842
25	25860	21152	21621	19624	17393	14416	11200	10689	16283	14464	18618	20130
26	25011	22270	22544	19994	17892	11679	11841	11243	18043	13201	18961	19905
27	24220	23247	22006	18573	16298	11212	10549	10962	17272	13694	18676	18553
28	22683	26112	21195	16158	15199	11319	10179	11489	16904	13917	19214	19236
29	22721	---	20404	16827	16660	10492	10570	10161	16950	13770	19710	19848
30	22326	---	17403	16532	15528	9544	10110	11931	15044	14025	21636	17954
31	21880	---	17757	---	14401	---	10736	11247	---	14229	---	20334

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1974

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	20273	26719	33327	59355	46928	35540	33828	9690	11063	14753	17557	17866
2	19566	26364	35644	61845	48114	36952	33776	9370	12218	14665	17418	17487
3	17339	24396	34573	59430	46352	39741	31275	10575	12156	15886	17233	17285
4	16515	24122	31494	56649	41043	41333	27757	10098	11415	15589	17999	17971
5	15497	24061	28873	53969	45812	41835	27696	11043	11958	15256	17560	18635
6	15721	23737	32894	50276	47059	44539	26455	11123	12686	13871	17666	19135
7	19530	23758	34306	50793	48961	41685	26092	10385	12478	14649	17822	19429
8	16666	24058	34913	50517	50027	38809	26440	10502	12364	15233	18689	18821
9	15229	24017	34276	49744	52596	36709	26262	11480	12982	16279	18330	18551
10	14503	25195	36876	49916	51893	36484	23697	10913	13175	16426	17793	18276
11	14848	24733	37746	48883	47386	36630	23373	10904	12313	17168	17029	18756
12	14492	23591	39096	46388	46316	37579	23249	11386	13747	17571	17005	18571
13	16603	23319	43345	47299	45228	39051	20246	11082	13625	16466	15935	18566
14	18401	24183	41814	46432	44081	40410	20275	11719	13785	17498	15719	19765
15	30252	28380	41468	48467	41640	42226	16927	11617	12731	17591	16401	19376
16	46230	23493	43366	49893	40200	43426	16463	10961	14297	17838	15768	19799
17	49336	28119	47757	50650	38798	43981	13960	11564	14207	16299	16470	19067
18	44810	28168	55248	49779	35772	42741	12369	10712	14593	17185	15291	20053
19	44975	28100	56662	49750	34741	43681	11906	11820	14239	16151	17698	19753
20	40516	29276	54407	48158	33918	41452	11520	11710	14285	15178	19260	19728
21	35249	32219	51604	49750	32332	43197	11048	11350	14416	16412	19214	18876
22	29907	31719	52848	51439	32376	40509	10732	11438	14282	16809	17920	20048
23	27981	29393	50936	50502	31005	40379	10268	11797	14474	16256	16216	18901
24	27257	28302	49541	53249	33191	40971	10002	11105	14493	16619	16614	18435
25	25339	27838	48184	57582	33394	42896	9639	11436	14509	16543	17544	17457
26	24757	27965	49271	54907	36255	42463	10408	11924	14329	16320	16920	17353
27	24770	29795	51012	51477	38789	40796	9376	11640	14765	16574	17737	16977
28	23563	29879	48696	48474	40550	39177	9690	11657	13769	16872	17898	19684
29	22160	---	48147	46690	41303	36525	10091	11586	13600	17924	17815	20606
30	22460	---	54791	42243	41028	39819	9514	11452	14196	18103	17597	20252
31	23029	---	52050	---	32612	---	10668	11495	---	17363	---	20133

Table 6-1.10

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1975

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	19451	19706	25441	38976	51542	47979	20627	11635	13506	15293	18864	21252
2	20028	20032	28567	38814	52628	47658	21436	9896	13756	17686	18278	20749
3	19630	20487	30522	41223	53885	50324	21258	11123	13283	15967	17860	23686
4	19403	20629	32104	42903	55183	49036	18085	12164	14386	15053	18081	23914
5	18400	20974	30805	40852	54849	46922	18737	10800	14649	15522	18720	26097
6	20176	20844	30903	38929	49048	48132	18596	11051	14941	16045	17628	24981
7	22367	20257	29960	37138	49125	48970	19636	10240	14558	17225	18362	25484
8	20635	20586	32470	39823	49358	47057	19977	10542	14819	18824	17990	27818
9	22758	20853	39115	40225	49441	44821	17346	10797	13298	18286	18741	27727
10	21162	21613	35424	39950	50534	43518	17996	10930	13763	18508	17991	26873
11	21261	21639	32761	39168	54515	39166	15201	11615	13800	18623	17727	26770
12	20294	22647	30892	39303	59522	36309	15829	11537	14254	19214	17312	26484
13	20823	28966	28308	41255	57610	37593	16988	10790	13899	19639	17060	26081
14	19865	33168	26882	42371	64046	36208	17628	10808	13586	21985	17967	24164
15	20316	27701	25959	47757	63474	32692	16473	10665	14027	21142	17410	23733
16	20972	27241	23865	52485	64564	32609	14844	11145	14499	19727	17400	22542
17	20459	24954	27159	53216	63115	27658	13939	11891	15118	18713	17187	21462
18	20437	22992	26652	52875	63526	28046	12888	11779	14501	19706	19227	20116
19	20235	23167	32924	52761	62990	31506	13807	13457	14985	19240	19906	20243
20	20022	23685	33170	52903	61384	30148	12551	14865	13831	19109	19251	21190
21	20227	23511	35036	52801	57838	30784	12219	15999	14420	18243	18394	19824
22	19707	22081	36497	52188	55549	29957	11908	14274	15225	20450	18190	21505
23	20084	21038	36523	54130	53162	29389	11436	15691	15268	17969	19714	22080
24	20759	22866	36907	55796	52518	31968	10944	15965	16090	18358	20261	21860
25	20468	23069	40378	57843	51246	35173	10485	16131	14865	18148	21515	23601
26	20442	22435	41476	50475	48066	34504	10523	15245	15682	17534	21658	23303
27	20024	23191	38138	54435	46987	33352	10117	14813	15463	18765	21300	23885
28	19916	23927	40327	54568	44332	30162	11187	13930	15425	19225	22194	23973
29	20987	---	38023	53243	46775	25223	10531	13058	16067	19122	21683	24483
30	18227	---	38755	51612	45466	23822	10339	13120	16229	18782	23017	22616
31	18728	---	39799	---	46444	---	11072	12456	---	18504	---	23885

Table 6-1.11

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1976

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	23466	26223	30873	43358	47558	37529	12077	12745	13550	17179	16844	18594
2	22287	26004	32208	42509	47753	36532	11519	14254	12443	16283	17015	19165
3	21313	25844	31679	42838	48599	35400	10561	14933	12706	16175	16524	12418
4	22612	27270	30266	43039	47541	33123	10159	15837	12496	17029	18245	19888
5	22459	26967	30760	44017	47543	30449	11180	16067	11417	17232	16795	22693
6	23383	25775	30879	47715	46920	28879	10061	15256	12051	17835	17357	22212
7	23370	25453	31256	49527	46535	29903	10171	15787	12292	17395	17106	22098
8	24688	24352	30356	50520	47655	27759	9478	15517	12623	17993	16714	20329
9	24123	25855	26235	55129	48922	29250	10103	14295	14223	19138	15980	20015
10	23901	27108	25755	59328	50371	31168	9717	13090	14240	18900	16805	20471
11	22702	25663	26520	60117	52122	31436	9108	11949	14408	19004	16315	20013
12	25757	25001	26217	60340	57385	33400	10722	11289	17286	19769	17612	19445
13	22852	24768	27086	60366	49235	34078	10014	11020	19856	19606	15590	18931
14	22281	25064	27257	60629	48010	33179	9609	11936	18664	20830	16303	18043
15	23669	26215	26898	58592	49429	31171	9654	11678	20333	21440	16377	18183
16	24072	26548	29001	57242	49438	30942	9785	11554	19555	20832	16802	17075
17	25797	28427	32521	55436	48431	31051	9778	13838	20613	20211	16543	17808
18	27103	26051	34056	53914	47061	31774	10558	14662	20453	20125	16951	15563
19	27571	25904	36919	53513	47011	29036	13170	16463	20682	19017	16420	17123
20	25738	26322	37482	50399	45072	29071	12772	15473	19972	19151	16926	16913
21	26361	25069	37397	51425	45509	28747	12136	15356	20164	17912	17495	16814
22	25395	25568	35607	51022	42210	25388	11444	14837	19568	18292	16727	18140
23	24658	25121	35851	49897	40127	23287	10896	14777	18924	17637	17245	16755
24	25537	25816	37055	49542	40792	20290	11086	15392	18972	17091	17419	16203
25	25107	25481	36737	49938	40082	20731	11509	15252	18865	16229	17268	15918
26	23578	27290	38381	50009	39441	21790	12251	14823	18497	16630	17485	16479
27	25280	31477	39817	47668	38251	19704	11517	15077	19068	16595	18254	16851
28	25227	32544	40043	47231	38867	17269	11850	15230	18491	16897	16510	16637
29	25543	32508	39794	46046	38230	13783	11736	14532	18207	16386	19616	16320
30	25140	---	40012	46546	38574	12574	10187	14209	18046	16236	18757	17584
31	25597	---	41635	---	38328	---	10804	14209	---	16343	---	17245

Table 6-1.12

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1977

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	16923	15985	13192	11633	7491	8977	4275	6147	8407	11064	10461	12519
2	18312	16362	13666	9821	7888	9025	4987	6314	7913	10334	11498	12537
3	17928	16294	13949	9981	7315	8536	4976	6123	8151	10801	10696	12746
4	17584	15862	13073	10314	8051	7957	5635	6264	8123	10020	10685	14082
5	16689	15481	12441	11224	8755	7511	5725	5975	7976	10893	11472	13717
6	17173	15917	12882	11224	9495	7721	6344	6162	7615	10884	11231	12934
7	16363	15148	14506	11022	9910	7114	6563	6532	8103	10971	10896	13220
8	14793	15669	14883	9209	9971	7367	6154	6198	6990	11158	11222	12658
9	14012	15234	14179	8891	10115	8037	6125	6213	7415	10124	11536	12746
10	13618	14877	15173	8891	9906	8004	5874	6406	7249	10834	11657	11846
11	13994	14720	14588	9587	9451	7337	6016	6422	7823	10553	11565	12129
12	16964	16183	14159	9035	9831	8737	5814	6294	8279	10236	11100	13116
13	16829	14717	14964	8144	9039	9372	5652	6403	8104	10481	11274	13638
14	17193	12941	14593	8178	8800	9253	5792	6355	7948	10875	11213	18619
15	18915	14789	13308	8426	8864	8897	5564	6340	7772	11165	11068	27459
16	17226	14395	14140	8394	8275	8905	5286	6508	8313	9938	10430	32465
17	16845	14645	13890	7352	8152	8446	5253	6080	8171	11406	11923	22821
18	16626	15003	13110	7878	8029	8082	4172	5969	8393	10481	12161	18812
19	15918	14602	13052	7985	7924	7734	5981	5461	8659	10827	10263	16921
20	16029	15123	12431	7608	7996	7625	5750	5792	9644	9881	10873	14958
21	15372	14732	11804	7664	7813	7608	5573	5968	9032	10131	11153	13199
22	16225	13709	10234	7259	8302	6285	5507	5926	9002	11074	11023	13303
23	15371	13004	10255	7313	8859	6357	5722	6071	9604	10863	11504	13448
24	15395	15440	12809	7434	8891	6688	6181	6484	9380	11123	11116	13239
25	15475	13924	12710	8002	9329	5714	6197	6285	10111	10956	12386	13940
26	16010	13073	12950	8002	9487	5220	6683	7247	10325	10502	12810	13771
27	15181	12441	12348	7705	11421	5734	7420	8028	10139	14086	12914	13160
28	16297	12882	12112	7353	11434	5724	6833	8965	11213	11244	13032	14060
29	15670	---	10415	6625	11292	4674	7102	8853	10257	11313	12653	13410
30	15663	---	13050	6740	10679	4972	6864	8876	10738	11140	12432	13560
31	16192	---	11089	---	9966	---	6692	8509	---	10651	---	13097

Table 6-1.13

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1978

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	12755	14146	17100	33317	46693	22779	15819	8702	11574	13459	15255	17880
2	11825	13699	16849	35647	47223	22347	15814	8853	11030	13627	15686	17029
3	11871	14061	16260	33771	44054	20656	15070	9225	11328	13561	16653	16038
4	12197	16278	16315	30047	42968	19538	17530	8462	11310	13602	15026	16434
5	12824	15529	17449	28480	39064	20157	17951	8794	11626	12360	14836	17117
6	12939	18375	20103	28611	36399	21535	18009	8950	12900	11828	15117	17875
7	12530	21571	19632	28540	33008	21688	17885	9188	14078	13029	14676	16811
8	12819	27568	20768	29339	34425	22523	17676	9540	16224	13331	14952	16380
9	12162	25056	22464	30676	34211	22782	19391	8609	16730	14539	15704	15095
10	13551	23956	22464	30126	33794	22035	16934	8572	16257	14108	14427	15312
11	14388	22360	22789	28998	33510	21865	17206	8786	16398	13209	15289	14425
12	15903	18584	22539	30840	32901	21728	15000	8578	16751	14312	15039	12683
13	15296	18666	22501	29702	30454	20610	13541	9271	16733	13981	15376	16042
14	15847	16728	20434	29627	28404	21270	12103	10320	16434	14813	15838	14945
15	15917	17252	20449	29763	29085	20058	11337	10035	18400	15058	16037	14959
16	18938	16341	19164	30819	30935	20943	10859	10423	18058	13717	15375	14837
17	22148	16098	18256	31163	29738	19876	10716	11066	16825	15638	15603	15792
18	24004	15286	17799	30269	28108	18492	9904	11016	15615	14761	16527	14621
19	23084	15446	19363	29420	24058	18533	9486	10967	14114	14249	16032	14197
20	19582	15709	20875	28791	22916	18358	8899	11293	14979	14037	16527	13221
21	17585	14946	22356	28784	22115	19169	8732	12351	15361	14595	16547	16124
22	16432	14249	23152	32107	22854	17287	9002	11843	15119	14583	17678	15833
23	16190	14920	24646	33952	23304	18030	9158	11794	15489	13660	16622	15238
24	14402	15325	26759	32938	25404	17533	9592	12323	15446	13641	16436	15004
25	13707	15675	27397	33200	25465	17558	9975	11051	15564	13823	16560	16141
26	15134	16411	26849	34357	23843	18058	8826	11492	15145	13685	16170	16684
27	14072	17377	25948	43951	23694	20667	9081	11368	14605	12783	16935	15470
28	14072	17411	25902	49658	23860	16694	9183	11407	14682	13439	15872	16013
29	13970	---	27861	50727	23597	15873	8977	11344	14159	12517	16158	14638
30	14149	---	31755	49038	22348	16412	8144	10832	14081	14212	17568	14615
31	13609	---	31839	---	23432	---	9335	11577	---	14496	---	12988

Table 6-1.14

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1979

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	12855	15603	20967	29650	18534	14034	9139	8495	14215	12557	11839	10689
2	12895	16635	20387	28058	18528	14015	9201	9057	12033	12963	12162	10817
3	15838	16916	20516	26869	17133	13232	8680	8088	12488	12181	12218	12133
4	15638	17844	20650	25851	17022	17567	8208	8245	12827	12265	12069	11822
5	17194	20769	20803	23394	17736	14424	8363	8067	13028	13059	12354	13102
6	16299	24502	20738	19946	17344	12531	9110	8443	12691	12412	12271	12452
7	15400	16696	22948	19651	18184	12941	8842	8922	12626	12275	12054	11742
8	13240	20666	24000	21738	18318	12433	7761	8109	11786	11822	12135	12231
9	12283	21510	25868	23201	18731	12068	7931	8241	11195	12761	12461	12142
10	14427	22035	24931	27437	17882	10985	8348	8257	10921	11968	12201	11463
11	14669	21509	28203	29622	18053	12523	7583	8340	11009	12437	11981	11224
12	16375	20972	27670	27985	18539	11921	8291	8588	11439	12670	11114	10726
13	21850	26258	27779	26048	17334	11901	8538	12013	11238	12163	10570	10392
14	21245	35516	28355	25937	16980	11520	7826	15895	11554	12268	11257	11116
15	27094	35932	27973	25078	14064	11437	8146	17218	11754	12128	11622	11341
16	24105	26255	31642	24832	16268	9539	8642	15663	11396	12771	11887	11536
17	23416	24455	34232	25263	17218	10822	8596	15060	11975	12166	11705	10497
18	21758	22314	31972	24812	15627	11354	8489	14250	12910	13895	12232	10866
19	19724	23250	30271	24450	15118	11855	9214	14645	12368	14111	12645	10019
20	20029	21382	28945	22738	14622	12034	8170	14218	13218	14742	11760	11098
21	19077	20636	27666	21917	15341	11467	8303	12888	11529	15837	11393	11417
22	19777	21552	27300	20477	16057	12152	8313	12179	10830	13585	12495	11458
23	18390	20386	27844	20954	16357	11051	9148	11817	10300	13628	11924	11563
24	18122	19694	29726	21865	17872	11081	9052	11778	11911	14495	11754	11351
25	18041	20395	27816	21439	18876	11517	9045	11855	10957	13428	12185	10931
26	17795	21104	28971	21029	18059	10441	9428	11209	10934	12927	12202	11531
27	17831	19759	30272	20796	17845	10925	8587	11750	12087	12973	12744	11697
28	17149	20562	31383	20273	17236	9777	8546	11765	11798	12778	11431	10529
29	17926	---	32078	21285	16548	8952	9001	11802	12326	12259	11442	10827
30	18030	---	31567	20204	15246	8549	9491	12686	12682	11826	11212	10231
31	16258	---	32138	---	14501	---	8930	12947	---	12408	---	10824

Table 6-1.15

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1980

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	10407	12731	17713	14156	27869	43290	15833	9688	11333	13501	14024	15263
2	12523	11954	17353	13188	24716	43794	14989	9601	12158	14497	13491	16597
3	11464	12074	17942	13426	29942	45965	15165	8969	11945	13713	14125	16020
4	11369	12109	17481	13326	31808	46094	16066	10139	12739	13264	15257	20481
5	11648	12235	17650	13120	31068	46731	16409	9344	12443	13264	16581	20559
6	12336	13179	18383	14653	28252	49989	16112	9489	13430	13138	16057	18178
7	13143	11348	16964	15318	30418	48849	16330	9407	12906	13289	18198	17124
8	12443	12347	17151	17668	30638	49238	13949	9234	13237	13004	17311	16501
9	11590	12116	16408	21194	28057	47777	15648	9465	12878	13895	17236	15419
10	12755	12225	16383	19492	29259	47115	13792	9605	12877	13520	16480	14674
11	13246	13149	15820	20994	27886	47926	12380	9819	15089	12513	15559	14506
12	12501	12435	16056	21589	27471	49879	11514	9538	17553	12968	14350	14837
13	18274	11517	14034	20484	27591	46764	11017	9745	17270	13804	15004	15015
14	24039	12192	15256	21149	26709	43794	10594	9325	19917	14070	13932	15095
15	26331	11701	14324	21778	29292	40433	9550	9307	19239	13464	15287	14882
16	24234	12248	15330	23009	30885	38111	9194	9679	18085	13708	15775	15301
17	25105	13985	14601	23078	31206	28096	9114	9266	17746	13830	13612	14777
18	23438	22882	15094	25578	30949	26435	9523	9289	18260	14545	15435	15112
19	19662	28631	14325	25507	30840	25170	8738	9875	17687	14287	14385	15609
20	16828	31504	13493	26490	30316	26941	9063	9595	16917	14455	15257	14863
21	16086	32583	15175	25718	28396	27727	9571	9594	15983	14593	15560	15059
22	13828	28258	17019	27121	27926	27775	9664	9960	16773	14325	14331	15422
23	13521	25066	15992	27136	28363	28318	8648	10267	16816	15065	15433	16602
24	13133	23081	16001	28233	28753	26672	8713	9615	16264	15495	16039	17720
25	13325	21043	15350	31140	29570	24076	8960	9885	16826	14684	14833	19866
26	12926	18205	15262	29554	31161	23591	8533	10568	16835	14600	15919	27305
27	12885	17747	15197	28182	36279	19595	8945	9818	15765	14977	15430	28950
28	12637	17541	15541	29490	38641	18392	9488	9490	16621	14592	14453	26328
29	12400	17928	14779	29332	40986	16092	8914	10533	15378	14071	13263	23700
30	10700	---	14396	28770	42773	16055	9971	10298	14893	13933	15581	21163
31	11657	---	14147	---	44032	---	9072	10833	---	14684	---	19723

Table 6-1.16

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1981

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	18752	15422	15486	19232	26152	33075	8184	8611	10654	15107	13605	13680
2	18521	14657	14651	19949	28274	34166	8310	9558	12089	14327	13692	14231
3	18120	14779	16338	19879	27758	35781	8020	8788	11944	14205	13544	13969
4	17069	14690	15281	19937	25133	33587	7728	9224	10759	13328	13448	13666
5	16931	14360	15542	19149	22811	34831	7824	8885	11323	14873	14018	13192
6	16343	15682	14847	18069	20251	33840	9329	8796	11620	14346	13290	12497
7	16380	15123	14182	18235	19394	33675	10042	8685	11633	14656	12652	13459
8	16470	14302	13571	17973	16585	34534	10714	8813	12404	15438	12756	13148
9	15653	14521	14801	19148	16466	36894	9408	8655	12852	14736	12415	14166
10	16296	14010	14236	19059	14485	38338	9518	9536	11768	15946	13010	13968
11	14989	13226	14312	15750	15135	37654	8958	8777	12676	14671	12898	14464
12	14927	13343	14658	15386	15378	39085	8552	8610	13112	16299	13021	13637
13	15072	13157	13834	16042	14398	40652	9366	8622	13551	16474	12872	13978
14	15677	14396	14247	14299	15171	41113	9399	8963	14374	16559	13239	14718
15	15179	20707	14577	14370	13331	38129	8847	9203	14345	15511	14585	16539
16	15075	25441	14432	14445	14172	33636	9039	8533	14190	17137	16227	19167
17	14706	29102	14435	15214	12977	31570	9817	9023	14747	15445	15018	17481
18	14922	28080	15387	14781	13025	27709	8991	9865	13455	15976	17122	17866
19	15312	31704	15670	14784	13886	20544	8123	9216	14159	15219	14022	18919
20	14042	28786	15306	17233	16725	17857	9056	8957	12848	14799	16198	29062
21	14106	25478	15606	21877	18269	16841	8790	9618	13239	14599	13168	31689
22	14720	20887	15861	22269	20334	14441	9306	10089	13490	14414	15111	28185
23	14795	19379	16662	24254	21149	14407	8881	9914	14047	14274	17296	24043
24	16587	18831	15659	26213	22083	12962	8132	10092	13687	14906	18097	20775
25	17892	17522	15045	26710	22003	11092	8544	10140	14605	14492	19142	18117
26	16014	16714	15980	27995	23499	11374	8704	9934	15164	14880	17220	17457
27	16751	17492	18851	30456	24197	9859	9036	10426	15044	14499	16968	15853
28	17767	15860	17841	29945	24101	9002	8913	10050	15591	14856	16156	15534
29	17812	---	17696	28808	25410	9763	9727	9894	16977	15098	15464	16051
30	17953	---	19420	27991	28515	7948	8965	10325	15515	14130	14026	15492
31	16204	---	20583	---	31179	---	8462	11282	---	13598	---	14935

Table 6-1.17

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1982

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	13361	17428	37586	44917	50539	36945	36857	11878	16026	19792	24571	27200
2	15843	18192	39091	43493	50380	37258	39242	12121	17178	19956	23634	26107
3	15173	18205	44956	44212	51730	39866	39635	13158	16900	19989	22272	27614
4	14251	18132	43008	45471	53330	41106	38868	12088	16900	20530	22080	28306
5	15093	14672	44565	45765	51043	41029	36273	12703	16204	19147	23963	28986
6	14363	17509	39868	46450	48132	40352	34754	12122	15246	20475	23588	31127
7	13017	18253	42238	47690	47566	39844	33340	11869	16351	20130	22937	31689
8	12778	18523	37270	48388	48590	38405	33515	11568	15369	19969	23623	29008
9	13433	19953	36609	47793	50507	39646	35677	12845	14612	20212	23138	27347
10	13723	19441	37158	47776	48350	36173	33626	11929	14810	21229	22871	26665
11	12809	20145	41115	49618	48180	35163	30716	12490	15000	21506	22693	26217
12	14566	22059	39957	49868	49069	34335	29732	12755	14551	22186	23048	26298
13	13691	21403	39500	50878	49018	33231	28253	12569	16993	21822	22402	26534
14	15681	29007	41746	50477	48867	30800	25852	12569	15860	21088	22257	27144
15	15195	29007	43598	55784	50451	32627	24822	12763	17053	20881	21584	27062
16	15842	55647	40568	56698	51844	30889	24028	13273	17742	18846	21511	30114
17	15575	70777	41284	57811	51362	32540	22847	12715	17496	18432	22995	32173
18	16012	66712	42137	57326	51799	31949	19904	13312	18471	21640	23143	32788
19	15701	65079	40739	55334	52167	31682	18523	15619	17972	22258	26079	30252
20	14911	68319	40739	54521	50994	30860	18065	12437	17725	21394	26301	30163
21	15840	71748	38235	53146	49704	31209	14193	11574	19129	20963	25615	33751
22	15729	68731	37235	51021	50284	31094	14536	11526	19129	20635	24879	43970
23	17065	69101	36256	49970	49322	30135	12805	12720	18592	20446	24827	39548
24	15120	65079	34847	49191	48512	30331	12271	13447	18212	21884	25226	35320
25	16335	53889	34044	50781	48209	31131	11705	12583	18739	22242	24577	31816
26	17421	47304	32195	52207	49300	34145	11972	12278	17927	22313	24959	30623
27	17580	42999	31199	52945	50283	32914	11825	13469	18868	22624	25288	29426
28	17410	38242	32344	52634	48108	33414	11998	12454	18754	22425	25842	27109
29	18138	---	35404	54147	42729	35503	12063	12639	18893	23733	27032	27203
30	17684	---	39178	52487	39933	34981	11309	13337	18963	24265	26583	26553
31	16579	---	42390	---	38000	---	12984	15095	---	25005	---	27241

Table 6-1.18

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	27072	29064	43437	55181	56668	62371	35544	12139	18854	17743	29185	28588
2	27365	28858	47381	53055	58777	60402	39104	12943	17596	18405	29380	27404
3	27884	28296	49201	52731	60422	62491	41381	13260	16952	18950	29057	26142
4	28763	27084	55180	49701	61065	61602	38836	12658	16883	18400	27131	25770
5	27963	26454	60258	48808	62092	59215	37484	12250	16591	20212	24929	26039
6	32326	26264	58806	48947	62058	57970	36516	10374	16301	20554	24304	26006
7	37235	26216	56675	47664	64896	55982	37358	11213	15964	20648	23819	25603
8	45709	25942	53534	47226	65377	55258	36856	11423	15753	20176	24220	26154
9	44860	25836	50615	47277	64198	55255	35308	12095	16720	21347	23962	27061
10	39619	25482	51083	46452	63055	54943	29826	13533	16292	22011	24366	29295
11	36931	26245	52723	45979	61684	56305	29456	12314	16479	22603	25411	33396
12	34388	27470	56546	43426	59211	56401	27118	14559	15738	21604	28173	36747
13	31725	31520	61655	43070	58579	54411	22687	16399	15145	21822	27166	33778
14	31547	37416	66551	42674	58011	52588	23001	17051	15335	24076	26517	32439
15	30768	34373	64572	41168	58104	52516	23825	15567	15376	25132	27541	33613
16	30674	38546	59976	38933	57207	52889	25786	16753	15861	24946	26826	33891
17	30180	39971	58354	37634	54679	51823	24525	17482	15403	22980	27651	32332
18	29367	42859	56000	39060	52826	52369	25049	16430	14926	24148	28261	31905
19	27773	43254	54485	39838	50981	51044	23926	16756	16264	24795	30097	32357
20	29231	40968	50434	40840	49420	48749	19046	16090	17033	24681	30149	33163
21	30618	38812	47603	44013	49532	45319	24451	15584	16211	25326	30423	32799
22	30609	41466	39939	44205	50852	42527	19783	16831	17390	24486	30074	32067
23	34600	42839	37600	48654	50837	35918	16824	18344	17456	26206	29268	30253
24	30561	40933	37899	54942	50753	36324	13087	20375	17755	26654	29006	28413
25	31639	41225	38705	60841	51517	36448	14045	20539	17421	26701	30160	25369
26	31032	44870	39136	58633	53223	35571	12034	20073	17968	27127	29682	29741
27	31617	43665	39594	54984	53762	34573	13114	19511	17727	28286	27759	33939
28	32190	41695	41232	52699	56192	33792	12151	18937	17778	28955	27974	35650
29	31649	---	42467	52527	57567	33606	12462	19993	17435	30162	27640	33698
30	30078	---	51403	54048	63506	33861	11657	17767	17736	29141	28776	34034
31	30225	---	54606	---	63191	---	11516	18259	---	29156	---	38448

Table 6-1.19

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	38401	34725	23306	51204	62061	66930	41554	18339	17464	20953	30467	30500
2	36055	34614	23538	50538	60181	63231	41701	18370	17444	21829	30258	29208
3	36361	34533	25202	50531	60106	59334	37701	18962	17187	21677	29451	27709
4	35312	33750	25444	50723	61258	58755	35501	21631	18006	20963	28808	27249
5	35385	33836	25050	49588	61597	59949	34627	20180	18693	20589	29336	27567
6	36157	30805	26604	50470	63231	58110	33380	19795	18934	20154	27758	25839
7	37506	28677	26660	50980	63539	60323	32619	20120	19003	21531	26816	24796
8	36712	27498	27873	53197	61588	61091	29472	19577	20021	24330	29114	25226
9	37927	28241	28706	59499	60521	61397	29017	16246	19299	24871	28077	26044
10	35769	27592	31641	57037	59664	59539	27888	15325	17028	23851	28965	26049
11	38372	25406	36567	55171	59486	60404	25522	14051	18770	24638	27659	23523
12	37588	24520	40184	54266	61104	61792	23859	12831	19230	24161	29335	30800
13	36828	23706	44391	53993	62875	62194	22278	13682	17140	24729	29097	22067
14	36076	28156	51067	56003	66935	60584	22562	12929	19135	24665	29363	22013
15	36122	31196	56796	59235	72054	60615	18208	12693	19425	26994	29336	22536
16	35645	29408	58466	62960	71957	60860	17065	13636	20295	26383	27097	22961
17	34914	28788	63387	69969	70502	60897	15950	13015	21004	27751	27952	21087
18	33584	29457	63528	77088	69619	62751	14243	13057	20424	27360	27662	19249
19	33666	28845	55252	82534	70688	62272	14090	13281	19750	29167	27675	20186
20	32008	27011	54589	84244	72366	61336	14370	14600	18696	29084	28359	19226
21	32523	26153	60869	81674	72740	63971	12514	15314	17929	29482	29641	18811
22	32414	23926	63558	77967	72221	63480	13477	15135	18610	29960	29198	20317
23	34054	22473	60083	74003	71367	60057	12386	14438	20275	30014	29131	21428
24	35521	22361	55362	71866	71670	59924	14942	13564	18848	30065	29544	25080
25	34601	23772	52982	69241	70932	57727	17063	12181	20657	29496	30686	24974
26	36814	22877	50428	66851	69501	56231	16486	14997	22536	31036	29565	23336
27	38535	22274	48923	67590	68116	56672	16153	14424	20522	30466	30081	24835
28	37156	22443	46059	67583	70796	54984	16100	16012	21005	30160	29599	27515
29	36413	23253	43929	66762	66733	49783	15913	14924	21813	30649	29624	26297
30	35921	---	46807	64897	69451	43225	16618	15354	20944	29866	29684	25787
31	35455	---	49799	---	70813	---	16494	17925	---	30028	---	26743

Table 6-1.20

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	26209	25047	23385	34220	27900	25232	9384	11953	11359	15884	14850	19854
2	26454	25568	22701	36668	27429	27058	9425	12499	13092	16427	15166	20983
3	26442	24229	22609	38140	25031	29542	9753	14355	14955	15375	15170	20021
4	25968	24193	20791	40091	23493	28124	9174	13032	13848	16346	14391	20980
5	25987	23214	21301	39500	22197	27417	8357	13043	15524	15399	14669	20870
6	24836	24105	21229	38761	20599	26632	9003	12593	14247	16023	15061	18184
7	25309	27121	20194	39654	19463	26860	10358	11064	13539	14316	16843	18135
8	25744	27280	19351	40810	21111	23228	10128	10510	16462	15274	16301	17029
9	26025	26987	19194	43020	21380	21326	10367	11018	17555	16276	15740	14747
10	25676	25527	19100	45648	21905	19394	9281	10149	20501	16610	17115	16365
11	26496	24136	19499	46134	21201	18970	9693	10415	21243	15793	14729	17510
12	25733	23014	19483	48327	21352	17911	11090	10623	19933	15686	15672	16309
13	26103	24057	21094	45971	25687	17564	10945	10467	20053	16495	15355	16347
14	25873	23118	23373	45874	28408	16195	9983	10828	19149	15786	14949	15176
15	25410	23681	24382	45460	31333	15972	9186	10932	18865	16348	16103	14522
16	25640	23941	26497	46334	30076	15272	10647	10236	18694	16016	15583	13703
17	25491	22415	28165	45925	30258	14438	10501	9812	17859	16745	14066	15345
18	26700	23264	28815	42086	32248	11697	10214	10612	18680	17068	17822	17005
19	26730	23220	30308	40171	31186	12527	9592	11515	18953	16024	17533	16148
20	25948	23218	31338	39005	28843	11302	9914	10690	18507	15928	16705	14910
21	25027	22531	29253	35960	28561	10942	9774	11205	17451	15380	16754	12986
22	25477	22801	27410	35408	27166	10546	10121	11520	16868	15633	15535	13917
23	25542	24767	26527	33750	27182	9060	10194	11496	16997	16096	14025	13231
24	25218	23837	28008	32826	26234	9902	9518	10852	16827	15944	15646	13538
25	25969	21221	28950	31569	28555	9960	9767	11802	17283	16393	14885	13639
26	25164	23143	29320	29421	25045	9407	10250	11664	15732	17001	15315	13009
27	23550	23298	31200	29537	23561	8977	10062	11493	15987	16561	15108	12620
28	24574	23342	27512	29774	21951	9829	10783	11828	16665	16152	15807	12698
29	23494	---	28529	29506	23967	9418	11458	11932	16128	16259	15963	14724
30	24915	---	29747	28095	24563	9676	10783	12252	15816	16236	16342	14749
31	24946	---	31975	---	24526	---	11827	11860	---	14838	---	14551

Table 6-1.21

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	15349	24014	62784	59889	42213	46598	16007	11292	13172	22565	25098	24796
2	17248	27353	61766	58506	41130	48424	13928	10532	13336	21968	25904	24226
3	16729	28771	60101	57912	41177	44368	14178	10168	13918	22290	24344	23696
4	18657	28317	57524	58498	43203	46497	13709	10398	14292	22371	23040	23255
5	19393	26109	55960	57189	44886	47603	13710	10605	14167	23131	20787	24702
6	18019	23915	53681	56139	45129	48258	15097	10780	15012	23743	20168	23484
7	18553	22026	57810	55528	44507	47011	15225	10477	14094	22923	16732	24649
8	18374	19621	66266	56169	44304	47661	13922	11234	15979	23281	15053	24044
9	17642	19227	72442	56633	43686	46523	15224	10891	16193	23233	15608	23208
10	17516	17908	72177	55035	44234	45415	14131	10960	17180	22791	17912	22780
11	18276	17803	75671	50704	45272	43999	13909	11221	17372	22969	20354	21910
12	18337	18626	74769	49117	45638	43452	12721	11260	16394	23520	20919	23277
13	17371	19491	72938	49057	45023	43560	12323	10742	15888	23362	21238	22492
14	17306	19462	70151	49886	44149	42392	13213	11799	16900	23959	21344	22487
15	16891	21883	66753	48573	44000	40715	11542	10390	16560	23313	22057	23018
16	17904	30974	65221	48732	42928	40011	12980	10812	16153	23656	22245	22543
17	18372	40385	64649	50051	40949	38196	11822	11276	16012	22513	21645	22749
18	24441	48719	59171	50559	40001	36349	13515	11819	16676	22816	21823	22546
19	23440	62689	51627	48553	40079	34232	10760	11273	16870	23026	21249	21000
20	22434	64529	46085	48329	40830	31883	10592	11652	17659	23997	21741	21658
21	20040	66122	41781	47974	42652	30596	11031	12274	18119	23233	20686	22342
22	19938	67295	41206	49025	41336	29801	11613	13256	17287	24075	21585	22576
23	20380	71008	43150	49480	40128	29563	10313	12936	17678	23800	22270	23067
24	18671	80084	50149	50077	35910	29374	10499	13734	18606	23578	21878	22917
25	19455	84721	55035	45945	34295	28616	10867	12974	19647	23167	23178	22482
26	18099	82790	55972	42163	35958	27889	10383	12095	18661	23664	22828	22413
27	17941	76050	55860	43151	40138	24361	11045	13147	20531	23961	24603	22300
28	18779	66958	56187	43412	42848	22016	10959	13053	20768	23655	23249	22082
29	18341	---	57647	41994	45822	19528	11590	12844	21284	24475	23150	21872
30	18619	---	59090	42682	46642	17382	11758	12613	21286	24104	24081	21783
31	20240	---	59769	---	46621	---	11495	13084	---	24054	---	21731

Table 6-1.22

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	21743	15786	13359	13240	14273	12214	8097	8227	11118	11466	12498	12531
2	21176	14676	13401	15756	15184	11895	7247	7993	10565	12263	12476	11989
3	21704	15474	13250	15223	13946	11503	7881	9352	10366	11941	12379	12336
4	21487	17137	14341	15155	14523	9615	7016	9953	10221	12705	12470	13346
5	22666	15633	16258	13737	13010	9225	9532	7882	11042	11313	11873	13464
6	22029	15186	17002	12832	12795	9621	8815	8549	10710	12603	11351	13548
7	21226	16253	23136	13160	13208	8779	7792	7988	11207	11995	12080	13258
8	21014	17083	22206	12954	12168	9111	8391	8223	11348	12715	11349	8673
9	21253	16955	16865	12414	11489	9883	8764	8598	11934	11489	11440	13368
10	21113	18127	16576	13155	10579	11402	8135	8305	11436	11931	15735	12663
11	21272	16073	15542	11815	10266	11191	8292	8415	13588	11470	12082	13612
12	21338	15029	17493	12880	10139	10138	8581	8821	11541	12050	13192	14214
13	21202	14089	20638	13319	10299	9818	10050	9091	11271	11887	13114	13355
14	20737	18683	20690	12331	9297	10450	9228	8839	11788	12436	11454	12502
15	21189	16931	16958	13507	11214	9950	8992	9862	10852	11849	11910	9055
16	21019	14893	17972	12493	9780	9322	8263	10495	11211	13237	10760	9273
17	21100	15996	16345	13370	10282	10296	8567	10638	11183	12616	11827	11423
18	20663	15179	16594	10319	10178	9460	8891	10523	11907	13076	11792	12020
19	18797	15818	16163	10510	10340	9316	9372	10145	12349	13454	10968	11312
20	18100	15289	14313	11192	10651	9440	9118	10111	12225	13127	12122	11367
21	17889	15289	14389	9091	10375	9320	10904	9918	12439	13221	11556	11420
22	17519	14843	15391	10058	11796	9854	11490	9312	12592	12797	11328	11489
23	16868	13949	14841	9764	9822	8948	11208	9823	12471	13945	10597	10581
24	15613	13935	13059	10415	10010	8054	11520	8313	12813	14634	11391	11212
25	16182	13693	12772	8721	10275	8767	11042	10900	11209	13507	11716	10806
26	15666	14200	12769	10184	10185	7897	10443	9835	11867	13343	11808	10738
27	16160	13406	12971	10423	13526	7315	10349	9577	11604	13053	11304	10365
28	16564	13208	12390	10620	15317	7920	9262	8920	11732	12946	11229	11370
29	16263	---	13298	11278	13369	7606	9573	8988	11509	12649	11706	10826
30	16424	---	14127	13807	12131	7661	8046	10086	11963	13191	12144	11141
31	15288	---	16293	---	12956	---	8238	10057	---	13229	---	10488

Table 6-1.23

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	11733	11584	13409	10713	9500	14166	7001	6075	8110	9928	10467	11680
2	10371	11267	15025	9843	9156	14807	7523	6391	7804	9259	10997	11666
3	10987	11003	13748	10096	9709	15538	7175	7661	8566	9297	11238	11539
4	11280	11240	14110	11305	9756	14777	7646	6367	8824	9322	10827	11615
5	10985	10670	13749	12115	10607	13906	7912	6837	9263	8904	12457	11529
6	11208	10614	13067	11394	10422	14349	8301	7019	8962	9359	11057	11138
7	11162	10950	13779	10984	9831	12952	6831	7776	9011	9696	11485	10872
8	10805	10522	12913	11736	11273	11773	7123	6892	8704	9370	11071	11822
9	11288	10808	12052	10153	9881	10487	7149	7574	8336	9629	10928	11477
10	11245	11573	12015	10944	11539	10150	6462	7108	8760	9318	9453	11686
11	11665	13568	10828	11365	10276	9800	7258	7250	8536	9847	11074	12085
12	10847	13299	10729	10693	10480	9008	6811	7119	8924	9998	11022	11948
13	10478	12641	10972	10551	10211	8713	5965	7830	9443	9919	12008	11397
14	12588	13499	10443	10972	10718	9062	7446	6535	9434	9852	10840	11181
15	12127	13320	9947	12121	10268	7949	6986	8244	9828	10272	11412	11851
16	13074	12874	10106	11427	10196	7510	6664	6570	9121	9377	11146	11602
17	11511	12442	9718	12051	10173	7973	6869	7060	8989	10098	11268	10794
18	11485	11704	10190	13375	11294	8039	7108	7169	8991	9978	11375	10545
19	11629	12032	10110	11607	11069	7077	7257	8139	8576	10857	12146	11496
20	10630	11415	9879	12552	10578	8012	6615	7057	9318	10639	11522	11431
21	9954	11670	10430	12849	10092	7132	6760	7516	9465	11062	11435	10489
22	11194	11437	10089	14642	10054	6961	6388	8136	9927	10477	11864	11933
23	11342	11900	11439	13078	10934	6267	5859	7784	10247	10793	13801	11146
24	11558	12345	11225	11593	10736	6994	6616	8190	10127	10722	13670	10828
25	10201	11283	11075	12374	10705	5616	6394	8092	9800	10373	13649	11161
26	10821	11943	10410	11531	10714	6934	6221	8430	10645	10051	13043	10940
27	10862	11838	10649	10632	11759	8329	7059	8500	9544	10372	13196	10575
28	10432	12144	10384	10577	10651	8360	6242	7991	8837	10345	13063	8845
29	11227	12182	10309	10547	11073	8084	6589	7694	9100	10355	12673	9177
30	11685	---	10342	9855	11529	7451	6549	8244	8922	11154	12026	10569
31	12020	---	11057	---	12011	---	7138	8365	---	11108	---	13737

Table 6-1.24

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	10523	10757	16723	25314	20189	14339	8728	9205	12097	13060	13900	11390
2	11429	11751	16928	26864	18359	15078	9295	8597	12081	13230	13920	11690
3	10480	11015	16904	27044	18774	15422	8815	9459	10959	13920	13010	12050
4	10434	10036	16409	25064	18131	16130	8678	9568	11020	15570	13050	12130
5	11147	8785	15873	26205	18080	15652	8978	9201	10952	12680	14950	11640
6	11663	7330	16363	25184	17138	15266	8738	7975	10348	13710	14810	12670
7	10329	7686	18311	23337	20643	15780	8739	10360	10854	14590	14710	12890
8	10455	7316	23337	26519	21217	16210	8781	9102	11588	13150	12860	12320
9	10320	6931	34286	27343	22732	15853	8928	9161	10708	12790	12530	12200
10	10949	7230	42116	27104	24199	14845	8263	9818	11159	14250	13110	12170
11	11172	8816	44211	24849	24099	14328	8172	9962	11183	16130	12690	11520
12	11992	7493	46355	23088	22664	14047	8235	9202	11206	16800	12420	11650
13	11516	8575	41417	24029	21987	14065	9013	10446	10989	17590	12980	11570
14	10815	13478	37367	25629	21058	14888	8857	10392	11093	14410	13420	11930
15	11106	10774	30328	26742	19641	15330	9330	10454	11584	13380	13170	11300
16	11047	10403	26616	28349	17590	16883	9603	10426	12502	11400	12850	11450
17	11028	12767	25199	29321	17387	15413	9658	10644	13541	10410	12470	11370
18	10043	11646	25000	29556	17999	14224	10293	10994	12530	10710	12740	11350
19	9961	13273	25134	32317	17637	14055	9496	10080	13304	10440	12570	11680
20	11311	14742	26474	35022	17107	14122	10259	9420	13364	11540	13410	11290
21	11393	15253	25476	36021	16283	12746	8977	11407	13553	11130	12060	10890
22	10761	18524	26244	36222	16172	11387	8904	10574	13331	11480	12500	12100
23	10296	16347	25603	35463	16561	12485	8963	11333	13463	13700	12610	11500
24	10209	16953	24393	33892	14959	11613	8968	12484	13394	13050	12140	11970
25	9664	18268	29027	32064	14213	10336	9326	13182	12826	12970	11670	11350
26	10241	17739	36633	30301	14341	9695	8648	13166	12302	13720	12730	11360
27	8187	16720	31440	27162	14717	9784	8911	14179	12746	13490	12530	11300
28	8546	16639	29926	25101	14375	9340	8938	13093	12811	14140	12190	10690
29	9980	---	30098	24276	15659	9826	8820	12235	12707	13770	12400	11970
30	11681	---	27069	22618	14895	9824	9495	14056	13216	12150	11440	11530
31	11869	---	25817	---	14946	---	9162	12670	---	11770	---	11540

Table 6-1.25

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	11190	10540	12260	10770	17210	21200	6760	6990	8970	10910	11910	11510
2	10980	11920	11470	12100	16180	22770	7490	6570	9810	9780	11980	11020
3	10840	11130	12540	11990	16270	21180	7180	6680	9050	10920	11790	12030
4	11490	10720	13220	13050	15740	20830	7550	6410	9120	11550	12330	11720
5	11720	11490	13690	12830	14930	20930	7760	7200	9160	11730	11470	10910
6	11520	11150	14330	12200	14480	18620	6870	7450	10290	11520	12780	10820
7	11710	10080	13820	11250	12870	17130	7120	6660	10220	11980	12620	10530
8	11760	10910	13700	10980	12700	17640	7490	7770	9450	11620	12570	10800
9	13140	10390	12570	11390	11180	17430	6880	6330	10220	11170	11440	9960
10	12680	11850	14590	11040	11490	15360	7300	7150	10300	11960	11400	10360
11	12870	11130	15500	9830	13890	16720	7190	7240	9980	12310	11850	11060
12	12550	10620	13470	11620	7550	15990	6810	6760	9860	10400	11690	11250
13	12680	10490	12250	12210	10730	13810	6910	7860	9300	12120	12530	11450
14	12230	10320	12160	10000	10490	14210	6930	6800	9180	11860	11150	11430
15	12070	11410	12090	9250	10450	14210	6980	6260	9770	11220	12230	10670
16	12310	10750	11580	9740	9720	13820	7560	6970	9690	12350	11250	10380
17	11220	10760	11200	10100	9510	13260	7490	7410	9810	12610	11130	10330
18	11080	10480	12360	11350	9360	14340	6750	8380	11880	12330	11260	11090
19	11810	10220	12230	11150	9400	12690	6800	7360	11150	12330	13020	10150
20	11400	9960	13050	11390	10270	12060	7110	9410	10860	12640	11760	9870
21	11780	10160	13250	11260	10760	11070	7200	11150	10250	11570	11180	8090
22	11690	10520	13240	13510	10440	9620	7230	10730	11730	12630	10880	6740
23	11360	10510	14420	14740	9990	10440	7170	11130	10680	12290	11820	7670
24	11210	10250	14720	15930	12910	8380	8460	11300	10750	13060	11720	7140
25	11080	11250	13690	15860	12960	9220	8120	11820	10370	12040	12050	7300
26	11450	10700	13240	15230	12640	7340	8030	11700	10700	12170	10980	7840
27	10770	11400	12550	15690	13880	7880	8820	12530	9580	12550	12080	7120
28	11290	12250	12340	17900	15480	7880	9010	10160	9920	11630	11460	9120
29	10840	---	12210	20100	16110	7690	8060	10280	10140	11340	11140	9910
30	11080	---	11780	19300	20820	7020	8370	9850	9490	11110	11530	10050
31	10640	---	11950	---	22600	---	7960	10590	---	10950	---	8320

Table 6-1.28

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	8420	11210	13380	8460	9750	12890	12570	7970	7620	10586	11370	11341
2	10480	11410	14060	8710	9440	13550	12060	8390	8700	10436	12372	10863
3	11390	12060	15070	8960	9290	13720	11040	8180	8590	9969	12331	11210
4	11170	11320	15640	9230	9400	14570	9730	8110	8520	10905	11306	11406
5	10520	11880	14020	9890	9420	13230	9140	8680	8820	10343	13281	10967
6	10450	15170	13960	10760	9040	13400	8290	8240	9370	9922	12061	11665
7	10530	12920	12770	12080	9130	13760	7320	8550	8580	10735	12352	13074
8	10420	11300	11210	11340	10140	12480	7830	8040	8810	10828	12385	14512
9	11230	10660	11290	10760	11850	12860	7150	6680	9580	11075	12102	12128
10	12060	10620	11020	9830	13820	13330	7100	7430	9920	10594	10531	12124
11	11830	10450	10690	10080	11860	13260	7180	7840	10910	10373	11899	12334
12	12840	10170	10080	9470	12390	12920	7300	7640	11130	10288	11792	11878
13	13260	9920	9470	9340	12670	12200	7730	7580	12810	10916	11351	11166
14	14400	10710	9040	9190	12790	11700	8360	8070	12450	10442	11228	11806
15	15310	11870	9520	8980	12880	10260	8200	7600	11580	10557	12129	10024
16	15970	12940	8840	8030	12030	10780	8010	8080	11760	10478	11789	11192
17	14600	13770	8940	9580	15710	10290	8570	7390	11290	10578	12042	10727
18	15180	12320	8890	10320	19050	9020	9070	8190	11670	10642	12016	11325
19	14410	12370	8680	9710	19600	9180	8180	8250	11290	11072	11247	11531
20	14430	10840	8110	9760	19050	9050	8610	7930	10090	10775	11507	11835
21	13800	10250	8620	9720	18550	9560	8190	7790	10590	10255	11215	10886
22	13710	10430	8650	9860	19440	9460	8380	7560	9620	10637	11478	11205
23	13280	10850	8800	10600	17960	9370	8350	7200	10620	10643	11219	11253
24	12420	10860	8550	11240	16510	8550	8930	6730	10700	10850	11671	11168
25	13130	10190	10150	12180	16310	8790	8920	7430	10460	11308	10955	10737
26	12560	9540	9840	10740	15290	8930	8790	8040	10460	11794	11325	10562
27	12140	12080	10230	10190	13780	9840	9010	7500	10810	11890	11526	10893
28	12230	13220	11300	10500	12950	9310	8510	8320	10570	12449	12777	11227
29	11070	---	11260	9410	12740	10210	8670	7890	10360	11890	11760	10988
30	11300	---	10920	10360	12430	11110	8250	8640	11290	11751	11390	11238
31	11600	---	8830	---	12660	---	8370	8710	---	11577	---	11381

Table 6-1.27

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	11109	12413	12707	9600	9893	4980	8519	5506	6027	7914	11508	9996
2	10901	11927	12583	8904	9443	5645	8898	5109	6055	8222	11310	10213
3	11548	12006	12781	8432	9221	5274	8736	5431	5998	7003	11449	10190
4	10881	11649	13367	8585	9200	5151	8490	5297	6110	7310	11140	9914
5	10827	12036	12851	8464	8307	4950	9217	5123	5808	7391	10707	9945
6	11461	11679	13151	9574	9643	4905	8126	5081	6207	7356	10358	8901
7	11469	10932	12637	7229	8857	4712	8197	4994	6806	8042	10288	10474
8	11031	11075	12791	7327	8893	5105	7206	5031	6579	7869	10515	11996
9	11033	10999	12347	6952	8907	4954	6881	4941	6726	8828	9221	10487
10	11955	10924	12196	5300	8791	5295	6431	5035	7215	8326	10522	10215
11	11742	11097	12017	9281	8278	4997	6092	5212	6366	8852	10640	10941
12	11819	11452	11636	9156	7882	6045	6184	5078	6870	8584	10170	11784
13	11441	12651	11626	9598	7340	6582	6252	5531	6671	8789	10611	10379
14	11450	12028	11316	9796	7692	6277	6377	5263	6992	9222	10198	10487
15	11672	11784	11260	9280	7275	8570	6066	5722	7500	8806	9944	11136
16	11502	12465	11318	9233	7587	8453	5593	5294	7488	9071	9965	11033
17	12039	11612	11311	9047	7802	8647	5994	5614	7307	8902	10462	10114
18	11971	11685	11549	9135	7711	9651	5443	5658	7315	9061	10576	10136
19	11661	11903	11505	9501	7642	7972	5698	5427	6780	9494	10300	11398
20	11803	16767	11131	9114	8228	7655	6114	5658	7483	9246	10449	11103
21	11358	17382	11095	11095	7984	7785	5552	5887	7938	9276	10812	12117
22	11391	17661	10992	10419	7449	6471	5943	5433	6402	9782	10087	11290
23	11317	17706	10690	9280	7291	6484	5841	5072	7158	9608	9767	11096
24	11415	14861	10468	10001	6983	5845	6032	5836	7130	9470	10850	11036
25	11570	13942	9575	9577	7393	5123	6221	6205	7163	10169	10408	11121
26	11531	12997	9558	9757	6795	5718	6156	6481	7417	10432	9900	11457
27	12057	12651	9573	9754	6378	5669	5919	5735	7673	10102	9622	11225
28	12162	13108	9413	9340	6327	6642	5838	6107	8313	9987	9193	10542
29	12712	13163	9590	9132	6254	6793	5796	6383	7418	10372	10209	10436
30	12967	---	9659	8819	5474	7077	5161	5942	8058	10330	9735	9223
31	12129	---	9493	---	5675	---	5135	6118	---	11588	---	9921

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	10602	11484	9930	32019	25705	23720	11700	12027	10618	12680	11979	13523
2	10165	10624	10305	32835	24317	27611	11101	11149	10537	11872	12194	12963
3	10422	10965	10161	31027	26150	27926	10599	11706	9963	11432	11864	13681
4	9337	10710	10068	35095	29002	29390	11212	11804	9922	12720	11404	12560
5	10613	10284	10285	44453	30340	30199	11387	10784	9832	12178	12877	13066
6	10483	10537	10716	39377	28373	28789	11544	11328	11115	12268	11973	12466
7	9488	10696	9809	33639	30715	30320	10138	12118	10982	12069	11794	13263
8	10229	11147	10535	30081	30452	33082	10595	11839	9364	12545	12019	13266
9	10291	10632	11296	29858	28895	32984	9560	12903	10759	12433	12447	13509
10	11732	10639	12259	31446	28618	39646	9122	14486	9007	12551	11952	13028
11	13486	11653	13500	30433	28435	42103	8662	13694	9972	12786	12517	12047
12	12585	12375	14051	29152	30544	42677	9249	12834	8502	12917	11973	13318
13	9988	13378	13568	28076	32232	42435	9220	13464	10336	13645	11734	14196
14	11197	13149	13917	27036	32865	40851	10696	12993	10031	13367	12251	12556
15	12018	13372	13044	26799	31918	39299	11375	13052	11304	13261	11098	13499
16	11722	11900	15694	25263	33050	37838	11549	14204	10910	13052	12162	12979
17	12821	11694	24996	24423	33953	35914	12403	13829	11546	13392	12112	12982
18	12059	11839	44290	25164	34051	33049	13574	14405	11564	12914	11303	13707
19	11446	10837	56994	26396	33269	26942	12368	13391	11472	14010	12168	13177
20	11984	11057	63788	24855	33625	23623	12503	12628	11948	13447	12120	13154
21	12445	12042	58105	25162	33125	22997	12960	12147	11257	12584	12043	13454
22	14796	12040	45358	24060	32283	24090	13069	11811	11670	13218	11430	11867
23	15946	12906	41642	24196	32347	21940	13624	11239	12353	13312	11789	12923
24	13649	12088	48416	25224	30337	21019	13675	10835	11811	14505	12082	12928
25	13163	11301	50075	25886	31185	19579	14164	10517	12129	14631	12303	13068
26	12367	10872	48431	25248	28404	17244	15200	10999	12472	12815	12320	13514
27	11824	10689	49064	25782	29532	16103	14680	10648	11910	12662	12021	13625
28	11471	10809	46918	25380	30516	15432	13793	10885	12268	12008	12310	12756
29	11680	---	45408	24801	28157	14332	14186	9959	12239	12471	12228	11965
30	11442	---	39925	24871	25357	12875	12840	10722	12352	11873	12853	12999
31	11514	---	36026	---	23551	---	12527	10601	---	12531	---	13545

Table 6-1.29

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	13875	11961	15723	12271	10496	13720	8093	8908	7987	9779	10920	10961
2	13568	11498	17713	12155	12933	13103	7842	8851	8151	9280	10591	11249
3	13544	10551	17786	12203	15267	13058	7714	9270	8380	9810	10953	11079
4	13295	10967	17063	11783	13700	12435	8690	8885	8196	9552	10319	11176
5	13389	11208	17022	12537	13726	12078	8725	8583	8284	11244	10751	10960
6	14160	12002	16422	12359	12884	12555	9555	8640	8550	10951	11331	11640
7	14258	11276	14344	12825	13316	12013	10859	8886	8344	11389	12392	11230
8	13641	12670	14844	13472	13779	10040	10551	8179	8139	10926	13282	11054
9	14274	11820	14388	11988	14749	10344	9754	8237	7899	10074	11743	10740
10	13744	11581	14645	11552	15887	9643	10132	8640	8812	11096	11139	10852
11	14084	12496	15552	12293	15461	9006	9721	7838	8161	10814	11479	10384
12	13942	12612	15285	13071	15250	8614	10446	7756	7758	10557	10901	10938
13	13640	12275	14566	13260	14287	9622	9737	7355	8606	10853	11089	10697
14	13743	12137	15327	13479	13158	8833	9221	7752	8153	11345	11268	10735
15	13324	12289	14889	12533	14577	8639	9301	8126	8627	11510	10989	11133
16	13968	12585	16138	11334	13201	8941	9475	7566	8777	12689	10782	11116
17	13835	11599	15582	10895	13326	8255	8915	7303	8999	11888	10367	11244
18	13910	11895	14766	11251	13684	8067	8098	7682	8554	13084	10436	12175
19	13436	13135	14638	11083	14774	9073	8863	7313	8659	11920	10762	12383
20	13677	12988	13067	12012	14981	7701	10730	7284	8417	11678	10097	11880
21	13585	13110	13399	12441	15191	8092	9794	7138	8334	11167	9968	11023
22	12504	12834	13824	13306	16061	7994	8546	7729	8451	11257	10308	11152
23	13057	13125	12383	13704	15565	6903	8138	7175	8431	11301	9980	10889
24	13283	12438	11269	12914	14457	7696	9269	7701	8734	11272	10178	10978
25	13653	13178	13368	13713	15403	7547	8874	7863	8144	11521	10401	10853
26	13781	14091	13446	14147	14905	7020	8157	7351	8461	11705	10380	10998
27	13347	15618	11928	13962	12793	7234	8489	8230	8850	10456	10663	11194
28	13104	16116	11685	15211	13268	7209	9179	8069	8849	10590	10163	11521
29	12749	---	11851	15375	14689	7117	9164	8153	9220	10833	10585	12556
30	13106	---	11596	17409	12990	6943	8354	7800	8813	11198	10808	11938
31	12755	---	12467	---	14225	---	9022	7875	---	11355	---	11738

BROWNLEE PROJECT INFLOW (CFS)
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	11230	23916	16500	16460	24038	40130	27283	12140	11907	---	---	---
2	10379	29634	15074	16215	24544	39436	26521	11758	11743	---	---	---
3	9976	29494	15462	18511	28991	37117	25605	10955	11531	---	---	---
4	9490	24778	15952	15514	27815	36601	24586	11335	11698	---	---	---
5	10107	19759	15620	16672	26751	36678	22064	10307	12134	---	---	---
6	12927	18691	14632	17691	29140	35668	21225	11250	12500	---	---	---
7	11756	16899	14023	21348	34079	36040	20609	11384	12527	---	---	---
8	12548	16873	14786	26208	35786	38038	19228	10933	12493	---	---	---
9	12564	16945	14939	28958	36490	37008	18991	10957	13210	---	---	---
10	17023	16163	16080	24623	37176	38305	19628	11026	12440	---	---	---
11	22546	15578	20011	22584	37564	40308	19653	10374	12726	---	---	---
12	24035	15057	23351	21043	41971	43330	21719	10569	13086	---	---	---
13	22533	15661	24667	21496	42260	42605	20242	10604	12869	---	---	---
14	29992	14731	24739	21949	38374	42099	20274	11144	12923	---	---	---
15	26459	13950	27212	22402	38225	40619	18061	10384	12931	---	---	---
16	21087	14058	29356	22359	37086	36631	17607	11546	12577	---	---	---
17	19157	14257	27124	22626	38827	34847	16508	11455	12997	---	---	---
18	17400	15145	25201	21356	39539	32821	15593	12005	12417	---	---	---
19	16150	16012	28669	20925	38415	31208	12990	11466	12922	---	---	---
20	15322	17182	27432	20426	36350	30714	12024	11482	12104	---	---	---
21	13363	17283	27140	19890	33726	29769	11610	11319	12725	---	---	---
22	13441	16928	26050	18964	35961	28109	12248	11105	12178	---	---	---
23	13541	16812	25408	19826	38796	29187	12167	11170	12581	---	---	---
24	12105	17354	25306	19740	38222	29052	12387	11253	12894	---	---	---
25	12494	17710	23241	18854	39482	28887	11968	10911	13091	---	---	---
26	12339	17803	20222	20349	39440	30532	10782	10258	13019	---	---	---
27	12891	17430	18768	21555	40787	29339	10314	11077	13592	---	---	---
28	13050	17066	18869	21458	41824	28920	11095	11357	13076	---	---	---
29	12845	---	17699	23715	40550	30200	10590	11284	13333	---	---	---
30	12903	---	16940	24768	39784	29295	11396	11044	12702	---	---	---
31	16911	---	16463	---	40006	---	11766	11486	---	---	---	---

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PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1966

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	---	---	---	---	52	254
2	---	---	---	---	---	---	---	---	---	---	52	393
3	---	---	---	---	---	---	---	---	---	---	50	492
4	---	---	---	---	---	---	---	---	---	---	50	414
5	---	---	---	---	---	---	---	---	---	---	50	440
6	---	---	---	---	---	---	---	---	---	---	52	348
7	---	---	---	---	---	---	---	---	---	---	53	320
8	---	---	---	---	---	---	---	---	---	---	54	271
9	---	---	---	---	---	---	---	---	---	---	54	218
10	---	---	---	---	---	---	---	---	---	---	54	222
11	---	---	---	---	---	---	---	---	---	---	56	218
12	---	---	---	---	---	---	---	---	---	---	64	252
13	---	---	---	---	---	---	---	---	---	---	78	482
14	---	---	---	---	---	---	---	---	---	---	92	685
15	---	---	---	---	---	---	---	---	---	---	105	531
16	---	---	---	---	---	---	---	---	---	---	117	462
17	---	---	---	---	---	---	---	---	---	---	135	450
18	---	---	---	---	---	---	---	---	---	---	136	348
19	---	---	---	---	---	---	---	---	---	---	123	314
20	---	---	---	---	---	---	---	---	---	---	123	284
21	---	---	---	---	---	---	---	---	---	---	136	259
22	---	---	---	---	---	---	---	---	---	---	130	210
23	---	---	---	---	---	---	---	---	---	---	154	200
24	---	---	---	---	---	---	---	---	---	---	132	200
25	---	---	---	---	---	---	---	---	---	---	120	194
26	---	---	---	---	---	---	---	---	---	---	125	169
27	---	---	---	---	---	---	---	---	---	---	121	121
28	---	---	---	---	---	---	---	---	---	---	117	125
29	---	---	---	---	---	---	---	---	---	---	220	140
30	---	---	---	---	---	---	---	---	---	---	192	140
31	---	---	---	---	---	---	---	---	---	---	---	138

Table 6-2.1

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1967

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	130	826	317	382	338	970	806	48	31	45	91	99
2	122	677	328	350	323	970	725	48	31	55	89	97
3	138	604	303	353	341	970	691	48	30	88	89	99
4	138	546	276	385	369	970	598	48	30	61	86	100
5	132	466	276	429	388	1010	566	48	32	60	84	128
6	132	424	292	429	481	1460	488	48	32	58	85	112
7	127	399	298	460	590	1440	453	47	32	57	88	108
8	122	375	300	519	700	1270	402	45	33	57	86	97
9	110	369	300	519	888	1220	353	45	33	58	105	97
10	122	357	418	522	1050	1220	329	43	30	57	139	100
11	122	340	387	522	940	1220	248	41	36	57	185	100
12	122	334	331	526	888	1240	197	40	41	73	143	92
13	128	326	337	566	785	1190	193	39	38	66	126	51
14	128	309	309	550	715	1190	173	38	38	66	134	50
15	138	303	317	503	755	1310	140	37	39	64	160	48
16	143	279	323	460	844	1280	111	37	39	64	137	50
17	141	269	462	432	1100	1280	111	36	37	64	124	90
18	136	269	531	412	1290	1210	122	36	36	60	118	88
19	149	240	496	415	1250	1210	108	36	36	58	114	87
20	231	212	460	402	1250	1390	71	35	36	60	108	84
21	384	222	474	378	1400	1530	73	35	36	68	107	80
22	434	224	481	353	1600	1430	73	34	34	83	104	84
23	247	235	496	353	1600	1420	71	34	33	75	102	86
24	220	235	526	353	1570	1160	67	33	33	72	102	86
25	235	247	507	385	1370	894	64	33	32	71	99	94
26	229	274	488	402	1140	916	62	34	31	72	91	99
27	295	274	456	420	1090	934	59	34	31	76	84	108
28	989	300	474	446	1120	940	56	35	32	152	100	112
29	3240	---	470	419	1200	828	54	35	33	105	105	110
30	1950	---	446	385	1130	844	53	36	39	96	97	105
31	1080	---	412	---	994	---	48	33	---	92	---	108

Table 6-2.2

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1968

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	107	92	806	436	396	724	228	32	61	50	86	162
2	105	96	776	500	396	820	197	33	65	44	85	151
3	88	108	747	472	408	1020	167	35	61	43	105	153
4	75	143	719	436	468	987	147	36	59	44	100	153
5	100	172	736	480	490	837	137	38	57	42	93	182
6	76	185	843	448	444	820	126	39	55	43	89	162
7	75	194	714	408	385	796	113	37	53	43	87	157
8	114	185	623	373	344	691	107	33	51	43	102	162
9	120	180	538	355	373	670	92	32	51	44	288	153
10	124	180	474	389	464	620	81	37	48	43	172	155
11	105	172	429	480	595	640	71	37	46	44	177	162
12	88	172	393	472	675	660	67	36	47	113	315	155
13	122	170	368	416	746	620	66	35	45	116	243	139
14	105	164	368	385	757	550	63	61	48	90	192	151
15	102	157	341	370	655	510	61	90	53	86	184	149
16	120	150	334	344	610	530	57	63	52	85	177	151
17	112	152	370	315	645	570	55	58	51	81	162	135
18	104	226	334	300	730	610	53	68	52	78	177	141
19	100	1330	309	300	837	680	51	102	55	76	197	133
20	100	2310	294	282	1090	691	44	120	63	79	177	97
21	100	4060	291	267	1180	595	44	115	72	81	172	87
22	99	2210	303	237	973	545	44	102	75	76	231	118
23	99	2940	330	231	808	550	42	90	70	75	225	128
24	99	1960	373	204	713	476	40	83	65	75	213	149
25	99	1440	420	202	790	440	41	79	62	76	222	197
26	82	1140	424	197	825	420	37	76	58	76	200	184
27	91	987	385	202	735	404	36	81	56	75	184	174
28	76	887	373	219	702	355	35	78	55	78	170	167
29	104	837	389	270	843	309	36	74	53	79	164	160
30	100	---	456	330	825	273	34	67	52	102	170	116
31	94	---	444	---	740	---	32	62	---	95	---	124

Table 6-2.3

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1969

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	160	225	216	1180	660	1040	309	35	29	48	61	68
2	164	210	222	1110	580	980	279	34	28	59	61	70
3	149	200	228	1100	515	994	267	34	27	62	61	71
4	145	182	246	1010	505	1050	240	34	29	59	61	72
5	164	192	288	1090	595	1150	225	32	32	57	68	71
6	243	190	282	1420	702	1570	192	32	31	56	74	71
7	282	182	273	1180	920	1410	172	32	31	53	71	72
8	285	174	267	926	1180	1500	153	33	34	55	70	72
9	261	180	252	881	1310	1720	120	32	33	58	67	71
10	246	177	249	946	1470	1320	97	32	34	57	67	71
11	234	194	243	926	1570	1100	90	34	34	55	68	74
12	234	285	249	980	1540	907	79	35	34	53	67	86
13	384	330	252	1060	1540	808	66	32	35	51	67	102
14	796	303	264	933	1400	702	65	32	34	52	66	103
15	565	297	270	849	1280	615	62	32	33	52	66	96
16	400	282	291	843	1160	570	59	32	33	55	67	86
17	358	276	309	894	1160	520	53	32	33	58	66	85
18	315	276	452	933	1330	476	51	33	34	57	65	92
19	306	264	480	855	1620	436	50	31	37	55	70	115
20	294	249	520	757	1580	448	47	32	42	55	67	264
21	297	240	570	757	1320	400	42	31	45	58	67	396
22	270	240	660	973	1250	352	38	32	42	61	67	370
23	216	240	768	1430	1490	381	37	32	47	63	66	297
24	150	234	670	1430	1480	530	40	27	62	63	70	258
25	180	234	670	1060	1470	432	42	27	55	65	65	222
26	315	225	740	855	1550	396	41	29	52	62	67	213
27	318	216	814	774	1360	381	40	28	51	59	62	184
28	285	219	843	774	1130	404	38	28	47	62	59	164
29	246	---	913	779	1020	381	38	29	46	62	59	145
30	243	---	987	713	1140	358	37	29	46	61	62	141
31	234	---	1150	---	1160	---	36	29	---	61	---	135

Table 6-2.4

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1970

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	115	540	552	343	202	1000	468	57	31	57	93	327
2	106	480	552	343	272	1130	440	54	30	57	92	327
3	98	440	498	320	399	1320	412	54	30	57	92	299
4	93	395	458	317	563	1550	404	54	45	57	93	299
5	89	374	417	324	778	1680	391	52	57	57	107	285
6	82	370	395	399	936	1740	358	50	47	59	159	306
7	72	370	417	514	850	1910	320	46	48	63	147	771
8	104	362	449	458	743	1620	285	47	118	63	166	1260
9	116	358	404	449	743	2060	232	44	78	64	320	984
10	155	366	387	478	771	1570	210	43	66	68	229	685
11	133	366	383	503	678	1200	247	39	62	65	269	585
12	141	399	370	468	630	1030	218	36	62	63	335	473
13	184	806	366	440	563	960	198	34	64	60	247	391
14	318	792	453	412	503	993	164	33	66	62	216	366
15	456	710	596	378	488	1040	138	33	78	62	205	347
16	575	648	585	339	618	952	128	33	79	60	190	339
17	746	813	568	309	920	944	120	32	81	62	175	299
18	1020	704	514	306	1210	968	96	31	75	63	185	250
19	1720	618	473	324	1470	1080	88	31	76	65	178	259
20	1720	558	453	317	1470	1140	79	31	79	69	171	250
21	1950	519	430	299	1430	1140	73	31	88	93	159	241
22	2170	493	408	282	1470	1160	65	31	78	93	126	208
23	2820	473	391	269	2040	1180	65	31	79	126	155	186
24	5070	449	383	256	1860	1140	62	32	76	140	399	198
25	1670	430	378	244	1730	1030	54	32	73	111	580	162
26	1220	421	374	221	1830	912	49	31	72	107	417	175
27	1660	421	366	210	1660	904	47	31	72	96	362	178
28	1010	430	383	208	1350	704	58	32	66	95	335	195
29	779	---	391	198	1150	624	60	32	62	95	317	185
30	655	---	370	190	1040	536	58	33	57	93	358	195
31	570	---	354	---	960	---	57	33	---	93	---	200

Table 6-2.5

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1971

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	178	530	275	730	1140	1330	806	75	50	82	109	147
2	110	536	259	691	1450	1190	858	73	52	85	100	144
3	118	498	272	698	1850	1060	778	71	54	85	100	140
4	120	483	269	724	2470	1070	736	68	54	82	102	134
5	126	435	247	792	2250	1070	717	72	52	82	93	134
6	156	383	224	881	1880	1100	666	71	50	81	85	169
7	190	347	232	1300	1970	1100	590	68	50	78	92	132
8	198	327	224	1120	1940	1600	546	63	51	75	98	102
9	190	309	227	1010	1860	1610	541	59	51	72	98	151
10	183	343	238	1010	1790	1460	580	58	47	71	102	171
11	169	383	335	904	1790	1460	514	54	45	69	105	155
12	162	391	374	771	1880	1410	463	46	45	66	128	155
13	157	417	417	743	2220	1610	430	45	46	65	157	153
14	155	440	374	799	1820	1560	417	45	44	66	164	155
15	219	478	362	1000	1500	1380	408	43	45	71	130	153
16	440	503	354	968	1360	1290	440	42	47	73	120	144
17	1240	488	327	944	1070	1230	440	44	47	75	109	151
18	1500	488	309	828	928	1210	404	44	51	73	112	142
19	1510	530	313	764	858	1300	350	44	54	107	107	136
20	1460	468	327	843	806	1300	320	41	54	132	102	155
21	1010	435	358	936	743	1410	306	41	56	107	102	153
22	750	417	435	944	764	1500	272	41	54	95	100	183
23	636	395	558	944	881	1590	244	45	54	96	98	324
24	580	417	678	851	1070	1360	218	46	54	109	107	285
25	563	426	750	785	1240	1760	205	44	57	98	112	272
26	698	358	1290	881	1490	1620	175	42	59	96	118	259
27	624	347	1260	960	2030	1160	149	41	78	96	136	229
28	558	317	993	920	2590	1120	132	40	79	92	142	200
29	536	---	836	1030	2440	928	118	40	90	78	153	205
30	530	---	836	1070	2040	792	103	42	90	93	164	188
31	525	---	806	---	1590	---	92	45	---	102	---	185

Table 6-2.6

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1972

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	180	223	928	478	449	2230	352	54	37	56	62	95
2	175	180	785	511	449	2200	322	52	37	55	65	95
3	126	190	952	536	508	2120	307	52	37	54	67	95
4	107	209	743	547	607	1990	282	50	39	53	152	83
5	155	229	737	589	743	1860	263	44	39	53	144	54
6	159	219	928	662	836	1900	260	42	40	53	104	78
7	162	205	866	685	960	1920	281	40	40	53	96	100
8	149	193	717	630	1060	2030	243	38	39	53	107	121
9	153	180	724	569	952	1980	246	35	38	53	100	210
10	144	171	1030	530	813	1930	248	35	37	54	101	223
11	168	164	1420	498	724	1450	225	36	37	56	101	255
12	443	157	1590	525	750	1180	193	39	45	58	99	244
13	371	164	2330	478	836	1040	180	38	59	58	92	208
14	287	166	2110	435	1060	993	162	39	59	57	87	191
15	249	166	1620	412	1300	1030	146	46	58	60	88	169
16	215	171	1600	421	1460	1270	123	49	57	60	88	194
17	232	227	1700	412	1470	1140	114	44	57	60	93	217
18	219	288	2130	391	1270	968	96	43	55	60	92	256
19	242	327	1850	370	1040	811	79	43	54	60	95	481
20	870	430	1420	366	993	709	87	41	53	60	88	476
21	1860	493	1210	383	1020	670	91	43	52	60	83	898
22	1300	519	1120	408	944	624	87	44	53	60	83	522
23	949	519	1190	412	866	594	81	42	55	60	87	495
24	631	468	1000	453	928	545	74	41	54	60	83	1050
25	530	426	984	453	896	515	65	40.	56	60	83	541
26	455	404	778	440	896	461	57	39	58	61	134	385
27	375	468	672	468	1000	402	55	39	58	62	135	346
28	331	960	597	530	1280	376	54	38	57	62	107	391
29	282	1360	539	547	1760	391	52	36	56	62	105	313
30	228	---	497	493	2020	380	48	38	56	60	96	261
31	223	---	467	---	2140	---	49	37	---	60	---	231

Table 6-2.7

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1973

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	203	162	877	335	424	807	113	32	30	51	149	704
2	195	145	879	313	415	683	110	34	30	49	100	858
3	157	151	713	303	549	569	90	33	30	49	92	660
4	122	153	614	329	715	499	81	32	30	51	88	558
5	156	179	600	406	787	486	80	30	29	51	96	483
6	145	195	576	445	809	535	72	31	27	52	142	444
7	129	195	565	407	760	602	67	30	27	62	157	750
8	94	199	580	379	809	618	67	31	31	59	182	785
9	111	213	576	372	778	636	59	29	30	56	331	574
10	147	218	622	364	678	504	50	29	29	56	536	493
11	143	226	605	416	610	472	42	30	28	57	1030	444
12	143	218	546	515	601	437	43	30	28	52	1560	412
13	207	217	522	668	666	443	44	29	26	51	984	417
14	273	224	475	667	804	480	43	28	27	51	691	404
15	292	228	439	596	928	468	38	28	29	50	730	378
16	1040	235	417	563	1090	390	35	28	30	49	1100	404
17	1100	246	422	560	1220	369	35	28	29	48	936	1180
18	665	231	387	488	1290	333	37	29	29	47	717	1110
19	596	217	362	433	1170	297	43	29	35	45	580	743
20	454	205	368	376	1120	266	53	29	56	46	503	618
21	393	203	427	345	850	255	59	28	67	49	463	764
22	282	203	398	345	705	244	51	27	51	51	421	888
23	278	212	382	370	682	257	44	26	49	65	395	936
24	250	229	401	376	1070	236	43	26	52	85	387	757
25	251	254	443	417	1770	231	41	29	59	95	374	648
26	227	290	469	459	1020	214	38	32	54	78	358	536
27	178	433	463	515	749	209	36	31	50	72	347	524
28	184	648	418	559	674	201	36	30	50	71	343	483
29	171	---	381	492	662	169	35	30	48	75	404	449
30	187	---	353	446	732	137	34	30	47	71	546	408
31	178	---	374	---	864	---	32	30	---	85	---	374

Table 6-2.8

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1974

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	275	702	427	1680	1120	1350	1020	113	61	55	74	85
2	256	585	495	1440	1210	1490	936	112	63	55	75	90
3	247	508	456	1140	1120	1750	851	111	64	55	75	95
4	230	486	431	980	1120	1910	831	111	62	57	76	97
5	224	456	477	879	1260	2470	824	110	62	59	79	100
6	218	404	590	817	1520	1970	743	109	58	61	81	95
7	253	381	504	773	1560	1660	761	108	55	63	85	95
8	232	366	477	755	1730	1410	914	107	56	63	97	88
9	221	348	439	767	1860	1440	1180	106	54	63	87	87
10	238	330	431	810	1510	1490	958	104	54	67	90	85
11	269	323	415	831	1300	1670	797	102	62	66	88	95
12	324	316	517	824	1160	2000	720	99	67	67	90	95
13	327	309	657	755	1000	2330	710	96	63	67	90	92
14	313	306	652	731	893	2610	720	93	64	66	93	93
15	2950	309	625	785	817	2770	730	89	64	66	92	93
16	5430	469	697	837	754	2860	640	86	64	66	90	93
17	3270	499	1000	914	697	2930	584	82	63	65	90	108
18	2560	456	1290	1040	641	2840	490	78	64	65	97	108
19	2410	536	1180	1140	595	2650	415	83	59	66	99	100
20	1610	504	990	1110	580	2590	326	86	63	64	90	104
21	1160	456	883	1020	560	2120	204	83	62	65	90	104
22	980	431	810	1060	575	1920	160	85	59	68	97	100
23	851	385	742	1110	631	1970	140	86	55	68	97	79
24	773	377	701	1430	749	1980	130	85	53	68	100	65
25	755	355	718	1460	879	1860	124	83	54	70	102	95
26	691	334	772	1340	1170	1480	120	81	53	71	99	93
27	615	334	890	1090	1690	1190	118	74	52	71	97	93
28	570	362	1260	921	1690	1090	117	69	54	72	95	76
29	536	---	1200	824	1590	1040	116	65	55	76	85	57
30	486	---	2030	886	1430	1030	115	62	57	75	88	92
31	560	---	2090	---	1340	---	114	61	---	74	---	69

Table 6-2.9

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1975

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	82	158	255	431	598	1290	707	85	97	48	141	112
2	85	180	544	412	642	1520	743	75	95	47	138	235
3	90	198	603	435	1040	1610	836	65	88	48	136	189
4	110	195	587	463	1030	1400	868	60	82	48	134	213
5	125	175	576	435	792	1420	842	55	74	48	136	252
6	131	164	560	382	671	1560	875	53	67	48	136	229
7	116	164	523	369	614	1490	817	52	65	71	156	313
8	116	153	842	357	665	1290	743	52	61	79	148	440
9	99	158	991	353	855	1190	671	51	56	70	136	454
10	97	172	902	382	1030	1150	625	49	53	72	131	395
11	90	204	773	404	1260	1140	534	47	51	93	134	353
12	90	337	701	449	1150	1170	488	46	52	95	129	333
13	99	565	625	560	1220	1230	677	45	52	92	125	298
14	95	544	609	659	1420	1320	483	44	51	85	125	242
15	95	404	581	642	1650	1250	449	44	50	82	122	252
16	99	337	603	713	1570	1180	390	44	49	81	127	235
17	104	269	587	689	1430	1030	337	47	49	81	125	210
18	122	238	625	689	1320	1020	291	58	49	81	118	177
19	127	242	779	725	1200	1140	255	76	52	79	110	151
20	120	222	701	695	998	1060	225	87	50	78	106	151
21	114	195	625	725	888	1010	192	85	50	84	114	146
22	108	172	550	749	875	970	156	81	49	114	112	172
23	114	172	508	810	881	998	122	116	47	110	116	195
24	116	177	555	849	956	1010	104	186	45	108	114	180
25	141	166	823	1000	810	1040	88	136	46	108	114	172
26	166	161	620	810	792	1020	78	120	45	186	112	198
27	136	166	493	695	743	881	72	112	44	186	116	255
28	146	198	417	654	749	767	71	110	44	166	114	232
29	134	---	421	598	823	695	72	108	44	153	93	222
30	95	---	463	614	1010	695	85	99	47	143	76	242
31	102	---	503	---	1140	---	82	97	---	146	---	222

Table 6-2.10

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1976

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	148	175	513	785	956	731	219	70	74	55	68	63
2	172	186	412	695	1070	642	169	104	68	61	69	63
3	180	204	345	743	1100	614	151	79	63	65	69	63
4	186	172	298	849	1140	576	146	75	59	63	68	66
5	186	114	269	1030	1100	544	148	74	58	63	68	64
6	175	102	259	1330	1080	550	136	63	63	66	66	58
7	169	118	245	1270	1200	592	120	60	60	61	65	66
8	172	155	232	1280	1280	598	131	72	58	59	65	66
9	169	190	232	1660	1320	631	127	76	55	55	65	66
10	148	230	255	1500	1340	707	116	70	57	55	64	63
11	161	225	345	1370	1280	731	97	61	58	52	63	63
12	156	211	313	1410	1200	671	153	63	70	53	63	58
13	136	202	306	1310	1210	636	166	63	65	54	63	60
14	158	212	349	1140	1210	539	146	61	64	55	61	57
15	169	231	390	1170	1100	493	134	85	63	55	68	55
16	213	221	435	1000	991	498	116	88	64	54	70	63
17	273	214	483	895	991	503	100	85	67	53	70	55
18	294	207	571	829	970	488	122	85	67	51	70	54
19	313	203	636	755	935	473	146	85	66	52	69	56
20	294	191	550	761	928	503	118	79	67	54	69	52
21	266	182	488	792	888	503	110	78	66	55	69	54
22	232	191	463	767	895	444	106	68	71	58	69	58
23	266	200	565	707	915	378	92	129	76	60	68	60
24	235	209	671	755	935	333	95	127	75	61	66	58
25	219	220	701	908	888	313	110	120	74	60	68	60
26	204	683	671	804	836	280	93	127	70	64	63	59
27	204	1000	631	737	888	262	87	116	64	65	50	59
28	198	998	648	725	855	255	75	110	64	64	57	54
29	195	659	603	719	761	245	67	102	60	66	63	56
30	189	---	609	817	743	255	64	95	59	66	66	60
31	177	---	695	---	792	---	59	81	---	68	---	58

Table 6-2.11

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1977

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	60	61	88	69	52	153	23	15	20	54	53	213
2	58	61	77	66	55	175	25	14	19	48	57	504
3	60	63	76	63	59	121	25	15	18	43	51	743
4	54	64	80	64	63	106	25	14	17	41	51	484
5	43	66	74	66	52	106	28	13	16	39	84	374
6	45	63	74	72	51	95	25	14	15	36	103	321
7	56	64	74	79	51	82	23	15	14	42	79	284
8	54	63	74	90	50	74	22	14	11	42	69	245
9	60	58	85	83	52	80	21	14	12	41	65	222
10	56	57	77	76	77	68	23	12	13	40	64	210
11	60	55	69	72	80	65	23	12	12	40	61	222
12	62	58	72	66	64	74	21	12	12	38	61	249
13	62	60	69	70	64	74	20	11	12	37	64	637
14	62	63	64	64	63	83	20	11	12	36	69	1620
15	62	61	63	60	66	70	19	13	13	36	85	3000
16	62	64	65	63	69	63	18	11	17	35	88	1200
17	62	64	66	64	72	59	18	10	28	33	76	856
18	62	65	65	60	80	52	19	10	34	31	66	671
19	60	68	68	54	88	49	21	11	29	31	66	545
20	57	68	66	52	82	57	18	11	23	31	59	441
21	57	77	64	53	77	50	17	11	39	31	58	400
22	57	90	63	54	74	44	17	11	36	33	70	366
23	57	77	65	59	88	35	16	11	34	34	78	349
24	59	72	66	69	153	31	18	12	32	35	93	317
25	60	68	61	76	134	28	23	20	45	35	146	295
26	58	70	60	64	153	27	24	23	41	47	255	284
27	55	69	60	55	242	26	21	20	37	44	235	269
28	55	77	61	54	204	25	18	18	33	42	213	252
29	55	---	66	58	189	24	17	19	90	47	255	242
30	55	---	63	53	167	23	16	21	68	55	245	262
31	59	---	63	---	143	---	16	21	---	55	---	238

Table 6-2.12

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1978

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	156	269	357	1540	1250	671	737	64	69	85	72	72
2	138	273	337	1310	1210	719	654	54	63	84	73	69
3	198	409	329	1030	1130	869	637	53	59	81	72	62
4	210	418	333	950	1010	1010	786	54	55	81	72	67
5	219	400	418	882	909	1170	761	50	58	79	70	65
6	225	626	465	1030	804	1240	666	46	125	79	70	68
7	210	731	450	1120	779	1210	660	44	151	76	70	57
8	213	798	593	929	773	1160	737	43	177	72	72	61
9	255	786	889	849	811	1150	654	41	153	68	84	64
10	333	713	869	811	889	1110	660	41	183	69	70	67
11	345	609	792	830	922	950	593	40	192	72	57	71
12	353	535	817	786	843	862	504	39	169	70	63	65
13	366	479	695	725	792	862	432	59	156	70	68	60
14	400	441	615	701	836	862	400	79	143	72	63	62
15	470	436	550	683	936	786	374	75	138	70	59	67
16	615	387	509	964	875	725	353	99	131	69	64	61
17	849	349	504	817	773	660	298	103	131	69	63	62
18	755	325	561	719	731	701	252	101	138	68	62	68
19	683	306	654	654	749	671	219	103	131	66	64	65
20	660	302	737	683	786	731	186	108	127	69	66	59
21	609	298	767	683	902	773	166	103	123	68	67	49
22	677	295	843	626	1070	737	156	99	123	68	73	52
23	530	295	985	604	967	773	141	97	112	70	78	50
24	446	306	1020	571	836	786	123	101	106	70	76	51
25	404	400	895	604	743	849	110	97	103	68	74	49
26	378	357	915	856	671	713	99	97	99	69	68	46
27	341	396	1020	2500	631	719	93	95	93	68	61	50
28	317	374	1150	2090	671	804	87	87	93	69	65	49
29	321	---	1220	1640	725	862	92	79	85	68	67	43
30	295	---	1280	1440	683	792	73	72	84	68	69	37
31	280	---	1240	---	666	---	66	70	---	66	---	38

Table 6-2.13

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1979

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	41	52	441	520	957	556	222	28	37	28	101	106
2	55	50	378	470	985	604	204	28	36	28	99	101
3	57	52	329	418	992	749	169	27	35	27	100	112
4	56	52	298	374	978	856	143	27	35	28	100	125
5	50	54	298	361	1200	843	141	27	34	28	105	136
6	48	52	470	427	1240	804	131	27	32	28	103	131
7	49	58	798	515	1050	660	118	26	31	28	100	136
8	52	54	875	550	978	561	110	26	31	27	93	153
9	56	56	689	643	836	545	105	26	29	26	93	164
10	58	65	587	593	761	598	93	26	28	27	90	175
11	52	78	604	525	701	637	78	26	28	27	90	151
12	52	141	666	460	713	731	69	26	28	27	87	146
13	50	396	701	427	767	767	61	26	30	27	87	134
14	52	654	731	400	836	719	57	57	31	28	87	127
15	53	499	773	427	978	593	52	55	31	31	83	125
16	54	387	1800	484	1140	540	48	44	30	34	90	123
17	50	309	1340	615	1030	561	43	40	29	33	105	120
18	52	309	1010	643	978	620	39	35	29	39	105	120
19	54	325	902	550	950	540	37	35	28	141	92	114
20	56	317	862	484	943	474	37	35	28	84	67	112
21	56	306	843	465	971	450	36	34	29	61	67	127
22	54	298	786	535	1050	455	35	34	28	59	77	146
23	51	295	761	643	1160	441	34	34	27	97	100	123
24	53	280	755	707	1120	418	32	35	25	97	102	125
25	57	366	755	695	1080	391	31	32	26	120	102	130
26	52	391	689	695	1100	366	30	33	31	213	102	114
27	50	427	755	767	1130	345	29	35	31	148	86	105
28	52	441	964	889	964	306	29	35	31	129	57	105
29	49	---	849	964	749	276	28	36	30	114	78	105
30	43	---	701	971	615	249	28	37	29	108	110	110
31	45	---	598	---	566	---	28	39	---	106	---	127

Table 6-2.14

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1980

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	123	156	604	229	950	648	455	47	36	64	73	95
2	120	151	571	225	985	677	530	44	41	63	73	113
3	120	166	530	229	1030	604	489	45	45	59	72	317
4	125	172	504	222	1130	577	525	48	39	57	71	512
5	140	158	525	238	1210	561	450	48	37	54	70	348
6	130	146	494	291	1300	561	409	45	38	54	75	271
7	120	146	436	269	1220	525	391	42	37	51	241	223
8	138	151	396	255	1110	520	374	41	37	49	244	176
9	140	151	361	287	1300	593	333	38	36	47	159	156
10	142	153	341	329	1110	626	306	39	40	46	140	164
11	136	146	345	321	964	725	276	37	57	48	123	157
12	172	141	321	353	915	909	238	37	49	52	116	147
13	341	138	321	432	882	862	216	37	101	73	103	135
14	609	134	321	550	849	957	204	35	222	70	98	131
15	755	136	317	620	909	849	195	35	141	71	101	132
16	561	141	291	626	889	792	172	35	105	71	91	125
17	550	325	276	695	811	869	158	33	95	73	97	122
18	465	1130	269	830	849	950	151	35	88	73	91	117
19	353	1280	249	957	875	971	129	38	88	72	89	114
20	298	1240	249	1060	964	950	112	36	90	73	86	115
21	287	1170	337	1180	1210	922	103	36	93	72	89	128
22	252	943	357	1240	1240	869	84	35	87	69	113	264
23	232	786	361	1280	1060	743	65	34	82	69	115	297
24	219	660	317	1320	856	660	58	35	78	70	103	371
25	210	598	302	1070	737	561	57	35	76	74	95	848
26	198	593	295	985	737	525	55	32	72	97	90	1970
27	153	604	298	1040	767	489	50	31	70	81	101	1790
28	95	637	269	1130	719	418	47	33	66	75	95	1120
29	136	626	259	1300	654	441	50	34	64	73	96	836
30	112	---	255	1070	626	465	45	35	65	73	99	707
31	146	---	242	---	604	---	44	35	---	74	---	620

Table 6-2.15

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1981

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	550	446	413	650	1120	810	176	47	27	47	84	227
2	499	387	396	600	1210	777	153	46	26	49	87	240
3	450	349	387	562	917	719	137	43	27	56	85	240
4	400	317	378	515	819	688	130	43	28	53	84	227
5	366	302	387	482	673	695	121	42	28	53	83	222
6	337	291	345	456	575	949	114	40	28	55	83	415
7	313	266	321	425	520	947	203	38	28	69	81	620
8	295	252	302	394	462	1420	181	36	28	95	78	518
9	273	242	291	376	408	1240	151	33	27	83	77	470
10	249	201	287	347	408	975	131	33	25	105	78	440
11	235	186	291	331	399	883	114	31	26	144	78	380
12	219	213	298	307	368	922	103	29	26	108	126	320
13	210	219	306	288	356	825	99	30	26	97	210	340
14	195	561	310	279	399	719	86	29	25	90	194	335
15	180	535	315	278	498	653	76	29	25	84	173	355
16	172	1610	376	314	465	662	64	30	24	83	243	385
17	180	1620	374	345	465	630	60	28	24	81	421	325
18	180	1450	350	398	501	568	59	28	24	77	311	305
19	172	1730	331	522	587	611	55	28	24	77	253	530
20	166	1280	330	627	639	628	54	29	25	74	224	1200
21	161	992	310	606	676	566	49	29	27	71	257	1050
22	161	817	323	569	664	531	47	29	29	71	300	780
23	249	713	329	585	670	497	43	27	29	73	372	575
24	470	648	315	791	737	437	43	26	32	73	430	525
25	333	587	399	781	887	383	43	27	33	73	364	450
26	317	530	651	707	987	342	44	27	37	81	311	400
27	309	479	626	706	939	278	45	27	49	87	287	320
28	446	446	585	666	918	224	43	26	75	84	260	300
29	660	---	625	715	881	190	46	26	51	95	240	280
30	620	---	634	853	915	173	45	25	45	88	227	250
31	520	---	643	---	846	---	45	27	---	84	---	240

Table 6-2.16

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1982

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	244	216	774	590	985	781	950	92	57	105	176	153
2	225	219	999	550	1110	763	930	99	52	103	164	148
3	220	219	934	541	1300	840	940	96	52	107	162	162
4	210	162	913	489	1190	939	800	91	53	120	157	221
5	202	135	872	457	998	877	710	90	55	126	153	248
6	183	166	799	462	908	786	615	83	59	118	151	405
7	172	205	736	448	933	763	605	68	59	128	142	334
8	198	164	712	414	933	735	650	65	51	122	138	257
9	202	186	693	393	870	746	495	72	51	116	140	238
10	198	159	799	401	816	792	445	63	52	114	134	210
11	198	166	1340	991	792	908	415	60	56	112	130	197
12	200	164	1080	1330	810	1090	375	69	63	109	122	189
13	194	169	900	1240	828	1270	345	72	69	107	128	194
14	192	202	1040	1360	933	1360	325	67	68	107	109	181
15	190	398	1160	1140	1290	1570	288	64	69	105	116	197
16	188	1550	920	939	1510	1560	268	67	69	103	128	267
17	196	1810	793	834	1440	1550	250	68	67	102	148	504
18	193	1690	761	775	1520	1540	225	63	65	102	174	400
19	192	2490	706	696	1310	1530	212	63	65	100	232	334
20	160	2630	624	626	1180	1510	200	62	90	100	189	305
21	158	3570	580	616	1180	1500	185	62	88	102	174	527
22	157	3340	553	690	1210	1400	182	62	81	110	153	709
23	146	2030	548	828	1290	1310	164	60	85	120	136	523
24	189	1390	618	991	1270	1190	159	57	81	181	128	405
25	194	1040	685	1040	1390	1140	151	57	88	146	130	334
26	199	839	746	985	1550	1060	137	56	108	218	138	338
27	219	718	757	1000	1340	1010	134	54	94	197	146	284
28	222	641	752	1110	1130	990	134	53	94	164	151	235
29	216	---	723	1140	939	920	124	56	113	281	167	218
30	213	---	679	1040	804	850	113	65	108	254	167	216
31	216	---	652	---	781	---	99	62	---	194	---	216

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	187	316	874	1080	1050	1890	1200	162	81	79	100	184
2	184	298	1290	1340	1050	1820	1490	128	109	76	114	176
3	229	267	1510	1090	1040	1540	1060	114	109	76	140	174
4	218	241	1660	905	1070	1530	917	109	103	78	174	169
5	221	221	1810	781	1210	1470	923	96	100	76	146	162
6	238	232	1430	703	1200	1380	973	87	95	78	241	169
7	388	235	1400	661	1060	1380	917	84	90	78	349	194
8	650	224	1390	625	986	1440	827	81	91	79	164	229
9	620	221	1400	615	893	1450	742	84	96	79	151	241
10	500	238	1490	595	770	1440	625	82	93	81	151	417
11	413	248	1680	532	682	1540	585	84	96	81	267	703
12	369	288	1860	495	645	1220	556	81	91	84	218	999
13	331	451	1950	464	645	1030	537	79	82	85	207	551
14	302	509	1950	451	656	992	580	81	79	85	187	451
15	274	464	1490	451	666	1080	504	84	76	85	207	388
16	274	810	1170	477	640	1050	430	98	71	87	221	331
17	257	1020	1010	537	670	1030	384	96	69	88	320	284
18	248	1590	868	570	750	1070	361	91	67	85	261	251
19	244	1370	787	595	870	905	331	84	78	85	227	229
20	248	1010	671	753	1000	798	323	88	79	85	229	187
21	248	880	615	923	1200	725	284	98	80	84	213	112
22	244	961	570	1010	1360	731	248	116	82	85	194	100
23	241	948	546	1190	1500	880	238	114	81	116	194	90
24	241	862	518	2000	1750	936	257	118	80	105	213	100
25	261	899	504	1580	1910	893	257	107	76	98	227	130
26	349	948	468	1200	2150	874	244	100	72	93	205	160
27	468	899	504	1020	2310	948	232	90	72	93	199	130
28	495	827	482	923	2360	886	213	88	68	91	197	175
29	405	---	585	923	2460	973	199	87	71	91	189	220
30	369	---	1530	973	2420	973	176	72	71	93	184	270
31	345	---	1320	---	2160	---	164	71	---	100	---	290

Table 6-2.18

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	275	98	126	620	442	1340	948	162	140	91	97	184
2	250	88	132	620	640	1080	905	138	112	86	110	172
3	240	98	202	590	661	917	874	126	103	86	128	132
4	250	91	229	580	677	1090	856	199	102	85	114	105
5	320	88	232	630	620	1170	851	171	98	79	110	110
6	300	82	244	880	546	1390	845	157	95	77	117	115
7	270	82	261	731	495	1240	758	138	91	79	124	135
8	260	87	288	1140	523	1080	656	120	105	79	119	161
9	240	84	316	1040	625	936	575	107	107	79	131	190
10	230	85	372	821	693	851	532	102	100	77	138	198
11	215	81	482	687	714	923	527	85	98	96	157	198
12	150	84	703	671	893	936	523	81	95	123	217	191
13	140	116	905	575	1160	967	491	78	90	138	210	181
14	115	216	1750	546	1550	1040	447	76	85	118	242	178
15	85	202	1780	703	1430	1150	417	68	87	110	178	180
16	95	197	1620	1080	1070	1250	388	63	85	109	168	169
17	98	189	1570	1340	868	1180	353	58	74	112	153	164
18	84	167	1990	1290	886	1140	334	59	65	110	162	164
19	91	148	1550	1340	1040	1160	302	57	60	111	155	155
20	83	155	1590	1100	1280	1140	261	57	65	111	163	125
21	110	162	2550	917	1210	1210	232	58	79	109	221	172
22	130	148	2090	886	1010	1010	216	57	85	106	177	186
23	145	136	1440	999	1350	961	205	56	100	101	166	174
24	160	134	1540	936	1330	1030	216	54	102	98	259	164
25	169	134	1160	753	1080	1240	210	53	93	96	219	158
26	136	132	1090	635	1190	1390	205	49	98	106	189	159
27	112	124	868	537	1220	1450	210	48	96	109	185	160
28	105	126	775	504	1270	1380	205	46	91	109	184	159
29	103	126	781	447	1510	1470	224	45	72	110	187	158
30	102	---	687	425	1880	1190	202	46	73	102	197	162
31	103	---	630	---	1890	---	181	124	---	105	---	157

Table 6-2.19

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	121	144	161	965	688	778	111	67	33	66	120	128
2	110	144	162	1260	815	733	104	63	41	66	124	132
3	129	122	166	1410	845	689	96	54	49	64	125	156
4	138	104	174	1220	789	703	89	51	46	62	121	173
5	166	136	173	974	643	892	80	53	45	62	131	165
6	171	156	170	947	580	995	75	49	42	62	127	162
7	190	168	169	973	576	1140	68	46	49	74	151	165
8	177	163	165	1050	569	996	65	43	115	74	188	179
9	166	143	174	1140	533	846	62	44	104	70	162	168
10	159	136	194	1260	522	765	56	41	111	73	160	144
11	164	128	220	1330	511	703	50	53	116	74	157	104
12	170	127	247	1140	473	664	50	52	112	75	146	120
13	167	126	275	1070	455	643	48	46	95	73	136	129
14	164	122	308	1160	485	546	47	45	106	73	130	131
15	151	121	350	1330	475	497	47	43	110	73	139	124
16	142	120	396	1350	548	486	41	42	102	73	145	122
17	146	116	464	1170	668	442	40	42	104	72	141	122
18	138	119	559	1070	771	410	40	41	101	70	139	122
19	140	117	664	966	846	386	39	48	93	69	115	120
20	142	131	768	765	943	354	37	51	88	68	140	118
21	142	120	976	634	900	288	37	50	83	72	139	112
22	140	126	794	555	946	254	36	45	78	110	137	110
23	135	127	645	491	1080	227	37	42	74	156	94	112
24	132	133	739	458	1220	212	35	39	71	135	131	108
25	131	139	747	427	1280	171	35	35	68	148	171	106
26	109	145	645	393	1070	160	32	36	69	162	148	100
27	113	143	555	359	904	152	29	35	68	152	137	95
28	150	151	514	385	860	144	29	32	65	145	149	93
29	143	---	492	467	1060	132	32	29	65	136	145	94
30	99	---	531	554	931	122	47	30	65	130	133	89
31	141	---	740	---	769	---	45	32	---	123	---	90

Table 6-2.20

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	110	495	1360	789	514	1910	163	42	39	103	83	101
2	107	575	1410	688	534	1640	141	41	43	98	81	100
3	114	614	1350	618	590	1430	127	41	38	94	80	95
4	105	578	1190	603	680	1370	116	41	34	92	78	99
5	108	554	1110	595	633	1380	116	40	33	93	77	107
6	112	489	1100	623	648	989	116	40	32	89	75	105
7	108	418	2330	679	598	875	114	40	32	86	80	99
8	108	362	3350	754	586	765	110	40	38	83	84	94
9	108	315	2470	869	573	687	104	38	41	79	84	78
10	111	294	1950	848	568	654	102	37	42	76	77	77
11	109	276	1590	792	530	637	102	36	41	75	80	90
12	106	257	1460	719	491	623	100	36	42	73	87	92
13	104	246	1220	632	474	597	95	36	48	73	84	88
14	106	244	1060	565	474	559	88	36	50	72	84	93
15	108	345	886	519	436	546	84	36	52	74	88	87
16	117	1170	855	520	404	498	82	36	56	74	91	83
17	160	1660	754	506	394	453	84	36	62	76	133	78
18	149	1970	652	479	433	425	84	36	84	74	117	72
19	158	1320	598	451	502	391	82	36	80	72	108	84
20	164	873	578	452	616	348	78	35	115	71	103	81
21	152	724	601	529	1030	303	72	36	114	71	107	80
22	151	1320	605	1050	854	269	65	38	93	69	117	76
23	153	3450	587	1140	668	247	61	36	81	66	124	80
24	147	2940	631	894	578	234	56	34	109	65	123	76
25	143	2290	649	780	605	220	52	32	115	65	117	76
26	138	2140	614	674	787	211	50	32	125	64	108	77
27	143	1780	627	645	1140	202	48	31	113	71	117	78
28	149	1490	724	632	1540	195	47	30	101	75	118	75
29	167	---	889	590	1700	186	45	31	94	74	112	74
30	236	---	989	540	1970	176	44	32	102	97	99	75
31	353	---	893	---	1990	---	43	36	---	90	---	61

Table 6-2.22

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	79	110	171	248	1320	232	34	23	21	22	31	57
2	83	128	177	281	871	196	36	24	21	22	36	83
3	81	146	288	314	645	179	33	24	20	21	32	107
4	82	153	476	352	563	169	31	23	21	21	31	94
5	80	144	743	381	557	149	31	23	20	22	31	90
6	76	142	1770	395	601	144	35	24	21	22	31	120
7	76	144	1550	413	658	140	35	25	21	22	31	133
8	75	144	1020	441	670	153	35	24	21	22	32	106
9	71	146	959	415	637	154	36	22	20	22	33	104
10	69	149	780	389	576	137	39	22	20	22	35	152
11	47	164	744	434	526	107	43	22	19	23	35	156
12	78	175	934	378	514	92	36	22	19	23	48	122
13	89	328	1550	341	513	79	34	24	20	23	92	109
14	88	640	1230	312	482	65	32	30	20	23	99	90
15	86	508	914	330	491	67	29	30	20	25	59	100
16	e83	443	722	343	514	68	27	27	20	24	52	98
17	e81	414	622	377	459	73	28	26	21	24	49	95
18	e87	377	663	379	405	79	32	25	21	25	42	91
19	e89	338	547	334	354	109	31	24	21	25	47	86
20	e87	297	480	291	312	109	29	24	21	26	48	68
21	e81	274	437	266	280	100	29	24	21	26	48	87
22	e82	260	397	279	254	88	40	23	21	27	46	83
23	e84	246	366	317	238	78	45	22	21	27	48	74
24	e89	225	343	385	230	70	36	22	21	27	46	54
25	e90	207	316	433	230	56	32	21	21	28	49	e48
26	e91	196	304	474	211	50	30	20	21	28	46	e45
27	e101	183	285	541	245	44	29	21	21	27	46	e50
28	e108	172	270	657	236	41	26	21	22	28	47	e57
29	e107	---	248	752	215	38	24	21	22	28	41	e72
30	102	---	243	1160	209	37	23	20	21	29	43	e69
31	104	---	236	---	281	---	22	21	---	29	---	e66

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e56	99	566	193	288	580	95	23	17	22	28	113
2	e51	93	583	204	258	613	84	22	18	22	30	110
3	e43	86	627	355	233	552	75	23	17	22	55	127
4	e57	80	542	388	234	544	74	22	17	23	43	116
5	e73	86	507	325	232	498	72	21	18	23	37	122
6	e66	88	519	298	218	411	79	22	18	22	39	126
7	63	95	443	332	211	375	70	22	17	22	43	113
8	64	91	386	317	206	315	63	22	17	22	41	111
9	66	100	366	282	220	280	50	22	17	22	39	115
10	71	120	322	262	219	243	43	21	17	22	47	123
11	82	150	286	268	220	229	42	20	18	22	53	134
12	72	178	259	306	263	216	41	20	19	22	61	153
13	71	206	241	399	418	206	40	22	18	22	69	173
14	78	219	229	496	415	179	38	22	18	22	84	160
15	96	214	218	562	346	178	36	23	17	22	65	133
16	95	236	207	564	418	188	33	23	17	22	63	111
17	89	225	200	607	569	185	31	24	17	23	69	111
18	81	203	197	614	478	189	30	24	19	24	65	111
19	68	183	203	538	408	181	29	24	21	25	59	e110
20	e60	174	220	493	392	176	30	23	24	25	62	112
21	e70	178	252	556	419	157	29	22	23	25	69	112
22	e80	194	255	529	484	145	27	22	23	25	120	111
23	e85	201	249	497	563	120	26	21	23	25	221	105
24	e77	201	224	438	552	95	25	20	23	26	160	101
25	e76	213	237	391	528	80	25	19	23	26	137	101
26	e75	241	231	337	501	110	24	19	23	26	134	69
27	e78	282	236	310	450	140	23	20	26	26	119	e68
28	82	323	225	315	428	117	23	19	26	27	127	e67
29	88	461	225	344	635	108	23	19	24	27	116	e66
30	104	---	213	337	499	93	23	18	24	28	108	e88
31	98	---	198	---	415	---	23	17	---	28	---	e92

Table 6-2.23

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e97	e83	250	952	697	576	307	31	89	75	111	104
2	e99	e70	252	886	718	689	282	32	89	76	113	102
3	e93	e56	226	744	705	861	257	33	91	73	113	103
4	e91	e58	207	651	734	954	235	33	91	70	116	106
5	95	e67	217	617	818	983	216	33	91	69	125	115
6	92	e76	227	733	990	1000	195	32	89	68	117	109
7	80	e81	344	1100	1560	1020	173	31	87	68	133	105
8	e76	e76	526	1230	1550	989	156	31	84	67	121	106
9	e80	e84	1060	1070	1420	968	145	31	81	66	144	110
10	e82	e98	1500	985	1770	922	139	32	79	65	155	99
11	e83	e90	1740	854	1570	809	92	37	76	63	151	88
12	e82	e95	1840	907	1230	798	77	35	72	62	149	82
13	e82	e93	1710	1020	1040	807	79	31	68	61	162	102
14	e80	e92	1440	1160	905	801	74	32	65	62	148	100
15	e81	e120	1140	1340	854	973	72	32	62	62	136	98
16	e80	138	997	1390	879	1150	79	31	60	64	137	94
17	e82	147	1020	1290	828	885	82	31	60	65	142	92
18	e82	153	1000	1200	901	739	79	33	65	65	136	86
19	e82	173	1340	1470	742	711	63	31	74	63	131	86
20	e80	162	1250	1640	661	629	54	32	78	62	126	80
21	e83	137	1310	1600	629	539	49	35	79	67	124	86
22	e82	132	1230	1450	612	501	45	38	79	147	118	81
23	e82	178	1170	1160	652	466	43	49	79	122	122	81
24	e73	206	1100	1000	592	460	40	58	79	126	128	77
25	e78	242	1580	929	537	425	37	71	78	126	124	75
26	e72	258	1990	817	503	401	34	81	78	118	131	74
27	e76	264	1710	744	505	394	33	85	76	164	110	73
28	e78	257	1810	694	557	367	32	87	76	140	104	76
29	e83	---	1550	657	592	347	32	89	75	122	101	75
30	e84	---	1160	654	546	325	31	89	74	120	101	69
31	e81	---	1080	---	535	---	31	89	---	119	---	69

Table 6-2.24

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	71	109	274	621	587	1020	171	32	40	29	137	71
2	69	102	296	744	574	912	159	31	39	29	103	86
3	52	98	422	844	561	814	195	32	37	30	95	87
4	72	103	514	866	571	765	165	33	37	35	108	86
5	70	86	480	820	630	701	159	31	37	35	139	84
6	75	103	492	784	702	734	150	30	35	36	112	71
7	87	85	484	787	615	846	145	28	34	38	99	74
8	290	102	568	831	546	729	128	28	34	38	105	88
9	357	117	514	795	508	734	106	26	35	39	103	82
10	228	285	850	707	485	835	80	27	33	40	102	88
11	197	331	841	680	433	722	79	27	33	41	99	113
12	178	265	614	707	396	604	72	28	31	42	95	98
13	187	219	511	652	369	540	75	29	31	41	94	98
14	243	155	469	660	375	494	68	28	29	42	93	82
15	220	139	442	718	351	463	54	28	28	47	93	75
16	205	166	423	853	328	436	50	30	28	50	86	80
17	188	150	426	934	320	436	43	33	31	49	85	82
18	169	123	471	942	336	423	40	56	30	55	86	85
19	158	118	588	867	326	403	39	58	29	100	83	77
20	143	120	696	868	373	389	37	58	28	69	86	e36
21	141	132	689	896	398	371	35	55	28	69	82	e40
22	136	127	671	979	372	341	37	62	28	104	89	e46
23	134	129	866	1020	392	333	36	56	28	78	87	e51
24	118	148	738	851	622	310	37	51	28	73	84	e62
25	121	186	608	728	549	297	43	73	29	71	92	e74
26	117	230	549	656	504	283	48	70	27	73	104	e80
27	111	258	545	674	488	245	44	63	28	73	90	e88
28	113	262	545	849	684	239	39	54	27	74	90	e75
29	119	---	542	660	1100	220	37	49	27	75	90	e65
30	116	---	541	618	1110	190	35	48	27	77	88	e56
31	109	---	556	---	1140	---	32	43	---	100	---	e65

Table 6-2.25

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e77	e78	363	256	299	624	317	33	27	30	49	115
2	e73	e86	366	315	307	681	300	33	27	28	47	122
3	e71	e94	415	327	322	706	282	33	27	28	44	116
4	e62	e90	453	388	302	644	267	32	27	28	52	115
5	e57	e100	450	440	298	570	248	31	26	29	62	113
6	e67	e117	377	451	364	483	211	30	26	30	101	228
7	e74	e113	330	414	404	452	176	30	26	30	73	447
8	e80	e110	298	362	723	434	153	30	27	30	71	290
9	e83	e108	273	343	738	442	136	29	27	29	81	235
10	e79	e107	256	312	554	486	131	29	28	29	75	208
11	e84	e110	235	285	492	592	125	28	31	29	72	182
12	e87	e110	243	266	469	615	107	29	29	28	105	175
13	e90	e108	287	272	504	522	98	28	28	28	160	160
14	e90	e200	282	288	525	438	93	28	27	29	104	143
15	e90	417	255	298	514	407	95	31	27	29	86	126
16	e87	708	239	298	532	414	93	28	26	28	76	121
17	e88	568	230	318	747	402	92	28	26	28	111	116
18	e88	461	230	337	1050	372	95	30	26	29	101	117
19	e87	388	232	329	1630	369	74	29	25	31	89	114
20	e82	354	246	355	1360	391	64	27	25	31	115	99
21	e77	392	236	389	1170	342	60	25	25	32	123	e86
22	e80	452	232	445	1090	327	53	25	24	32	100	105
23	e83	465	226	469	1030	322	45	26	26	34	88	94
24	e83	414	241	557	959	295	43	26	26	35	100	87
25	e80	388	247	519	959	319	52	27	26	40	107	89
26	e72	379	253	444	869	360	39	26	26	52	121	86
27	e76	365	227	388	759	329	37	26	26	51	154	85
28	e74	344	214	339	634	287	36	26	27	44	145	82
29	e70	---	207	313	584	315	37	26	30	43	139	87
30	e68	---	201	293	601	371	36	26	30	41	114	89
31	e72	---	212	---	554	---	34	27	---	43	---	89

Table 6-2.26

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	87	234	527	276	401	187	133	26	23	26	95	68
2	85	242	516	292	382	170	135	25	23	25	97	74
3	81	234	498	322	386	152	127	25	23	28	83	68
4	90	217	503	384	403	133	116	25	24	30	76	44
5	87	204	507	356	428	118	105	24	25	28	77	e43
6	95	198	478	298	457	106	104	25	25	28	72	e42
7	97	194	471	272	489	96	95	25	25	28	74	e48
8	74	196	521	250	515	90	84	25	26	28	82	e71
9	78	204	475	273	464	83	75	25	26	29	82	e80
10	88	207	451	315	401	69	63	25	25	29	72	e82
11	90	225	421	291	373	69	54	25	25	29	71	e75
12	85	250	401	324	311	69	53	25	25	29	71	e67
13	83	323	399	447	276	176	49	25	25	29	69	65
14	81	339	406	439	271	164	41	24	26	29	69	69
15	79	331	413	429	286	172	39	24	26	29	68	69
16	80	341	431	426	295	200	35	25	26	29	66	66
17	76	303	431	516	300	173	32	26	26	30	65	70
18	68	283	411	505	315	147	30	24	26	30	65	70
19	63	281	370	454	350	135	30	24	25	30	66	58
20	64	791	328	430	471	123	31	23	25	30	68	83
21	76	990	305	439	426	111	34	23	25	30	69	84
22	75	995	295	402	363	100	33	23	25	30	73	75
23	76	845	285	361	337	80	38	25	25	31	84	75
24	72	663	278	324	329	69	39	26	24	31	61	74
25	70	563	268	296	323	57	36	25	26	31	56	70
26	71	519	270	315	342	66	33	24	26	31	56	83
27	78	516	264	342	305	71	33	24	27	32	72	82
28	234	521	255	351	276	78	29	24	28	33	78	81
29	315	525	250	381	259	130	28	23	27	45	77	85
30	290	---	242	433	238	119	27	22	26	90	70	86
31	247	---	255	---	217	---	27	23	---	80	---	88

Table 6-2.27

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	96	128	118	1080	800	984	272	70	48	41	73	e90
2	88	122	128	1120	837	964	268	63	46	42	71	87
3	82	121	120	1310	1070	968	293	61	44	42	71	78
4	e82	119	115	1780	1460	869	283	60	43	42	72	86
5	e88	108	116	1510	1190	966	276	59	41	43	71	85
6	90	121	124	1170	1240	1130	252	58	40	43	69	75
7	88	118	139	1010	1290	1080	229	57	39	44	69	77
8	e88	116	155	952	1110	922	221	56	39	44	68	101
9	e92	118	205	985	964	827	205	55	37	45	67	109
10	97	124	268	963	958	858	185	53	36	49	74	103
11	97	145	305	872	1160	990	168	50	36	57	68	104
12	95	157	324	728	1510	836	154	47	36	59	70	109
13	94	167	298	621	1750	721	139	46	36	60	68	99
14	e98	176	329	584	1900	703	129	45	36	67	66	94
15	103	194	417	584	1820	747	122	44	36	67	64	92
16	101	175	741	586	1650	768	122	45	36	67	72	88
17	102	150	1130	636	1540	706	126	48	37	68	68	87
18	103	172	1620	850	1490	733	131	49	37	68	66	86
19	105	169	1860	791	1460	746	131	51	37	67	56	78
20	127	175	2370	728	1530	872	125	52	37	66	e52	80
21	183	164	1970	691	1440	851	118	52	37	65	e53	80
22	205	153	1490	736	1170	825	99	55	37	65	e54	78
23	185	156	1710	737	979	594	153	56	37	66	e46	67
24	182	153	3190	695	891	503	171	58	38	67	e41	74
25	169	142	2220	710	915	461	152	56	38	66	49	75
26	156	114	1760	762	1140	438	157	56	38	68	e43	80
27	139	111	1650	727	1100	427	144	56	38	70	e47	76
28	143	122	1520	675	1120	399	133	54	39	71	e54	74
29	144	---	1340	690	1100	349	124	53	40	71	e65	80
30	133	---	1080	791	917	312	114	52	41	71	e92	74
31	133	---	960	---	899	---	86	50	---	72	---	74

Table 6-2.28

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	83	102	475	435	508	393	46	25	20	27	63	93
2	89	e98	560	483	478	385	45	25	19	26	64	98
3	102	e95	647	549	464	357	44	24	20	26	56	93
4	146	e98	900	516	486	337	43	23	20	26	59	85
5	181	e95	877	446	568	301	45	22	21	28	59	67
6	162	e89	679	429	615	284	66	21	20	30	77	111
7	144	e81	593	412	684	283	54	21	19	30	75	97
8	139	e76	547	371	787	271	50	22	18	30	64	90
9	133	e78	533	377	910	231	44	22	17	30	81	90
10	128	e80	554	374	924	205	40	21	17	30	109	89
11	127	e80	629	377	855	196	38	21	18	32	98	86
12	124	81	652	409	883	212	37	20	19	32	97	94
13	124	94	615	392	749	206	35	19	19	32	93	94
14	133	88	617	371	622	189	34	18	20	40	83	91
15	149	86	701	345	572	169	34	18	21	44	79	94
16	149	84	802	380	517	171	32	19	21	40	83	99
17	142	89	701	478	505	177	32	18	21	39	79	159
18	134	103	601	628	461	158	30	19	20	40	76	190
19	129	106	564	750	422	147	30	19	20	40	67	198
20	120	104	486	824	494	138	28	20	20	40	81	182
21	114	106	435	853	473	121	28	19	19	40	64	167
22	117	107	392	833	480	105	28	19	19	40	57	147
23	110	116	349	723	447	96	27	20	19	40	72	137
24	117	205	314	867	456	90	28	20	20	40	90	157
25	128	206	292	836	476	84	26	19	20	41	89	150
26	137	206	282	748	510	74	26	20	20	41	79	153
27	144	472	301	649	584	65	25	19	20	45	71	259
28	141	502	336	582	523	58	26	18	20	66	72	318
29	135	---	389	546	466	55	26	18	23	55	75	303
30	134	---	421	535	418	49	25	19	28	49	77	221
31	113	---	436	---	392	---	25	19	---	54	---	191

Table 6-2.29

PINE CREEK DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13290190
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	156	1850	650	584	877	1440	674	78	52	67	---	---
2	142	1890	582	576	933	1400	658	77	49	66	---	---
3	133	1260	567	565	906	1450	630	71	50	---	---	---
4	142	1010	535	609	882	1440	582	72	53	---	---	---
5	223	865	481	717	868	1750	546	68	51	---	---	---
6	209	804	439	860	914	1360	545	66	47	---	---	---
7	176	734	402	1150	1010	1020	557	69	49	---	---	---
8	170	684	392	1300	1090	867	552	89	50	---	---	---
9	235	635	460	1060	1100	833	582	77	51	---	---	---
10	679	582	571	872	1150	784	592	71	51	---	---	---
11	953	546	1070	783	1310	937	564	72	48	---	---	---
12	939	501	960	741	1240	1010	554	68	46	---	---	---
13	1150	466	963	837	1050	1030	699	65	46	---	---	---
14	1890	419	1020	839	959	999	514	65	46	---	---	---
15	1300	385	1760	748	977	913	448	64	45	---	---	---
16	905	358	1530	676	1060	887	416	70	45	---	---	---
17	676	367	1250	630	1260	1150	383	119	45	---	---	---
18	562	457	1570	608	1240	1310	349	97	44	---	---	---
19	503	705	1650	583	1200	1330	328	85	42	---	---	---
20	456	861	1410	556	1190	1010	302	77	42	---	---	---
21	402	913	1280	517	1220	843	308	74	44	---	---	---
22	343	939	1100	486	1250	758	279	69	46	---	---	---
23	313	905	1190	512	1240	765	242	67	50	---	---	---
24	301	913	956	580	1180	851	199	64	52	---	---	---
25	285	951	814	693	1160	987	164	61	54	---	---	---
26	325	929	713	742	1110	1030	144	58	55	---	---	---
27	346	867	641	775	1070	1010	115	54	55	---	---	---
28	330	755	592	925	1090	842	99	55	58	---	---	---
29	321	---	559	942	1180	736	101	53	70	---	---	---
30	406	---	537	895	1330	698	102	53	70	---	---	---
31	1570	---	529	---	1590	---	89	52	---	---	---	---

Table 6-2.30

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1978

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	---	---	---	36	27	29
2	---	---	---	---	---	---	---	---	---	35	31	27
3	---	---	---	---	---	---	---	---	---	35	29	22
4	---	---	---	---	---	---	---	---	---	34	27	32
5	---	---	---	---	---	---	---	---	---	34	27	30
6	---	---	---	---	---	---	---	---	---	34	25	21
7	---	---	---	---	---	---	---	---	---	32	27	15
8	---	---	---	---	---	---	---	---	---	30	29	19
9	---	---	---	---	---	---	---	---	---	29	30	23
10	---	---	---	---	---	---	---	---	---	30	24	28
11	---	---	---	---	---	---	---	---	---	31	15	29
12	---	---	---	---	---	---	---	---	---	31	20	28
13	---	---	---	---	---	---	---	---	---	31	23	24
14	---	---	---	---	---	---	---	---	---	31	22	26
15	---	---	---	---	---	---	---	---	---	31	23	27
16	---	---	---	---	---	---	---	---	---	30	25	23
17	---	---	---	---	---	---	---	---	---	29	25	25
18	---	---	---	---	---	---	---	---	---	28	25	29
19	---	---	---	---	---	---	---	---	---	28	26	27
20	---	---	---	---	---	---	---	---	---	29	27	27
21	---	---	---	---	---	---	---	---	---	28	26	26
22	---	---	---	---	---	---	---	---	---	28	26	26
23	---	---	---	---	---	---	---	---	---	28	26	26
24	---	---	---	---	---	---	---	---	---	29	24	26
25	---	---	---	---	---	---	---	---	---	27	25	25
26	---	---	---	---	---	---	---	---	---	27	25	20
27	---	---	---	---	---	---	---	---	---	28	21	22
28	---	---	---	---	---	---	---	---	---	29	26	24
29	---	---	---	---	---	---	---	---	---	29	28	23
30	---	---	---	---	---	---	---	---	---	28	28	22
31	---	---	---	---	---	---	---	---	---	26	---	19

Table 6-3.1

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1979

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	20	23	60	239	496	344	91	28	26	19	31	32
2	22	24	52	222	466	344	83	27	25	18	30	34
3	24	24	52	219	456	328	73	27	24	18	30	37
4	24	24	56	213	466	336	73	27	23	18	30	44
5	24	25	54	255	528	336	68	26	22	18	32	45
6	21	23	56	364	544	324	67	25	22	17	31	43
7	23	24	116	595	476	294	73	25	22	17	30	42
8	25	23	183	476	471	269	74	25	20	17	28	45
9	25	23	137	572	436	242	70	25	20	17	28	47
10	25	24	112	422	399	235	69	24	20	16	27	48
11	26	27	106	348	340	245	68	24	20	17	27	39
12	26	47	123	309	328	252	64	24	19	17	26	40
13	25	166	132	283	340	252	65	27	19	17	26	40
14	25	163	137	272	369	213	63	33	19	18	26	41
15	25	102	155	313	456	174	56	32	19	22	25	39
16	25	83	324	348	550	158	52	34	19	26	27	38
17	22	69	272	539	539	161	48	27	18	23	32	38
18	24	65	239	427	512	161	47	31	18	25	32	38
19	25	63	235	313	486	153	46	31	18	44	27	35
20	26	56	242	283	466	129	40	30	19	38	20	38
21	25	59	269	259	471	127	37	27	18	32	20	38
22	24	56	301	290	481	129	36	27	18	31	24	40
23	20	55	336	344	522	123	33	27	18	38	30	32
24	27	54	364	413	550	110	32	26	17	37	31	38
25	27	55	456	382	539	112	32	26	18	34	31	40
26	26	56	413	352	528	114	31	24	20	54	31	34
27	25	57	486	399	496	110	30	24	20	40	26	32
28	26	62	550	471	533	99	29	26	20	36	25	32
29	25	---	461	501	451	99	29	25	19	34	26	31
30	24	---	356	481	395	89	29	25	19	32	29	33
31	23	---	283	---	352	---	29	26	---	31	---	38

Table 6-3.2

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1980

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	39	52	252	129	517	476	134	45	29	31	28	34
2	37	54	235	129	589	561	145	42	30	30	29	40
3	37	50	229	127	572	481	137	41	31	30	30	97
4	37	50	242	129	561	466	132	41	30	30	30	249
5	44	51	252	145	578	427	120	40	27	30	30	120
6	39	50	213	189	636	382	116	40	26	29	30	89
7	36	49	189	174	601	375	108	40	26	28	30	61
8	42	47	177	166	533	360	102	39	25	28	30	56
9	43	46	163	216	501	375	99	37	26	28	34	61
10	43	45	161	245	476	395	94	35	29	28	60	59
11	42	44	177	216	386	400	88	34	40	28	50	57
12	48	44	153	232	324	385	86	32	34	28	45	53
13	102	43	145	276	298	350	83	32	47	30	43	51
14	203	43	180	336	280	325	80	32	72	33	37	49
15	280	44	172	386	320	300	79	31	50	32	25	52
16	181	44	132	390	382	290	68	32	43	32	25	51
17	145	53	129	441	324	310	65	31	39	32	25	50
18	119	229	129	501	320	336	61	34	38	32	32	49
19	88	348	123	550	320	313	61	37	40	33	33	49
20	76	427	120	661	336	280	60	35	40	34	32	49
21	82	301	134	624	399	259	56	33	41	32	32	51
22	77	216	139	583	456	242	54	32	39	32	33	91
23	74	192	172	561	466	222	52	32	37	32	36	110
24	70	174	153	766	352	192	52	31	36	31	33	102
25	68	166	145	661	324	169	51	29	35	31	30	232
26	52	186	145	661	404	169	48	27	34	32	25	673
27	45	222	142	686	461	183	48	27	34	39	27	686
28	37	276	134	712	544	155	47	27	32	37	30	476
29	38	269	142	706	506	139	47	28	32	34	35	309
30	39	---	137	624	476	137	45	28	32	32	35	252
31	47	---	134	---	441	---	43	29	---	31	36	216

Table 6-3.3

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1981

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	189	110	174	301	540	183	84	39	23	30	37	76
2	166	108	174	280	640	169	79	37	24	30	37	77
3	153	108	174	262	620	145	74	37	24	32	36	62
4	137	106	169	235	500	127	72	36	23	31	37	77
5	123	106	180	229	400	118	77	35	24	30	36	72
6	114	120	166	229	290	123	102	33	23	30	36	145
7	106	99	158	219	250	120	84	32	23	32	36	183
8	99	97	155	210	230	201	74	31	23	40	35	150
9	97	92	158	207	220	283	70	31	24	35	36	137
10	81	83	161	198	230	210	69	30	23	39	36	135
11	80	74	166	189	210	174	67	30	23	49	35	125
12	77	94	174	183	183	189	67	29	22	41	40	110
13	73	94	183	172	172	195	67	26	21	40	60	115
14	68	185	192	166	177	161	64	27	21	40	76	115
15	62	186	201	161	189	137	61	26	21	40	65	115
16	60	572	262	174	177	129	59	26	20	39	74	130
17	68	436	249	186	169	120	57	25	20	39	102	115
18	72	377	229	198	172	116	53	26	20	38	104	155
19	69	512	219	239	180	116	51	27	20	38	83	210
20	67	496	216	305	204	116	48	34	22	37	72	335
21	67	356	210	336	245	108	48	31	23	38	73	280
22	65	283	222	316	242	110	48	27	24	38	127	210
23	94	245	232	313	229	106	47	26	24	38	116	170
24	145	229	219	390	232	101	46	26	24	38	120	165
25	118	226	229	400	259	102	46	24	27	34	108	160
26	110	204	298	380	294	97	44	24	31	35	94	155
27	110	192	283	410	280	96	44	24	31	38	91	145
28	118	183	266	390	266	92	43	24	37	36	80	135
29	142	---	272	410	255	89	41	23	34	40	70	125
30	134	---	269	470	290	92	40	23	31	38	79	120
31	132	---	269	---	269	---	39	23	---	37	---	110

Table 6-3.4

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1982

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	115	68	368	326	622	520	360	74	38	35	50	54
2	110	69	402	297	708	515	375	76	36	30	45	53
3	100	69	351	288	851	550	340	76	34	30	43	53
4	98	43	329	276	827	530	335	76	33	40	45	54
5	96	73	313	259	712	500	320	72	33	44	45	54
6	90	61	285	250	673	460	280	69	33	38	43	54
7	85	84	270	233	677	440	280	66	33	44	40	49
8	80	61	267	230	686	430	260	64	30	43	36	37
9	80	65	253	236	634	430	240	63	28	38	40	48
10	80	65	264	256	540	450	225	58	29	36	37	54
11	84	86	392	651	505	470	210	58	33	35	39	51
12	84	69	371	794	520	500	190	60	34	33	28	53
13	80	62	322	832	524	540	180	57	39	33	40	61
14	76	69	322	753	580	600	170	54	38	32	26	60
15	74	155	319	677	682	640	155	54	39	31	26	60
16	78	677	279	647	781	640	145	54	44	31	27	66
17	78	708	270	601	767	640	135	50	44	30	43	86
18	78	664	252	572	809	640	130	49	41	31	49	83
19	72	690	244	497	795	600	120	46	40	31	55	77
20	65	885	247	471	739	580	115	45	64	30	77	74
21	58	1390	239	467	673	550	110	50	54	33	61	86
22	64	915	233	505	699	550	105	48	45	33	55	84
23	67	597	225	643	744	500	100	44	43	36	26	82
24	67	501	236	735	758	480	94	40	40	48	23	78
25	67	371	250	758	776	450	92	40	41	45	35	63
26	70	335	313	776	780	450	86	39	54	58	48	88
27	70	342	345	758	770	450	86	37	51	63	50	72
28	69	316	355	720	725	450	85	36	53	50	55	50
29	69	---	355	544	670	420	83	36	63	53	60	64
30	68	---	329	556	610	380	81	43	51	61	60	64
31	68	---	332	---	550	---	77	41	---	53	60	64

Table 6-3.5

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	66	86	322	639	568	652	306	75	52	42	43	51
2	66	79	669	686	584	639	352	73	62	41	45	52
3	72	64	416	626	576	605	297	71	67	41	47	51
4	78	60	669	576	568	576	265	69	64	40	58	49
5	74	58	588	528	618	564	248	68	60	40	62	45
6	86	69	572	497	631	548	235	67	57	39	60	51
7	92	74	524	490	618	540	219	64	54	39	71	51
8	86	66	494	490	593	536	195	63	51	38	59	53
9	84	64	568	509	576	528	180	63	49	42	56	53
10	81	61	580	532	493	524	173	64	47	42	55	73
11	77	60	762	505	420	540	160	64	46	42	63	82
12	76	63	651	497	359	478	151	64	45	41	67	89
13	76	77	656	486	352	423	143	64	44	41	64	80
14	72	84	664	490	359	392	145	63	44	41	59	78
15	70	77	622	497	365	396	137	64	43	41	57	76
16	75	86	532	520	372	392	129	68	43	41	59	65
17	80	115	475	572	372	389	115	64	42	41	68	63
18	78	348	427	639	375	389	112	63	41	41	67	60
19	78	316	375	695	392	365	101	62	41	41	59	58
20	77	233	319	832	438	343	94	63	40	42	58	49
21	76	212	282	1120	552	321	91	68	40	42	52	43
22	76	236	259	1170	601	309	86	86	39	41	46	39
23	76	233	273	1190	618	321	85	88	38	47	50	33
24	76	228	273	1630	785	321	86	76	37	46	56	29
25	72	253	267	933	752	303	83	71	37	43	56	33
26	76	332	270	833	873	294	82	68	37	43	54	37
27	92	236	276	679	898	291	82	64	37	42	53	42
28	105	214	282	609	898	279	79	61	38	42	53	39
29	93	---	297	576	888	279	76	58	38	42	48	48
30	97	---	643	552	799	285	76	55	39	42	45	63
31	83	---	669	---	742	---	75	53	---	42	---	53

Table 6-3.6

Table 6-3.7

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	52	56	92	576	463	635	306	76	56	38	34	39
2	51	58	125	614	584	532	291	80	49	37	42	32
3	51	54	129	631	609	467	279	76	46	37	48	28
4	51	54	129	635	622	482	265	79	44	37	43	26
5	51	53	131	724	609	532	251	71	43	36	40	27
6	50	54	135	809	540	605	238	67	42	36	41	29
7	51	53	139	692	501	657	217	64	42	36	42	31
8	51	53	160	923	520	614	204	59	43	34	42	35
9	50	53	180	804	609	536	192	59	43	34	43	40
10	50	53	243	715	652	501	183	57	42	34	41	42
11	50	53	356	648	626	489	167	55	41	38	42	44
12	49	53	385	609	626	489	151	53	40	48	45	42
13	49	91	389	576	771	485	145	53	39	44	47	42
14	43	156	674	631	858	482	139	53	39	44	52	42
15	40	143	631	790	923	501	133	51	38	41	42	43
16	34	119	544	898	838	508	125	50	37	39	44	42
17	19	106	548	1030	679	520	115	50	36	38	42	42
18	16	91	420	888	597	516	113	47	35	38	43	41
19	18	97	369	923	597	493	112	46	35	38	41	35
20	21	92	618	1020	683	497	103	46	37	37	41	33
21	35	97	838	959	701	508	101	45	43	36	42	40
22	41	91	706	873	618	467	94	43	41	35	38	45
23	48	86	683	833	679	416	92	41	41	35	39	45
24	58	88	697	888	692	409	89	42	40	39	44	44
25	62	88	622	742	584	441	78	42	41	37	38	42
26	57	83	548	670	580	463	76	42	41	39	39	41
27	54	86	508	576	552	463	85	42	41	41	37	42
28	54	86	508	532	548	420	85	41	41	40	39	42
29	54	89	493	493	609	416	103	40	40	40	41	42
30	54	---	489	463	724	346	86	42	40	39	41	43
31	55	---	524	---	706	---	78	63	---	38	---	43

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	31	43	54	226	253	238	47	40	18	54	37	38
2	30	43	54	382	290	238	47	35	20	52	37	39
3	34	38	53	444	318	222	46	33	22	49	37	47
4	37	34	51	401	299	214	46	29	20	46	36	46
5	42	42	54	385	276	242	44	28	19	44	43	45
6	44	46	50	447	258	246	43	27	20	41	40	46
7	49	51	52	467	251	255	41	26	24	47	42	47
8	47	50	51	560	251	250	39	25	34	44	69	48
9	43	44	52	604	247	233	38	25	47	38	59	44
10	40	42	55	593	240	212	37	25	41	36	52	42
11	44	42	59	534	229	195	36	27	48	37	52	35
12	44	41	62	474	211	183	35	27	46	35	44	37
13	43	41	66	411	197	171	34	25	40	33	44	40
14	42	40	70	415	197	157	33	23	38	31	60	41
15	41	40	75	441	188	146	31	22	39	29	45	39
16	41	39	83	451	188	130	30	22	36	29	49	39
17	39	40	95	392	206	116	29	22	38	29	46	38
18	41	41	112	359	224	108	29	21	41	29	46	38
19	42	42	140	352	247	101	28	22	36	29	41	37
20	45	43	164	295	261	97	27	24	34	28	44	37
21	45	43	188	263	257	89	26	23	32	29	42	36
22	43	43	163	250	253	84	26	23	31	34	41	35
23	44	43	143	236	257	76	26	21	30	39	29	36
24	44	46	216	216	260	70	26	20	29	42	46	34
25	43	47	202	202	268	68	25	19	28	48	58	32
26	36	47	170	183	254	67	24	19	28	51	51	30
27	37	48	156	171	235	65	24	19	27	46	56	29
28	44	51	137	167	232	60	22	18	26	44	44	28
29	42	---	123	194	251	58	25	18	26	42	41	29
30	32	---	120	223	249	53	30	18	26	39	39	26
31	43	---	123	---	235	---	34	18	---	37	---	27

Table 6-3.8

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	31	199	753	553	283	528	68	37	28	44	33	31
2	30	219	904	496	279	449	65	37	28	39	31	31
3	31	213	912	444	315	405	64	36	28	38	29	31
4	30	186	844	408	429	372	67	35	28	36	30	32
5	31	173	822	380	399	372	68	34	29	35	32	37
6	32	157	869	382	393	378	67	32	29	35	32	35
7	31	131	1630	404	367	355	66	32	29	33	32	32
8	30	125	1740	445	337	309	65	34	31	32	32	31
9	30	122	1520	510	315	267	64	32	35	31	32	30
10	30	126	1320	515	310	248	63	31	31	29	33	e29
11	30	133	1270	493	285	213	63	31	31	29	32	e29
12	30	129	1100	460	263	195	66	30	31	29	32	29
13	29	132	801	403	252	182	65	31	31	29	31	30
14	29	132	711	357	247	171	63	30	31	29	32	31
15	30	174	597	318	237	159	60	29	31	29	33	30
16	30	337	579	346	225	140	63	29	33	29	33	29
17	37	375	520	310	218	125	68	29	32	29	34	29
18	39	383	460	284	226	108	58	29	34	29	33	29
19	40	375	415	265	254	104	55	28	36	29	34	29
20	46	359	410	259	318	98	52	28	42	29	34	29
21	46	335	430	301	443	94	51	28	46	28	46	29
22	44	352	435	535	414	90	49	28	40	28	46	29
23	45	592	420	605	344	85	47	27	37	28	40	29
24	43	805	445	516	300	82	45	28	38	28	39	29
25	41	830	460	469	297	80	42	28	47	28	36	29
26	42	929	450	409	349	78	42	28	48	28	32	29
27	42	879	450	367	446	77	41	28	44	28	39	30
28	42	734	502	359	547	75	41	28	41	29	38	31
29	44	---	583	331	574	74	40	27	40	29	37	31
30	70	---	634	304	624	72	39	28	41	39	32	31
31	119	---	594	---	581	---	38	28	---	38	---	31

Table 6-3.9

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	31	32	46	120	359	101	28	14	12	12	13	19
2	31	32	42	135	295	86	37	14	12	12	16	27
3	31	35	54	159	246	79	35	14	12	12	16	33
4	31	34	139	186	208	73	31	13	12	13	15	31
5	31	35	327	211	192	69	30	13	12	13	15	28
6	31	33	623	211	186	62	30	13	12	13	15	28
7	31	34	528	214	195	62	27	13	12	13	15	34
8	31	34	364	228	204	65	25	13	13	13	16	28
9	31	35	387	214	208	64	25	13	12	13	16	26
10	31	36	332	201	204	60	25	13	12	13	18	37
11	e31	36	358	231	188	55	27	13	12	13	18	42
12	e31	38	397	214	170	51	25	13	12	13	21	28
13	e31	58	737	195	168	49	22	13	12	13	27	20
14	e31	107	563	179	148	46	21	14	12	12	34	16
15	e31	87	411	182	143	43	20	15	12	12	26	19
16	e31	76	341	192	135	48	19	13	12	12	22	23
17	e31	70	295	211	125	52	19	13	13	12	20	24
18	e31	63	275	221	113	56	25	13	13	12	14	24
19	e32	62	253	208	104	59	25	13	13	13	16	23
20	e32	50	231	182	98	57	23	13	12	13	17	16
21	e32	54	201	168	88	49	24	13	12	13	19	21
22	e32	58	182	162	81	46	33	13	12	13	17	24
23	e32	50	174	176	76	44	29	13	12	13	19	22
24	e32	46	165	198	74	42	24	13	12	13	18	e20
25	e32	43	151	221	89	39	20	13	13	13	18	e16
26	32	45	151	228	84	37	18	13	13	13	16	e15
27	32	40	132	249	104	34	16	13	13	13	14	e16
28	32	41	128	268	89	32	15	12	13	13	17	e20
29	32	---	132	295	81	30	15	12	13	12	14	e22
30	32	---	132	324	78	30	15	12	13	12	13	e22
31	32	---	116	---	107	---	14	12	---	12	---	e21

Table 6-3.10

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e18	24	131	129	156	156	40	15	7.7	14	16	17
2	e15	22	165	145	143	179	38	15	9	14	16	17
3	e14	21	195	289	136	168	35	15	9.6	13	18	20
4	e18	24	179	276	133	167	35	14	9.6	14	19	19
5	e22	29	149	218	128	159	38	14	9.5	13	20	18
6	21	28	297	198	129	150	41	14	9	13	20	20
7	20	23	180	221	120	138	37	14	8.6	14	23	20
8	21	23	145	201	115	131	33	14	8.6	14	20	19
9	22	23	151	179	123	126	31	14	9.3	13	20	19
10	22	25	129	166	121	114	28	14	9.4	13	20	19
11	26	25	113	167	124	108	28	14	10	13	20	19
12	24	28	95	190	146	102	27	14	10	13	21	19
13	24	29	94	238	206	95	27	13	11	13	21	20
14	24	28	98	276	223	90	26	13	11	13	21	20
15	35	30	91	290	197	84	26	14	11	13	20	15
16	37	29	86	299	206	77	24	14	11	14	19	e13
17	30	26	84	315	250	73	22	14	11	14	22	e15
18	21	29	96	328	215	70	21	12	11	15	21	e15
19	e19	27	116	289	183	64	21	10	12	15	18	e16
20	e20	27	143	265	168	58	20	9.6	13	15	18	e18
21	e21	28	177	292	167	56	18	9.4	13	16	19	18
22	e27	29	193	266	174	53	16	9.3	13	16	23	18
23	28	27	175	237	195	52	15	9.4	14	16	31	18
24	24	29	159	210	199	49	15	9.7	14	16	27	18
25	24	31	147	192	191	47	15	9	14	16	22	18
26	23	34	158	173	179	54	15	8.7	14	16	20	e15
27	23	39	218	160	171	52	15	8.1	15	15	18	e13
28	23	49	168	154	160	46	15	8	17	16	20	e13
29	24	73	156	159	178	44	15	7.8	16	16	21	e12
30	26	---	146	167	152	44	15	7.7	15	16	18	e16
31	25	---	129	---	133	---	15	7.4	---	16	---	e18

Table 6-3.11

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e18	e18	68	320	248	199	87	21	28	35	32	e25
2	19	e15	69	297	254	214	87	21	26	32	30	e25
3	19	e11	61	279	255	227	80	20	24	32	e30	e27
4	e17	e12	61	250	255	249	76	20	24	26	e30	e28
5	e17	e15	65	244	e320	256	72	20	23	24	e30	e29
6	e17	e18	63	306	e450	256	71	19	22	24	e30	e29
7	e16	e18	80	474	e630	253	69	19	21	24	e30	e28
8	e16	e17	129	634	e570	247	65	19	21	23	30	e28
9	e16	e18	384	500	e650	235	63	19	20	23	29	e29
10	e17	e21	571	453	e650	226	60	19	20	23	30	e24
11	e18	e19	612	402	e710	210	58	18	20	23	31	e20
12	e18	e18	574	422	333	207	56	18	20	22	31	e19
13	e17	e17	449	450	284	194	57	18	20	22	33	e26
14	e17	e20	317	499	246	184	e52	18	20	22	33	e25
15	e17	e23	259	591	251	218	e50	17	21	22	30	e25
16	e17	e28	233	594	249	232	e50	17	20	22	30	e23
17	e17	e31	240	563	254	193	e52	17	35	22	33	e23
18	e17	34	216	500	256	178	e46	17	78	33	34	e21
19	e17	36	295	622	253	164	e40	17	44	37	33	e22
20	e17	36	264	647	222	156	e37	18	35	40	32	e21
21	e18	36	250	648	207	147	e35	17	34	32	32	e22
22	e17	38	251	555	207	138	e32	30	33	27	30	e21
23	e15	44	261	489	216	133	e31	49	30	34	31	e21
24	e17	55	272	376	213	123	e28	58	29	37	33	e20
25	e17	68	488	351	203	118	26	59	29	33	33	e20
26	e16	70	492	319	185	113	25	42	27	30	32	e19
27	e17	71	484	265	182	106	27	37	26	33	27	e19
28	e18	70	607	244	225	103	26	34	27	30	21	e20
29	e18	---	495	249	213	96	25	30	26	26	e20	e19
30	e18	---	349	243	208	88	22	29	31	30	e22	e19
31	e18	---	342	---	197	---	21	31	---	32	---	e19

Table 6-3.12

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e20	32	52	309	258	412	68	24	23	17	37	20
2	e19	31	57	343	258	362	70	24	22	17	28	22
3	e17	30	69	360	273	324	79	23	22	17	24	27
4	e20	31	95	359	266	294	67	24	20	19	26	27
5	e21	26	96	342	264	249	62	22	19	23	28	26
6	e22	e29	98	330	271	234	58	20	18	23	26	21
7	e23	e28	108	312	258	255	54	20	18	23	23	20
8	e80	32	146	323	247	220	52	20	19	23	26	22
9	87	31	117	298	223	221	50	19	18	23	26	26
10	75	34	134	263	206	213	47	19	18	22	25	28
11	55	34	139	257	193	195	45	21	17	22	25	30
12	49	33	111	260	180	179	42	19	17	23	24	23
13	46	31	100	255	173	166	42	19	17	21	24	e23
14	56	e29	93	256	169	146	39	19	17	20	25	21
15	51	e26	86	264	164	149	37	18	17	20	26	e20
16	47	e28	90	280	153	146	36	18	17	19	23	e24
17	39	e31	109	307	141	135	33	20	17	20	23	27
18	35	e29	160	322	138	128	31	22	17	24	27	27
19	e32	e28	287	290	132	121	30	24	17	32	25	24
20	e30	e30	326	272	144	117	31	27	17	22	26	e16
21	33	32	310	290	153	113	30	29	18	20	25	e17
22	35	31	313	353	140	106	28	31	19	25	27	e20
23	35	31	377	359	151	97	28	29	18	23	26	e21
24	e33	34	277	331	225	95	29	28	18	21	26	e22
25	33	39	234	281	212	89	35	33	17	21	29	e24
26	34	45	240	262	191	84	36	32	17	21	35	e25
27	32	49	261	248	179	81	34	29	17	22	26	e26
28	33	51	246	307	225	76	30	26	17	21	27	e24
29	34	---	238	287	347	76	29	24	16	21	27	e22
30	33	---	238	277	402	72	26	24	17	22	28	e21
31	32	---	272	---	422	---	26	24	---	25	---	e24

Table 6-3.13

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e26	26	128	103	177	254	112	27	14	17	22	24
2	e24	25	145	133	179	267	103	27	15	17	20	29
3	e23	26	157	132	178	263	92	26	15	18	17	30
4	e21	30	208	184	173	268	86	24	15	18	24	29
5	e19	49	222	226	172	273	81	26	14	18	25	27
6	e20	47	151	267	177	245	76	25	14	18	30	42
7	e21	43	127	245	215	226	73	24	15	18	27	78
8	22	41	114	221	276	214	69	23	14	18	26	55
9	23	38	103	207	292	205	66	22	15	18	27	46
10	23	38	98	190	268	217	63	21	16	17	27	40
11	23	39	86	182	236	234	61	21	17	17	24	30
12	30	38	80	176	227	236	58	20	17	16	28	38
13	31	38	79	157	226	226	55	19	17	16	37	33
14	32	45	80	151	233	196	53	19	16	16	31	27
15	37	68	78	159	222	189	52	19	16	16	26	23
16	34	135	74	162	229	187	48	19	17	16	22	26
17	31	121	70	200	293	183	45	19	16	16	29	28
18	30	88	72	213	385	171	42	18	16	18	31	30
19	30	75	73	192	750	153	41	17	16	20	27	30
20	29	72	85	189	573	148	40	17	16	20	30	e22
21	e25	104	84	198	458	137	40	16	16	20	29	e22
22	e27	145	82	231	408	135	38	17	16	19	25	29
23	e28	143	77	238	359	135	36	16	16	21	20	26
24	e26	117	76	270	374	131	36	15	17	20	25	25
25	e24	112	76	267	353	132	40	15	17	21	28	25
26	e27	118	77	239	329	127	37	15	17	23	29	25
27	e28	119	71	215	301	127	33	16	17	22	33	25
28	e24	116	67	181	276	117	32	15	18	21	31	24
29	e21	---	67	180	275	121	30	15	18	21	30	25
30	e23	---	68	178	298	129	28	15	18	18	22	26
31	e26	---	79	---	261	---	28	15	---	18	---	26

Table 6-3.14

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	25	46	178	90	157	52	38	9.1	8.2	12	36	21
2	25	47	173	97	132	50	35	8.8	7.9	12	37	22
3	23	45	168	105	124	48	32	9.1	7.7	13	33	20
4	26	42	171	121	124	47	29	9.2	8.7	14	27	e15
5	26	42	163	120	125	45	29	8.5	9.5	15	26	e14
6	26	41	153	115	132	42	31	8.4	11	15	25	e14
7	e24	42	161	102	140	40	31	8.5	11	15	24	e17
8	e19	41	155	96	130	37	29	8.2	10	14	28	e22
9	e23	41	135	100	128	35	26	8.5	10	14	28	e25
10	26	44	126	121	122	33	26	8.2	10	13	24	27
11	27	49	124	117	115	33	25	8	9.8	11	20	28
12	26	65	123	126	107	32	24	7.7	11	10	23	27
13	25	81	124	166	99	55	23	7.4	11	10	24	23
14	25	92	125	165	94	50	21	6.9	11	11	25	27
15	24	96	126	161	96	49	20	7	11	11	25	25
16	24	89	127	160	97	56	19	7.9	11	11	24	23
17	24	77	133	174	95	47	18	8.3	10	11	22	25
18	e22	70	126	177	92	42	18	8.1	11	12	22	25
19	e19	117	118	168	93	40	18	7.9	11	12	23	e21
20	e19	323	116	155	115	40	18	7.3	10	12	21	e24
21	e21	277	107	155	106	34	17	7.3	9.5	12	21	26
22	e23	277	103	146	92	31	17	7.5	8.7	13	23	25
23	25	225	96	128	83	28	18	8.2	8.8	13	25	25
24	24	181	94	124	79	26	18	8.5	11	13	14	25
25	25	176	91	121	78	25	17	8.5	13	12	e13	22
26	24	190	91	119	77	29	15	8.4	13	12	e13	26
27	25	181	92	121	75	30	14	8.3	14	12	17	26
28	32	183	90	124	68	28	13	8	15	13	24	26
29	47	182	88	130	64	39	12	8.2	14	16	21	28
30	50	---	87	165	61	39	11	8.2	13	29	23	28
31	47	---	86	---	57	---	10	8.1	---	38	---	28

Table 6-3.15

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	29	35	e36	454	434	329	120	47	29	22	28	31
2	e28	e32	44	525	440	325	124	45	28	22	27	31
3	e26	e31	43	558	520	335	135	43	27	21	27	29
4	e28	36	41	740	663	314	120	41	25	22	28	30
5	e27	36	42	663	583	299	116	40	25	24	26	29
6	e26	37	41	554	585	312	112	36	24	24	24	28
7	e25	37	44	503	583	394	103	34	25	27	24	29
8	e24	36	46	455	564	329	94	39	23	27	24	31
9	e26	38	48	484	484	310	90	39	24	26	25	32
10	e26	40	60	454	454	298	85	35	23	26	30	32
11	e27	45	67	429	513	306	75	33	22	27	26	32
12	e28	46	70	375	607	291	75	33	22	26	26	34
13	e29	47	75	353	688	278	71	34	24	28	28	31
14	e28	50	74	332	728	253	73	33	24	34	26	31
15	31	51	74	326	691	255	70	34	22	32	23	31
16	30	e37	92	324	665	255	70	41	23	31	27	30
17	31	e34	129	328	669	243	67	45	24	33	28	30
18	28	e44	263	407	654	236	64	40	23	30	27	29
19	32	54	510	438	615	232	62	37	22	29	20	27
20	39	54	841	400	629	229	58	34	23	28	19	28
21	47	51	620	391	595	224	57	34	23	28	22	30
22	46	48	527	390	541	221	56	36	23	28	25	29
23	38	47	650	407	463	209	77	35	24	26	e22	e27
24	43	49	1020	398	376	201	70	33	24	26	e18	e26
25	44	41	742	392	359	177	62	33	25	27	e17	e27
26	41	e35	811	413	406	162	62	34	24	27	e18	e27
27	40	e34	759	412	398	153	58	34	23	27	e19	29
28	42	e35	702	413	375	151	55	32	23	27	e22	e27
29	40	---	641	416	342	142	53	31	23	27	e25	28
30	37	---	510	432	330	125	53	31	23	28	30	27
31	37	---	450	---	333	---	50	30	---	28	---	28

Table 6-3.16

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	28	e25	58	165	163	120	32	14	9	13	24	32
2	29	e25	79	176	147	113	31	13	8.9	13	28	35
3	29	e26	94	203	142	103	30	13	9.3	13	22	32
4	34	e26	129	188	145	94	29	12	9.6	13	23	27
5	39	e26	154	156	160	88	30	12	9.8	13	27	e25
6	38	e26	114	152	155	86	38	12	10	13	29	32
7	34	e24	95	148	177	84	38	11	11	13	29	32
8	35	e23	86	130	197	80	35	11	10	13	22	28
9	34	e23	83	127	210	78	32	11	10	13	25	26
10	33	e24	91	125	208	73	29	11	11	13	31	26
11	33	e25	96	122	203	69	27	11	11	14	30	32
12	33	27	111	120	206	66	26	10	11	14	30	26
13	34	27	119	121	204	65	26	10	12	15	26	26
14	34	27	139	123	181	65	24	9.2	12	16	27	26
15	35	27	185	117	153	64	23	9.3	12	17	25	26
16	34	27	215	120	147	63	23	9.2	11	16	31	27
17	31	28	213	122	155	60	22	9.1	10	16	25	34
18	32	31	189	157	147	54	21	9.3	11	16	23	41
19	33	30	187	191	138	52	20	9.2	11	15	19	42
20	30	29	148	214	156	49	18	9.1	11	15	26	39
21	30	29	131	213	160	47	17	9.1	11	15	e20	38
22	33	28	123	207	152	45	16	9	12	17	e20	34
23	31	29	106	208	143	42	16	9.3	12	17	e25	37
24	31	41	94	217	139	37	16	9.2	12	16	29	37
25	33	40	97	220	139	37	16	9.4	12	16	29	37
26	32	40	102	214	142	36	15	9.4	12	15	27	36
27	31	53	120	214	150	36	14	9.5	12	17	25	37
28	29	58	136	204	146	36	14	9.1	11	27	24	46
29	30	---	160	184	141	34	14	8.9	12	25	24	51
30	30	---	164	176	127	33	14	9.1	14	20	24	e40
31	e26	---	168	---	123	---	14	9.1	---	20	---	e35

Table 6-3.17

WILD HORSE RIVER DAILY AVERAGE DISCHARGE (cfs): USGS STATION 13289960
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	e30	494	226	223	398	357	171	70	38	30	32	131
2	e25	528	194	221	398	398	168	65	37	30	29	129
3	e25	241	178	214	410	365	176	64	36	34	32	104
4	e30	221	169	226	365	316	158	63	36	42	35	104
5	e30	207	158	269	410	335	147	59	39	39	42	73
6	e30	205	147	312	548	303	139	57	40	38	41	75
7	e30	187	141	421	582	278	144	60	39	38	42	86
8	33	168	143	645	645	246	139	65	40	37	43	68
9	38	157	168	582	645	223	142	60	39	37	51	74
10	145	146	267	474	649	204	148	57	38	37	45	79
11	207	137	689	376	785	224	139	55	37	40	46	120
12	140	132	626	304	756	241	143	53	36	50	51	317
13	119	126	440	421	665	243	232	51	35	44	52	325
14	289	106	387	482	602	234	162	51	35	42	53	241
15	222	108	760	365	516	218	146	50	34	41	51	256
16	174	104	536	315	536	233	138	58	33	39	49	233
17	126	102	376	293	571	284	126	79	34	38	48	178
18	114	114	602	274	536	313	117	63	33	42	48	163
19	106	188	709	259	571	306	107	56	33	39	48	139
20	93	266	559	249	516	289	106	52	33	39	50	147
21	76	257	536	232	482	271	107	50	33	39	49	135
22	68	257	474	212	528	252	100	48	33	40	48	97
23	67	255	494	206	536	234	93	47	33	40	47	81
24	73	236	357	214	429	228	88	45	33	39	47	82
25	71	262	297	248	335	232	82	45	32	38	53	94
26	77	268	265	270	324	233	79	43	32	43	61	99
27	86	261	256	284	310	221	77	42	32	45	55	73
28	76	251	238	376	306	203	74	41	33	42	54	86
29	73	---	223	463	304	192	76	40	34	41	63	91
30	75	---	215	482	324	181	87	40	34	41	91	92
31	267	---	208	---	365	---	76	39	---	38	---	93

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2075.52	2066.60	2059.65	2031.90	2046.10	2061.70	2076.95	2076.50	2067.95	2061.65	2075.80	2075.37
2	2075.10	2065.91	2058.93	2033.65	2046.63	2064.40	2077.10	2076.15	2067.80	2063.10	2076.25	2075.60
3	2074.89	2065.08	2058.62	2034.35	2047.63	2066.20	2077.27	2075.81	2067.85	2065.03	2076.21	2075.52
4	2074.70	2064.09	2058.07	2035.32	2048.25	2068.50	2077.30	2075.33	2067.95	2065.66	2076.44	2075.08
5	2074.50	2063.04	2058.42	2035.75	2048.02	2070.30	2077.15	2074.85	2068.25	2065.95	2076.25	2074.50
6	2073.78	2062.65	2058.92	2035.40	2048.35	2072.12	2077.28	2074.90	2068.20	2066.35	2075.80	2074.20
7	2073.28	2062.48	2059.16	2033.70	2048.33	2073.48	2077.00	2074.75	2067.35	2066.80	2075.40	2073.85
8	2073.62	2061.90	2059.04	2032.12	2048.56	2073.78	2077.00	2075.00	2066.65	2067.29	2074.91	2073.38
9	2073.40	2061.25	2058.50	2030.62	2048.74	2073.65	2077.05	2074.85	2065.76	2067.72	2074.70	2072.78
10	2073.21	2060.78	2057.68	2029.35	2048.80	2073.63	2076.95	2074.95	2065.11	2068.71	2074.85	2072.81
11	2072.88	2060.12	2057.08	2027.78	2048.86	2073.54	2077.10	2075.47	2064.28	2069.15	2074.60	2072.80
12	2071.95	2059.42	2055.85	2026.40	2048.30	2073.60	2077.12	2075.74	2063.49	2069.94	2074.42	2073.99
13	2071.51	2059.12	2055.58	2023.95	2047.30	2073.65	2076.75	2076.10	2063.09	2069.86	2074.77	2075.19
14	2070.54	2059.30	2056.35	2021.65	2046.90	2073.95	2076.10	2075.98	2062.49	2069.68	2075.15	2075.79
15	2070.10	2060.45	2057.95	2019.50	2045.10	2073.25	2075.48	2075.90	2061.62	2069.92	2074.90	2075.91
16	2069.86	2060.55	2058.35	2018.95	2044.35	2072.60	2074.71	2075.44	2061.10	2070.80	2074.89	2076.13
17	2069.82	2061.05	2057.85	2018.70	2042.80	2072.70	2074.41	2075.05	2060.98	2071.63	2074.72	2076.42
18	2069.68	2061.35	2057.45	2018.95	2040.30	2073.50	2073.75	2074.72	2061.10	2071.47	2074.60	2076.32
19	2069.80	2062.05	2056.00	2020.95	2038.60	2074.03	2073.50	2074.14	2060.58	2070.95	2074.93	2076.18
20	2069.40	2062.80	2053.90	2023.65	2037.46	2074.38	2073.51	2073.80	2060.50	2070.60	2074.90	2076.12
21	2069.20	2063.60	2051.15	2026.90	2036.54	2074.70	2073.72	2073.35	2060.18	2070.53	2075.16	2076.09
22	2069.40	2063.30	2049.10	2030.70	2036.42	2075.00	2074.82	2074.25	2059.56	2070.65	2075.40	2076.10
23	2069.35	2063.30	2045.50	2034.71	2036.85	2074.98	2075.39	2073.80	2060.12	2070.20	2075.55	2076.30
24	2069.45	2063.30	2042.79	2036.90	2037.31	2075.34	2075.91	2073.65	2059.85	2070.30	2075.70	2075.95
25	2069.45	2063.00	2040.61	2039.24	2038.05	2076.66	2076.35	2073.10	2059.88	2070.60	2075.75	2075.50
26	2069.65	2062.42	2038.74	2043.10	2039.88	2077.29	2076.55	2071.92	2059.88	2070.83	2076.00	2074.45
27	2069.22	2061.84	2036.17	2045.84	2042.50	2077.29	2076.70	2070.85	2059.85	2070.85	2075.85	2074.45
28	2068.79	2060.90	2034.09	2046.43	2045.78	2077.58	2076.23	2069.90	2060.15	2071.05	2075.70	2074.85
29	2068.62	---	2032.16	2046.15	2049.35	2077.48	2075.78	2068.60	2061.10	2071.30	2075.55	2074.80
30	2068.19	---	2030.81	2046.02	2053.12	2077.12	2075.73	2067.90	2061.15	2072.55	2075.45	2074.21
31	2067.34	---	2030.44	---	2057.95	---	2075.82	2068.60	---	2074.00	---	2073.96

Table 6-4.1

Table 6-4.2

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2073.99	2062.99	2038.19	2047.05	2060.15	2059.95	---	2074.45	2071.20	2067.55	2073.58	2071.20
2	2073.60	2062.30	2038.46	2046.44	2059.58	2061.56	---	2075.15	2071.80	2067.55	2073.61	2071.23
3	2072.78	2061.69	2037.92	2045.82	2061.78	2062.52	---	2075.50	2072.40	2067.80	2073.65	2071.08
4	2072.48	2061.35	2039.55	2045.18	2061.00	2062.84	2077.32	2074.95	2072.35	2067.61	2073.43	2070.72
5	2072.10	2060.70	2041.78	2044.68	2063.18	2063.20	2077.25	2075.25	2071.95	2068.08	2073.20	2070.40
6	2072.19	2060.40	2041.60	2043.98	2063.00	2063.72	2077.25	2075.30	2071.35	2067.90	2073.05	2070.10
7	2071.79	2059.99	2041.52	2043.20	2062.06	2064.25	2077.00	2075.10	2070.93	2068.53	2072.85	2069.44
8	2071.40	2059.08	2041.48	2042.76	2060.95	2064.60	2076.85	2074.75	2070.44	2067.93	2072.71	2068.58
9	2071.15	2057.90	2041.15	2042.32	2059.90	2065.30	2076.60	--	2071.50	2069.00	2072.85	2067.70
10	2070.95	2056.80	2040.50	2043.41	2058.45	2065.95	2076.60	--	2071.20	2069.59	2073.05	2067.07
11	2070.78	2055.22	2040.70	2043.92	2057.05	---	2076.50	--	2070.51	2070.15	2072.55	2066.65
12	2070.76	2053.52	2042.25	2042.95	2055.70	---	---	--	2070.07	2071.20	2072.14	2065.21
13	2070.60	2051.68	2043.29	2042.05	2054.65	---	---	2072.58	2069.70	2071.10	2071.90	2063.50
14	2070.27	2049.80	2043.39	2040.75	2053.90	---	2076.36	2072.89	2069.19	2071.15	2071.82	2062.50
15	2069.55	2048.63	2044.05	2040.05	2053.45	---	2076.20	2073.13	2069.05	2070.95	2071.75	2061.52
16	2069.28	2048.25	2046.10	2040.05	2053.80	---	2076.33	2073.30	2068.65	2071.35	2071.58	2061.13
17	2068.70	2047.65	2046.95	2040.45	2054.45	---	2076.25	2073.72	2068.30	2071.80	2071.10	2060.70
18	2068.30	2046.65	2048.15	2042.05	2054.90	---	2076.10	2073.80	2068.28	2072.95	2070.82	2059.72
19	2067.90	2046.30	2049.60	2045.09	2055.19	---	2075.65	2074.11	2068.63	2073.65	2070.65	2058.45
20	2067.45	2045.65	2049.65	2048.29	2055.57	---	2075.21	2074.57	2068.65	2074.00	2070.50	2057.65
21	2066.50	2044.55	2051.25	2051.75	2056.50	---	2075.38	2074.72	2068.91	2073.58	2070.65	2056.50
22	2066.15	2043.80	2055.41	2054.01	2057.08	---	2075.84	2074.65	2069.08	2073.35	2070.65	2055.75
23	2065.80	2042.75	2057.00	2055.62	2057.63	---	2076.85	2074.40	2068.89	2073.25	2070.80	2055.95
24	2065.30	2041.43	2057.48	2056.74	2058.20	---	2076.53	2073.36	2068.95	2073.50	2070.80	2056.54
25	2065.05	2040.18	2056.81	2057.80	2059.00	---	2075.70	2072.70	2068.51	2073.55	2070.90	2056.95
26	2065.00	2039.92	2056.20	2058.05	2059.50	---	2075.30	2072.78	2068.51	2073.35	2070.85	2057.90
27	2064.80	2039.53	2054.65	2057.85	2059.56	---	2074.85	2072.68	2068.40	2073.70	2071.05	2057.28
28	2064.76	2038.41	2053.12	2057.60	2059.30	---	2074.38	2072.78	2067.70	2073.85	2071.15	2057.10
29	2064.12	2038.21	2051.33	2057.43	2059.05	---	2075.00	2072.18	2067.35	2073.75	2071.22	2057.10
30	2063.50	---	2049.55	2057.21	2058.95	---	2075.18	2071.50	2067.30	2073.62	2071.19	2056.74
31	2063.28	---	2048.32	---	2059.08	---	2075.20	2070.70	---	2073.58	---	2056.19

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2056.10	2043.29	2033.47	2021.50	2040.50	2076.20	2063.35	2056.65	2064.65	2066.80	2065.06	2065.61
2	2055.61	2042.79	2032.63	2022.57	2040.15	2076.05	2061.78	2057.20	2064.65	2066.70	2064.44	2065.70
3	2055.18	2043.05	2031.55	2023.70	2040.80	2076.52	2060.20	2057.95	2065.35	2066.95	2064.62	2066.10
4	2054.95	2042.78	2030.70	2024.13	2042.40	2076.75	2058.85	2058.65	2065.90	2066.51	2065.31	2065.69
5	2054.65	2042.32	2028.95	2024.45	2043.63	2076.89	2058.55	2058.60	2065.79	2066.30	2064.74	2066.18
6	2054.10	2041.88	2027.57	2024.70	2045.00	2076.55	2057.75	2058.35	2066.00	2066.71	2064.05	2066.68
7	2053.35	2041.78	2026.10	2024.35	2045.70	2076.61	2056.30	2058.30	2066.30	2067.43	2063.95	2066.50
8	2052.85	2042.42	2024.80	2024.98	2046.30	2076.78	2055.10	2058.32	2066.53	2066.54	2064.43	2066.85
9	2052.15	2043.43	2023.45	2025.62	2046.65	2076.40	2054.30	2058.80	2067.70	2066.10	2064.31	2067.40
10	2051.70	2044.10	2022.30	2026.45	2046.90	2077.00	2054.15	2059.10	2067.92	2066.40	2064.24	2066.85
11	2051.32	2044.88	2021.22	2026.65	2047.55	2076.50	2053.50	2059.08	2068.68	2067.43	2064.45	2066.35
12	2050.90	2044.70	2020.03	2026.05	2049.10	2075.95	2052.90	2059.26	2069.28	2067.55	2064.00	2066.40
13	2050.45	2043.90	2018.78	2027.45	2051.25	2075.71	2052.75	2059.81	2069.70	2067.70	2064.05	2066.40
14	2050.05	2043.15	2017.65	2029.35	2052.39	2075.82	2053.53	2059.86	2069.88	2068.48	2064.20	2066.33
15	2049.60	2041.90	2017.30	2030.85	2054.20	2075.60	2053.82	2060.20	2070.02	2068.45	2064.00	2066.72
16	2048.85	2041.20	2016.85	2032.30	2057.02	2075.26	2053.07	2060.40	2070.22	2068.68	2063.88	2066.78
17	2048.35	2040.20	2017.70	2033.72	2059.61	2075.15	2052.51	2060.61	2070.10	2068.40	2064.65	2065.94
18	2047.75	2039.25	2018.85	2035.41	2061.12	2074.80	2052.17	2060.70	2069.78	2067.82	2065.12	2065.35
19	2047.40	2038.40	2020.45	2036.21	2063.90	2074.40	2052.54	2061.02	2069.90	2067.58	2065.75	2065.10
20	2047.65	2037.40	2021.45	2036.74	2066.30	2074.15	2052.63	2061.47	2069.82	2067.26	2065.02	2064.35
21	2047.75	2036.38	2022.92	2036.70	2068.00	2074.15	2053.11	2061.47	2070.02	2066.70	2065.15	2063.35
22	2047.15	2035.15	2022.57	2036.21	2069.19	2073.20	2053.60	2061.55	2070.02	2066.55	2065.20	2063.85
23	2046.90	2034.99	2022.21	2036.68	2070.30	2072.25	2054.05	2062.20	2069.62	2065.75	2065.50	2063.60
24	2046.40	2035.90	2021.71	2037.12	2071.60	2071.69	2054.38	2062.50	2068.98	2066.15	2064.90	2062.65
25	2046.10	2036.32	2021.89	2037.22	2072.78	2070.80	2053.98	2062.33	2068.70	2065.70	2064.95	2062.85
26	2046.04	2035.85	2021.62	2037.09	2073.79	2070.00	2054.31	2062.85	2068.45	2065.68	2064.80	2063.47
27	2045.88	2034.85	2021.11	2036.99	2074.70	2068.75	2054.85	2063.08	2067.90	2066.19	2064.75	2062.74
28	2045.11	2033.85	2021.30	2037.61	2075.29	2067.44	2055.00	2063.20	2067.65	2066.35	2064.83	2062.04
29	2044.58	---	2021.30	2038.48	2075.50	2065.90	2055.60	2063.40	2067.85	2065.45	2065.36	2061.00
30	2044.20	---	2021.05	2039.40	2075.90	2064.50	2055.70	2063.80	2067.85	2065.35	2065.72	2061.61
31	2043.85	---	2020.95	---	2076.35	---	2056.31	2064.40	---	2065.20	---	2061.44

Table 6-4.3

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2061.72	2054.10	2072.98	2044.50	2047.30	2076.30	2076.68	2075.92	2075.88	2073.30	2074.70	2073.65
2	2062.30	2054.25	2071.39	2044.38	2047.40	2077.40	2076.50	2076.10	2075.85	2073.87	2075.02	2073.95
3	2062.18	2054.82	2069.72	2044.05	2047.25	2077.89	2076.25	2075.85	2075.85	2074.28	2075.50	2073.81
4	2062.00	2055.80	2068.20	2044.20	2047.30	2077.61	2076.40	2076.12	2075.80	2074.86	2075.74	2073.78
5	2062.00	2056.60	2066.59	2044.40	2047.60	2077.65	2077.10	2076.10	2076.04	2075.12	2076.00	2073.86
6	2061.95	2057.10	2065.08	2043.93	2048.22	2077.55	2076.45	2076.10	2075.91	2075.74	2075.85	2074.18
7	2061.89	2057.25	2063.21	2043.78	2050.60	2077.30	2076.95	2075.95	2075.94	2076.12	2075.37	2074.09
8	2061.98	2056.90	2062.33	2044.00	2052.60	2077.28	2077.05	2076.01	2075.74	2076.10	2074.35	2074.70
9	2061.80	2056.12	2062.97	2043.50	2053.30	2077.30	2076.70	2076.20	2076.10	2075.95	2072.95	2074.79
10	2061.95	2054.95	2064.90	2043.85	2053.70	2077.14	2076.95	2076.05	2075.86	2076.04	2072.12	2074.46
11	2061.85	2053.60	2066.00	2043.75	2053.80	2076.95	2077.05	2076.23	2075.80	2075.90	2071.13	2075.03
12	2061.85	2052.10	2067.00	2043.75	2053.85	2076.99	2076.88	2076.19	2075.62	2075.60	2070.88	2075.33
13	2061.95	2050.95	2067.90	2043.85	2053.94	2077.42	2076.68	2076.30	2075.48	2075.65	2070.22	2075.25
14	2061.65	2050.30	2067.85	2044.00	2053.95	2077.49	2076.35	2076.20	2075.83	2075.78	2070.00	2075.70
15	2061.40	2049.10	2067.25	2043.85	2054.05	2077.14	2075.97	2076.17	2076.20	2075.85	2069.61	2075.70
16	2061.20	2047.98	2066.10	2043.50	2054.23	2076.88	2075.95	2076.38	2076.13	2075.70	2070.01	2075.50
17	2061.05	2048.35	2064.60	2044.07	2054.29	2077.05	2076.09	2076.24	2075.25	2075.69	2070.18	2075.25
18	2060.50	2050.45	2063.10	2044.22	2054.01	2076.99	2076.15	2076.25	2074.43	2075.55	2070.00	2075.25
19	2061.15	2053.70	2061.05	2045.76	2054.22	2076.75	2076.36	2076.22	2073.60	2075.10	2070.15	2075.15
20	2061.75	2056.00	2058.80	2045.48	2054.28	2076.80	2076.39	2076.11	2072.78	2075.15	2070.10	2075.00
21	2061.85	2058.48	2057.19	2045.59	2054.92	2076.83	2076.70	2076.11	2072.30	2074.98	2070.45	2074.45
22	2061.25	2060.25	2054.23	2045.90	2056.71	2077.08	2076.46	2076.15	2072.26	2074.70	2070.30	2073.55
23	2060.50	2062.52	2051.91	2045.61	2059.04	2077.40	2076.60	2076.42	2071.72	2074.65	2070.15	2073.40
24	2059.92	2065.12	2049.88	2045.95	2061.88	2077.28	2076.50	2076.45	2071.05	2074.40	2070.50	2073.35
25	2058.82	2069.07	2048.51	2046.38	2063.30	2077.33	2076.45	2076.40	2070.65	2074.25	2070.50	2073.13
26	2057.83	2071.75	2047.22	2047.10	2065.00	2077.38	2076.45	2076.35	2071.45	2074.10	2070.80	2073.01
27	2057.01	2073.39	2046.40	2046.90	2066.75	2077.21	2076.25	2076.25	2072.05	2073.95	2071.00	2072.99
28	2055.55	2073.85	2045.28	2047.40	2068.90	2076.85	2076.47	2076.20	2072.30	2073.85	2072.86	2072.61
29	2055.78	---	2044.00	2047.44	2070.45	2076.82	2076.37	2076.20	2072.90	2073.62	2073.54	2072.52
30	2055.60	---	2044.18	2047.12	2072.28	2076.70	2076.13	2075.94	2073.30	2074.41	2073.65	2072.11
31	2054.44	---	2044.10	---	2074.37	---	2076.05	2075.92	---	2074.65	---	2071.79

Table 6-4.4

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2071.33	2058.58	2047.57	2065.11	2074.21	2071.90	2076.15	2074.30	2071.02	2068.68	2076.05	2069.90
2	2071.37	2058.50	2048.58	2065.35	2075.15	2072.73	2076.31	2074.50	2070.69	2068.96	2076.24	2069.60
3	2071.09	2058.31	2048.50	2066.05	2076.30	2073.37	2076.46	2074.15	2070.41	2068.66	2075.75	2069.80
4	2070.98	2058.12	2048.81	2066.75	2076.75	2073.80	2076.25	2073.74	2070.58	2068.62	2075.54	2069.63
5	2070.93	2058.05	2049.60	2067.55	2076.77	2074.25	2076.20	2073.38	2070.30	2069.40	2075.52	2070.04
6	2070.57	2058.30	2050.63	2068.54	2076.60	2074.40	2076.58	2072.80	2070.50	2068.81	2075.09	2070.80
7	2069.80	2057.75	2052.11	2068.40	2075.54	2074.65	2076.81	2072.26	2070.52	2069.02	2074.76	2071.98
8	2068.98	2057.60	2054.78	2068.73	2073.90	2074.88	2076.50	2071.80	2070.55	2069.25	2075.16	2071.72
9	2068.45	2057.20	2057.10	2069.15	2073.17	2075.35	2076.10	2071.53	2070.66	2068.98	2075.43	2070.74
10	2067.80	2056.30	2059.00	2069.24	2073.45	2075.85	2076.22	2071.41	2070.48	2069.15	2074.81	2070.20
11	2066.82	2055.57	2060.20	2069.47	2073.98	2076.30	2076.30	2070.60	2070.28	2069.26	2074.77	2069.50
12	2066.00	2054.62	2061.35	2069.75	2072.65	2076.85	2076.41	2070.24	2070.11	2069.35	2074.48	2069.20
13	2065.55	2053.37	2062.72	2070.43	2070.65	2076.78	2076.40	2070.20	2069.55	2069.75	2074.40	2069.55
14	2065.31	2052.00	2064.30	2071.05	2068.24	2076.90	2076.60	2070.53	2069.57	2070.11	2074.42	2069.80
15	2064.65	2051.40	2065.50	2071.25	2066.25	2077.00	2076.10	2070.26	2069.41	2070.25	2074.30	2068.75
16	2063.65	2049.55	2066.72	2071.49	2065.82	2076.94	2076.10	2070.65	2069.51	2070.00	2074.42	2067.44
17	2062.65	2047.86	2067.29	2071.03	2065.76	2077.09	2076.30	2071.43	2069.10	2070.65	2074.02	2066.27
18	2062.20	2047.72	2067.74	2070.79	2065.83	2077.27	2076.40	2071.70	2068.15	2070.60	2073.70	2065.50
19	2062.40	2047.27	2068.00	2070.91	2065.83	2077.23	2076.03	2071.98	2067.50	2071.27	2073.50	2064.95
20	2061.85	2046.90	2067.83	2071.70	2065.49	2077.25	2076.47	2071.95	2067.40	2071.75	2073.08	2064.71
21	2060.45	2047.28	2067.30	2071.29	2065.77	2077.11	2076.30	2071.75	2067.85	2072.00	2072.60	2064.64
22	2059.50	2047.68	2067.15	2071.02	2066.15	2077.39	2076.80	2071.90	2067.95	2072.55	2072.55	2064.46
23	2058.71	2048.01	2067.41	2071.16	2066.48	2076.81	2076.45	2071.76	2068.00	2072.85	2072.59	2064.31
24	2058.04	2047.50	2066.82	2071.08	2066.95	2076.30	2076.20	2072.10	2067.72	2073.27	2071.79	2063.60
25	2058.20	2047.43	2066.30	2071.28	2067.13	2076.12	2076.00	2071.50	2067.68	2073.65	2070.63	2062.78
26	2059.20	2047.31	2065.83	2071.94	2067.51	2076.10	2075.65	2071.38	2067.10	2074.29	2069.60	2062.52
27	2059.80	2047.20	2065.20	2072.92	2067.93	2075.90	2075.25	2070.78	2067.10	2074.44	2070.00	2062.22
28	2059.00	2047.42	2064.48	2072.90	2068.83	2076.05	2075.05	2070.60	2068.02	2074.59	2069.80	2061.69
29	2059.18	---	2064.08	2073.04	2069.80	2076.25	2075.10	2070.50	2068.15	2074.58	2070.00	2061.15
30	2059.40	---	2064.20	2073.33	2070.60	2076.05	2074.95	2070.80	2068.35	2074.81	2070.11	2060.65
31	2059.58	---	2064.34	---	2071.23	---	2074.45	2071.28	---	2075.16	---	2060.12

Table 6-4.5

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2059.10	2044.20	2046.85	2048.10	2071.35	2070.55	2077.20	2075.60	2072.80	2076.10	2076.74	2075.00
2	2059.48	2043.87	2046.91	2049.30	2072.20	2071.27	2077.00	2075.55	2073.05	2076.08	2076.80	2074.65
3	2058.20	2043.20	2047.35	2049.80	2072.65	2071.79	2077.10	2075.65	2072.85	2075.82	2076.85	2074.67
4	2057.49	2042.85	2047.35	2050.10	2072.70	2072.25	2077.10	2075.77	2073.30	2075.80	2076.98	2075.10
5	2056.42	2042.55	2047.45	2050.25	2070.67	2073.13	2077.05	2075.43	2073.17	2075.80	2077.05	2075.08
6	2055.58	2042.12	2048.05	2051.00	2068.50	2074.15	2077.10	2075.26	2073.35	2075.85	2077.00	2075.13
7	2054.80	2042.49	2048.50	2051.75	2066.80	2074.77	2077.25	2075.53	2073.40	2075.78	2077.06	2075.02
8	2054.20	2043.00	2048.45	2052.30	2064.90	2075.40	2077.10	2075.60	2073.70	2075.83	2076.90	2074.93
9	2054.00	2042.60	2048.45	2052.90	2063.50	2076.12	2076.95	2075.50	2073.81	2075.78	2077.08	2075.02
10	2053.44	2042.30	2047.30	2053.36	2061.78	2076.42	2076.90	2075.41	2073.62	2075.86	2077.10	2075.18
11	2053.15	2042.73	2045.95	2054.56	2061.92	2076.65	2077.05	2075.45	2074.05	2075.74	2077.08	2075.70
12	2052.03	2042.84	2044.38	2055.25	2061.36	2076.95	2076.55	2075.20	2074.31	2075.75	2077.08	2075.71
13	2051.25	2043.38	2043.46	2055.90	2061.09	2077.40	2076.45	2075.10	2074.40	2075.80	2077.17	2076.01
14	2051.00	2043.95	2043.40	2056.55	2061.67	2077.01	2076.45	2074.85	2074.51	2075.75	2077.18	2076.26
15	2050.95	2044.84	2043.15	2057.28	2062.51	2077.10	2076.60	2074.30	2074.32	2075.79	2076.91	2076.16
16	2050.93	2045.10	2042.40	2058.51	2063.30	2077.30	2076.60	2074.03	2074.30	2075.82	2076.70	2075.90
17	2051.86	2045.09	2042.38	2059.70	2063.38	2077.15	2076.70	2073.39	2074.41	2075.80	2076.86	2076.05
18	2052.11	2044.90	2042.29	2061.14	2063.86	2077.42	2076.64	2072.90	2074.47	2075.75	2076.70	2076.00
19	2051.00	2045.28	2042.60	2062.05	2064.20	2077.55	2076.84	2072.75	2074.72	2075.75	2076.56	2075.90
20	2049.55	2044.98	2043.13	2063.06	2064.75	2077.21	2076.80	2072.47	2074.60	2075.81	2076.53	2075.55
21	2048.22	2044.98	2043.90	2063.85	2065.21	2077.16	2076.72	2072.68	2074.93	2076.07	2076.50	2075.44
22	2046.83	2045.69	2044.05	2064.86	2065.58	2076.98	2076.60	2072.92	2075.10	2076.20	2076.46	2075.15
23	2045.90	2045.92	2044.21	2065.33	2065.71	2077.10	2076.20	2073.00	2075.15	2076.40	2076.54	2074.73
24	2045.92	2045.10	2044.32	2066.58	2065.98	2077.05	2076.12	2072.99	2075.52	2076.30	2076.12	2074.50
25	2046.55	2044.85	2044.85	2067.40	2066.12	2077.10	2076.20	2072.50	2075.44	2076.40	2076.82	2074.41
26	2045.59	2044.95	2045.60	2067.88	2066.35	2077.20	2075.98	2072.41	2075.46	2076.45	2076.28	2074.40
27	2044.90	2045.46	2046.65	2068.70	2067.10	2077.25	2076.15	2072.43	2075.55	2076.44	2075.99	2074.10
28	2044.00	2046.50	2047.36	2069.55	2067.65	2077.40	2076.15	2072.63	2075.62	2076.39	2075.75	2073.39
29	2043.21	2047.13	2047.02	2070.15	2068.50	2077.35	2075.90	2072.74	2075.74	2076.59	2075.50	2072.40
30	2043.21	---	2047.09	2070.95	2069.25	2077.40	2075.65	2072.50	2075.80	2076.58	2075.39	2071.65
31	2043.17	---	2047.55	---	2070.30	---	2075.55	2072.57	---	2076.65	---	2071.25

Table 6-4.6

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2071.40	2048.65	2030.18	2051.00	2041.93	2062.60	2076.33	2069.74	2065.86	2060.32	2066.53	2072.90
2	2071.20	2047.17	2030.18	2049.93	2040.61	2063.56	2076.44	2069.43	2065.52	2060.85	2066.45	2072.89
3	2070.90	2045.54	2030.01	2049.58	2038.61	2064.05	2076.73	2069.10	2066.02	2060.07	2066.65	2072.93
4	2070.44	2043.90	2029.50	2049.18	2036.50	2065.35	2076.75	2069.01	2066.12	2060.62	2066.94	2073.41
5	2069.98	2042.04	2029.20	2048.30	2034.20	2066.60	2076.95	2068.48	2066.31	2061.75	2067.46	2073.60
6	2069.41	2040.23	2028.88	2047.58	2031.90	2066.66	2076.73	2068.20	2066.12	2061.97	2068.30	2073.70
7	2068.70	2037.69	2028.91	2046.50	2029.00	2067.55	2076.42	2068.02	2065.67	2062.71	2068.40	2074.25
8	2067.60	2035.51	2029.26	2045.25	2027.72	2067.79	2076.01	2067.72	2065.25	2063.65	2068.45	2074.63
9	2066.84	2033.70	2030.35	2044.80	2028.85	2068.13	2075.68	2067.02	2065.07	2064.35	2068.17	2074.93
10	2065.94	2032.31	2033.40	2044.40	2030.91	2069.19	2076.00	2066.63	2064.30	2064.69	2068.52	2075.34
11	2065.21	2031.10	2037.80	2044.10	2034.20	2070.22	2075.57	2065.73	2064.07	2064.66	2069.08	2075.67
12	2064.15	2031.34	2042.15	2043.25	2037.42	2071.20	2074.81	2065.05	2063.42	2065.79	2069.57	2075.17
13	2063.58	2030.53	2046.86	2042.16	2040.20	2071.72	2074.05	2064.54	2062.64	2067.00	2070.35	2074.88
14	2063.00	2030.04	2049.95	2041.57	2043.12	2072.30	2073.62	2064.48	2061.77	2068.05	2070.76	2074.51
15	2062.44	2030.84	2052.50	2040.88	2045.95	2073.33	2073.27	2063.87	2060.98	2068.59	2070.93	2074.38
16	2062.40	2030.72	2053.70	2040.15	2048.11	2074.43	2073.67	2063.48	2060.67	2069.06	2070.74	2074.32
17	2061.98	2030.95	2053.51	2040.50	2048.92	2075.28	2074.26	2063.28	2060.38	2068.81	2070.83	2074.55
18	2061.64	2031.71	2052.77	2040.35	2049.89	2075.63	2074.09	2063.05	2061.10	2068.53	2070.83	2074.52
19	2060.95	2032.41	2052.31	2040.84	2050.40	2076.55	2073.87	2062.81	2061.12	2068.09	2070.96	2073.91
20	2059.71	2032.69	2052.05	2041.85	2051.70	2076.50	2073.30	2063.15	2061.41	2067.75	2070.91	2073.63
21	2058.76	2033.31	2051.36	2043.00	2053.20	2076.95	2072.62	2063.53	2061.40	2067.47	2071.23	2073.36
22	2058.51	2033.10	2050.50	2044.24	2054.25	2076.96	2071.71	2063.82	2061.62	2067.75	2071.26	2073.25
23	2058.48	2033.30	2050.14	2045.57	2054.63	2076.58	2071.82	2063.70	2061.97	2067.88	2071.29	2073.11
24	2057.13	2033.10	2049.49	2047.00	2055.19	2076.08	2071.83	2064.12	2061.81	2068.21	2071.94	2073.35
25	2055.72	2032.69	2048.75	2047.52	2055.90	2076.32	2071.55	2064.50	2062.32	2068.25	2072.82	2073.72
26	2054.40	2032.42	2048.80	2048.11	2057.03	2076.89	2071.10	2064.47	2061.77	2067.73	2072.94	2073.97
27	2053.10	2031.85	2050.75	2048.48	2057.86	2076.64	2070.80	2065.17	2061.36	2067.74	2073.43	2073.87
28	2051.62	2031.02	2051.65	2047.90	2058.79	2076.62	2070.16	2065.63	2061.12	2067.01	2073.51	2073.33
29	2049.94	---	2051.54	2046.76	2059.48	2076.62	2069.93	2065.97	2060.51	2067.20	2073.17	2072.82
30	2049.25	---	2051.90	2044.07	2060.98	2076.22	2069.96	2065.47	2059.80	2067.49	2073.29	2072.55
31	2048.70	---	2051.46	---	2061.88	---	2069.86	2065.60	---	2066.77	---	2072.60

Table 6-4.7

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2072.83	2062.82	2051.98	2050.14	2075.48	2074.12	2076.03	2076.97	2073.26	2064.60	2072.88	2076.45
2	2073.04	2061.92	2051.93	2050.18	2075.84	2074.82	2076.21	2076.67	2072.50	2064.94	2073.08	2076.28
3	2072.87	2060.76	2051.81	2049.79	2075.60	2075.76	2076.42	2076.33	2071.94	2064.72	2073.40	2076.36
4	2072.23	2060.74	2051.50	2050.27	2075.78	2076.30	2076.60	2076.16	2071.22	2064.72	2073.64	2076.41
5	2071.82	2060.60	2051.47	2050.97	2076.19	2076.83	2076.85	2075.97	2070.67	2064.72	2074.03	2076.64
6	2071.53	2059.75	2050.60	2051.85	2076.62	2076.73	2076.97	2076.22	2069.71	2064.80	2073.66	2076.71
7	2071.57	2059.22	2050.30	2052.22	2077.02	2076.50	2076.89	2075.78	2069.15	2064.86	2073.67	2076.55
8	2071.74	2058.36	2049.94	2052.91	2076.67	2076.37	2076.73	2075.12	2068.66	2064.33	2073.49	2076.24
9	2071.47	2057.67	2049.60	2053.67	2076.50	2076.04	2077.00	2074.60	2068.16	2063.79	2073.84	2076.63
10	2071.33	2057.11	2049.29	2053.95	2075.40	2076.45	2076.75	2074.02	2068.03	2064.01	2073.97	2076.60
11	2071.47	2057.77	2049.61	2054.65	2073.13	2077.08	2076.84	2073.61	2067.38	2064.44	2073.84	2076.63
12	2071.89	2058.48	2049.75	2055.20	2071.67	2077.23	2076.60	2073.59	2066.53	2064.61	2074.76	2076.06
13	2072.27	2058.07	2048.96	2056.02	2069.50	2077.02	2076.58	2073.83	2065.76	2064.97	2074.65	2075.97
14	2072.78	2057.11	2047.76	2057.05	2068.06	2076.57	2076.73	2073.72	2064.78	2065.57	2074.68	2075.92
15	2073.72	2055.78	2047.19	2057.63	2066.90	2076.70	2076.86	2073.17	2064.61	2066.24	2074.54	2075.64
16	2073.34	2054.54	2046.90	2058.58	2066.34	2076.58	2077.02	2072.76	2064.26	2066.06	2074.38	2075.82
17	2073.13	2053.11	2046.74	2059.00	2066.31	2076.82	2077.12	2072.79	2064.67	2066.34	2074.42	2075.71
18	2072.60	2052.95	2046.77	2059.73	2065.99	2077.13	2077.12	2072.83	2064.31	2066.46	2074.83	2075.11
19	2071.92	2052.77	2047.98	2060.55	2065.51	2076.96	2077.12	2073.40	2064.22	2067.13	2074.76	2075.10
20	2070.84	2052.53	2047.88	2061.30	2066.02	2076.36	2076.83	2072.92	2064.57	2067.40	2074.84	2074.75
21	2069.77	2051.90	2048.54	2062.60	2066.98	2075.94	2077.08	2073.38	2064.85	2067.95	2074.62	2073.60
22	2069.45	2051.35	2048.73	2063.55	2067.50	2075.79	2077.15	2073.36	2064.39	2068.35	2074.37	2072.16
23	2068.75	2051.33	2048.94	2065.06	2068.03	2075.78	2077.15	2073.86	2064.40	2068.78	2074.96	2070.55
24	2067.90	2051.10	2049.03	2066.46	2068.13	2075.56	2077.00	2074.26	2064.70	2069.31	2075.31	2069.15
25	2066.69	2051.14	2049.50	2067.77	2069.08	2075.36	2077.32	2074.62	2064.65	2069.98	2075.34	2067.58
26	2066.11	2052.09	2050.22	2069.30	2070.08	2075.36	2077.62	2075.02	2064.66	2070.45	2075.93	2066.50
27	2065.62	2052.28	2050.22	2070.73	2071.13	2075.33	2077.28	2075.39	2064.87	2070.99	2075.64	2065.79
28	2065.07	2052.22	2049.87	2071.63	2071.40	2075.68	2077.18	2075.61	2064.73	2071.41	2075.47	2065.07
29	2065.09	---	2049.76	2072.75	2071.73	2075.93	2077.24	2075.10	2064.70	2071.54	2075.78	2065.06
30	2064.56	---	2049.52	2074.32	2072.36	2076.06	2077.18	2074.41	2064.46	2071.90	2075.94	2063.98
31	2063.73	---	2049.50	---	2073.42	---	2077.17	2073.48	---	2072.58	---	2063.38

Table 6-4.8

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2062.53	2063.21	2062.16	2065.75	2076.64	2076.45	2076.81	2073.51	2076.08	2058.30	2059.35	2070.00
2	2062.24	2062.89	2061.99	2065.57	2076.35	2076.36	2076.73	2073.72	2076.02	2057.80	2059.72	2070.91
3	2061.47	2063.29	2062.74	2065.38	2076.18	2076.43	2076.35	2073.95	2076.13	2057.42	2060.45	2070.88
4	2060.84	2063.85	2063.67	2065.20	2075.95	2076.12	2076.02	2074.33	2075.86	2056.97	2061.52	2071.05
5	2060.41	2063.87	2063.84	2065.33	2076.21	2076.17	2076.53	2075.00	2075.72	2056.78	2061.39	2071.39
6	2060.34	2064.04	2063.48	2065.84	2076.64	2076.06	2076.49	2075.08	2075.61	2056.49	2061.92	2071.79
7	2060.03	2064.85	2063.99	2066.51	2075.70	2076.14	2076.49	2075.08	2075.31	2056.28	2062.48	2071.91
8	2059.72	2065.14	2063.53	2067.74	2074.37	2076.10	2076.44	2074.94	2074.60	2055.90	2062.78	2072.53
9	2059.70	2065.03	2062.72	2068.40	2073.52	2076.28	2076.44	2075.10	2074.13	2056.06	2063.10	2073.31
10	2059.60	2065.62	2063.39	2069.01	2072.78	2076.59	2076.01	2074.95	2072.99	2055.57	2063.36	2073.33
11	2059.95	2065.92	2064.56	2069.75	2072.22	2076.40	2074.85	2075.22	2071.81	2055.50	2063.75	2073.88
12	2060.07	2065.27	2064.12	2070.49	2071.11	2076.06	2073.69	2075.41	2070.42	2055.64	2064.16	2074.23
13	2060.75	2065.25	2064.21	2071.05	2069.81	2075.79	2072.68	2075.20	2068.89	2055.64	2064.37	2074.64
14	2061.71	2065.17	2064.28	2071.24	2068.53	2075.36	2071.59	2075.29	2068.17	2056.01	2064.65	2074.78
15	2062.10	2065.54	2064.26	2071.94	2067.27	2074.91	2070.72	2075.59	2067.30	2055.60	2065.10	2075.01
16	2063.04	2065.70	2064.25	2072.01	2065.85	2075.47	2069.82	2075.81	2066.06	2055.24	2065.21	2075.18
17	2063.63	2065.91	2064.24	2071.46	2065.98	2076.13	2070.06	2075.91	2064.83	2055.68	2066.07	2074.87
18	2064.54	2066.23	2064.31	2071.96	2066.70	2076.00	2070.69	2075.83	2063.45	2055.38	2066.62	2074.71
19	2065.26	2066.15	2064.58	2072.48	2067.87	2075.86	2070.68	2075.77	2062.38	2055.39	2066.64	2074.62
20	2065.94	2066.15	2063.87	2072.79	2068.71	2076.09	2070.92	2075.98	2061.77	2056.01	2067.11	2074.36
21	2066.75	2065.60	2064.08	2073.21	2069.57	2076.10	2071.24	2075.77	2061.06	2056.37	2067.52	2073.91
22	2066.33	2065.00	2064.13	2073.69	2070.25	2076.09	2071.34	2075.88	2060.66	2056.34	2067.61	2073.97
23	2066.02	2064.10	2063.78	2074.24	2071.30	2076.61	2071.42	2075.86	2060.20	2056.49	2067.62	2074.30
24	2065.79	2063.53	2063.83	2074.49	2072.39	2076.97	2071.75	2076.00	2059.72	2056.51	2067.93	2074.14
25	2065.31	2063.30	2064.42	2074.70	2073.28	2076.58	2072.08	2076.30	2059.46	2056.59	2068.55	2074.42
26	2064.89	2062.82	2063.96	2075.00	2074.04	2076.50	2072.43	2076.29	2059.09	2056.61	2068.72	2074.60
27	2064.35	2062.26	2064.33	2075.09	2075.33	2076.50	2072.45	2076.44	2058.74	2057.57	2069.21	2074.38
28	2064.19	2062.62	2064.22	2075.71	2075.76	2076.63	2072.76	2076.66	2058.40	2057.89	2069.01	2074.22
29	2063.92	---	2064.88	2076.58	2076.02	2076.63	2073.33	2076.37	2058.46	2058.29	2069.58	2074.31
30	2063.63	---	2065.08	2076.37	2076.21	2076.75	2073.35	2075.79	2058.61	2058.95	2069.96	2074.53
31	2063.24	---	2065.46	---	2076.43	---	2073.35	2076.04	---	2059.17	---	2074.46

Table 6-4.9

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2074.67	2068.55	2074.28	2074.70	2076.41	2074.14	2076.50	2065.16	2060.00	2059.37	2054.60	2061.43
2	2074.97	2069.37	2074.37	2074.73	2075.57	2073.98	2076.72	2064.71	2059.88	2058.90	2055.17	2061.71
3	2074.48	2069.90	2074.07	2074.56	2074.11	2073.93	2076.85	2064.34	2059.85	2058.64	2055.50	2061.98
4	2074.18	2069.23	2074.14	2074.29	2072.47	2074.00	2075.94	2064.31	2059.91	2058.48	2055.80	2062.03
5	2074.11	2069.13	2074.25	2074.37	2071.14	2074.02	2074.75	2064.36	2059.62	2058.70	2056.45	2062.23
6	2074.27	2069.42	2074.39	2074.81	2069.58	2074.10	2073.42	2064.36	2059.52	2058.42	2056.64	2062.30
7	2074.15	2069.22	2074.22	2074.85	2069.18	2074.18	2071.78	2064.10	2059.75	2058.11	2056.84	2062.63
8	2073.57	2068.81	2074.60	2074.52	2069.22	2074.19	2070.47	2063.60	2059.92	2057.81	2057.05	2062.53
9	2072.83	2069.04	2074.85	2074.41	2069.55	2074.08	2069.14	2063.32	2059.62	2057.43	2057.21	2063.30
10	2072.01	2069.60	2074.75	2074.20	2070.02	2074.04	2067.28	2062.96	2059.62	2057.20	2057.27	2063.39
11	2071.68	2069.19	2074.59	2073.85	2070.46	2074.17	2067.19	2062.63	2059.95	2056.85	2057.52	2063.46
12	2071.40	2069.24	2074.54	2074.29	2070.36	2073.86	2067.55	2062.53	2059.72	2056.74	2058.06	2063.67
13	2071.33	2069.09	2074.23	2074.76	2069.93	2073.91	2067.02	2062.28	2059.61	2056.52	2058.20	2063.99
14	2070.78	2069.77	2074.00	2074.58	2069.68	2074.21	2067.02	2062.11	2059.83	2056.23	2058.49	2064.49
15	2070.20	2069.66	2074.26	2074.73	2069.82	2074.70	2067.09	2061.83	2059.53	2056.06	2058.65	2064.76
16	2070.00	2070.22	2074.65	2074.79	2069.85	2075.46	2066.93	2061.92	2059.87	2055.70	2058.79	2064.86
17	2069.90	2070.73	2074.09	2075.01	2069.95	2075.62	2066.65	2062.14	2059.76	2055.34	2058.84	2065.14
18	2069.74	2071.00	2074.06	2075.45	2070.26	2075.56	2066.46	2061.76	2060.05	2054.81	2059.13	2065.40
19	2069.66	2071.07	2073.77	2075.34	2070.02	2075.88	2066.47	2061.33	2059.74	2054.52	2059.43	2065.70
20	2069.64	2071.00	2074.12	2076.06	2070.43	2075.95	2066.28	2061.13	2059.92	2054.31	2059.54	2065.97
21	2069.12	2071.68	2074.08	2076.41	2070.95	2076.15	2066.26	2061.10	2060.04	2053.96	2059.93	2066.47
22	2068.46	2072.39	2074.20	2076.17	2071.14	2076.86	2066.13	2061.08	2059.91	2053.77	2060.16	2067.07
23	2068.46	2073.24	2074.46	2076.17	2071.57	2076.75	2065.91	2061.07	2059.60	2053.64	2060.59	2067.08
24	2068.09	2074.22	2074.18	2076.24	2072.05	2076.77	2065.94	2060.71	2059.75	2053.30	2060.26	2067.49
25	2067.89	2074.64	2074.42	2076.57	2072.45	2076.91	2065.67	2060.69	2059.90	2053.05	2060.80	2067.86
26	2068.35	2074.74	2074.40	2076.45	2072.48	2076.70	2065.58	2060.49	2059.86	2053.33	2061.13	2068.06
27	2068.58	2074.71	2074.18	2076.80	2072.82	2076.45	2065.92	2060.32	2059.82	2053.72	2061.44	2068.24
28	2068.43	2074.80	2074.26	2076.30	2073.15	2076.28	2065.55	2060.12	2059.77	2053.54	2061.43	2068.69
29	2068.01	2074.79	2074.49	2076.30	2073.43	2076.59	2065.53	2060.18	2059.82	2053.74	2061.50	2069.05
30	2068.08	---	2074.81	2076.44	2073.52	2076.70	2065.44	2060.17	2059.93	2054.01	2061.58	2069.04
31	2068.30	---	2074.84	---	2073.73	---	2065.31	2060.09	---	2054.23	---	2068.95

Table 6-4.10

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2068.75	2063.98	2051.59	2075.70	2075.68	2076.07	2075.45	2064.18	2056.18	2045.90	2035.50	2052.20
2	2069.22	2063.19	2050.56	2075.83	2075.61	2076.00	2075.39	2063.45	---	2043.80	2035.50	2053.00
3	2069.06	2062.02	2049.57	2076.13	2075.87	2076.54	2075.65	2063.14	2055.30	2042.00	2036.00	2053.60
4	2068.73	2061.66	2048.76	2076.21	2076.23	2076.81	2076.23	2063.00	2054.30	2041.00	2037.30	2054.20
5	2068.20	2061.01	2048.58	2076.83	2076.44	2076.85	2076.57	2063.23	2053.50	2039.40	2037.00	2054.90
6	2068.18	2060.08	2048.46	2076.59	2076.66	2076.83	2076.59	2063.18	2053.30	2037.80	2037.70	2055.50
7	2068.25	2060.04	2048.27	2076.28	2076.56	2076.56	2076.33	2063.07	2052.70	2036.90	2038.60	2056.20
8	2067.73	2060.43	2048.04	2076.53	2076.73	2076.43	2076.41	2062.93	2052.20	2035.50	2039.50	2056.80
9	2067.90	2060.06	2048.02	2076.51	2076.70	2076.81	2076.11	2061.78	2051.40	2034.40	2039.50	2057.40
10	2068.10	2059.67	2048.02	2076.69	2076.59	2076.70	2075.96	2060.58	2050.20	2034.00	2040.20	2058.30
11	2068.05	2059.48	2048.63	2076.62	2076.52	2076.87	2076.30	2060.29	2049.40	2033.50	2041.00	2059.30
12	2068.20	2059.49	2049.00	2076.58	2076.46	2076.82	2076.06	2059.27	2048.80	2032.70	2042.10	2060.20
13	2068.15	2059.74	2049.19	2076.30	2076.62	2076.72	2075.50	2059.50	2049.10	2031.40	2042.50	2060.30
14	2067.52	2060.41	2049.14	2075.93	2076.74	2076.55	2075.04	2058.91	2050.10	2031.10	2042.80	2060.70
15	2067.52	2061.00	2048.99	2076.15	2077.13	2076.27	2075.03	2059.49	2051.00	2029.50	2043.70	2061.30
16	2067.66	2060.75	2049.51	2076.55	2076.91	2076.24	2074.81	2060.25	2051.90	2028.00	2043.80	2062.20
17	2068.07	2059.87	2050.46	2076.72	2076.74	2076.63	2074.33	2059.96	2052.80	2026.70	2044.60	2062.80
18	2067.95	2058.71	2052.76	2076.50	2076.75	2076.64	2074.12	2059.33	2053.80	2026.10	2045.60	2063.20
19	2067.62	2057.58	2058.04	2076.17	2076.67	2076.49	2074.22	2059.14	2054.00	2025.90	2046.00	2063.80
20	2067.74	2057.18	2063.15	2076.44	2076.17	2075.83	2073.36	2058.26	2054.40	2026.40	2046.00	2063.80
21	2067.28	2056.53	2067.45	2076.36	2076.04	2075.69	2072.54	2056.95	2054.40	2026.70	2046.90	2063.80
22	2067.11	2056.72	2070.73	2076.12	2075.78	2075.87	2071.62	2056.90	2054.30	2026.70	2047.50	2063.90
23	2066.77	2056.42	2072.46	2076.32	2075.51	2076.50	2070.69	2057.22	2053.50	2027.50	2048.00	2063.90
24	2066.85	2055.93	2073.03	2076.44	2075.64	2076.41	2070.00	2056.97	2052.60	2028.70	2048.50	2063.80
25	2066.85	2055.18	2073.33	2076.43	2075.29	2076.05	2069.29	2056.50	2052.40	2029.90	2048.40	2064.10
26	2066.93	2054.14	2073.39	2076.64	2075.92	2075.68	2068.52	2056.44	2052.30	2031.20	2048.80	2064.80
27	2066.57	2052.82	2073.00	2076.73	2076.24	2075.19	2067.86	2056.26	2051.50	2031.40	2049.60	2064.70
28	2066.12	2051.97	2072.94	2076.59	2076.51	2074.62	2066.70	2056.51	2050.60	2032.30	2050.60	2065.00
29	2065.56	---	2073.26	2076.33	2076.69	2074.40	2065.58	2056.32	2049.30	2032.60	2051.40	2065.20
30	2065.17	---	2074.49	2076.06	2076.43	2075.16	2064.41	2056.69	2047.70	2033.40	2051.80	---
31	2064.62	---	2075.17	---	2076.04	---	2064.92	2056.23	---	2034.20	---	2065.30

Table 6-4.11

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2065.80	2067.90	2064.60	2071.90	2074.20	2069.60	2076.70	2056.30	2060.20	2060.10	2054.60	2063.80
2	2067.10	2068.20	2065.70	2072.50	2072.40	2069.90	2076.40	2056.70	2060.20	2061.00	2055.00	2064.00
3	2067.70	2068.50	2066.50	2073.30	2071.00	2070.40	2075.70	2056.80	2060.30	2062.00	2055.30	2064.70
4	2068.30	2068.30	2067.80	2073.80	2070.20	2071.10	2075.00	2057.20	2060.40	2062.20	2055.50	2064.90
5	2068.70	2068.00	2068.80	2073.90	2069.00	2071.60	2074.60	2057.90	2061.20	2061.70	2055.70	2065.30
6	2068.30	2068.00	2069.90	2074.60	2067.50	2072.10	2073.70	2058.30	2061.00	2061.70	2056.50	2065.40
7	2068.80	2068.30	2070.90	2074.80	2065.60	2072.80	2072.30	2058.80	2060.50	2061.70	2057.50	2065.70
8	2068.90	2067.80	2070.70	2074.90	2064.00	2073.40	2071.20	2059.50	2060.00	2062.10	2058.10	2066.00
9	2068.70	2066.70	2070.70	2075.20	2062.40	2073.40	2070.80	2059.70	2059.60	2062.40	2058.60	2066.20
10	2069.10	2065.40	2070.80	2075.20	2061.00	2073.70	2070.30	2060.10	2059.10	2062.50	2059.00	2066.70
11	2069.10	2065.00	2070.80	2074.70	2059.60	2073.70	2070.00	2060.50	2059.40	2062.40	2059.20	2067.20
12	2068.90	2064.90	2071.30	2074.50	2058.40	2073.70	2069.20	2060.60	2060.20	2062.30	2058.70	2067.30
13	2069.00	2064.80	2072.20	2074.00	2059.30	2074.00	2068.50	2060.90	2059.60	2061.80	2059.00	2067.80
14	2068.80	2065.10	2072.50	2074.20	2060.50	2074.20	2067.50	2061.00	2059.30	2061.40	2059.20	2067.90
15	2068.70	2065.00	2072.80	2074.30	2061.10	2074.50	2066.60	2061.40	2059.30	2059.90	2060.00	2067.40
16	2068.80	2064.30	2072.80	2074.50	2062.50	2074.60	2065.80	2061.30	2059.30	2058.60	2060.20	2067.50
17	2068.80	2064.40	2072.70	2074.50	2062.80	2075.00	2064.90	2061.10	2059.30	2057.50	2060.40	2067.80
18	2068.30	2063.90	2072.60	2074.90	2063.50	2075.00	2064.30	2060.90	2059.90	2056.10	2060.70	2068.30
19	2067.30	2063.10	2072.40	2074.60	2064.30	2075.40	2063.40	2061.10	2060.50	2055.10	2060.80	2068.70
20	2067.40	2062.70	2072.00	2074.90	2065.00	2076.00	2062.80	2060.90	2060.30	2053.90	2061.60	2069.20
21	2067.20	2062.20	2072.00	2075.20	2066.00	2076.10	2062.60	2061.30	2060.00	2052.50	2061.70	2069.30
22	2066.70	2062.00	2071.70	2075.70	2067.00	2076.40	2062.40	2061.40	2059.90	2051.20	2061.60	2069.70
23	2066.70	2061.80	2070.80	2076.30	2068.20	2076.70	2061.60	2061.30	2059.30	2051.40	2061.80	2069.70
24	2066.90	2061.50	2069.70	2076.00	2068.80	2076.30	2060.60	2061.30	2059.20	2052.00	2062.20	2070.00
25	2066.70	2061.30	2069.00	2076.30	2068.70	2076.30	2060.00	2060.80	2059.70	2051.90	2062.50	2070.60
26	2066.70	2061.80	2069.30	2076.70	2068.90	2076.40	2059.30	2060.30	2060.10	2052.60	2062.60	2070.90
27	2066.30	2062.40	2069.90	2076.60	2069.20	2076.70	2058.20	2060.30	2059.80	2053.20	2062.70	2071.70
28	2066.20	2063.70	2070.60	2076.10	2069.40	2076.60	2057.30	2060.40	2059.50	2053.00	2063.10	2071.60
29	2066.70	---	2071.10	2076.10	2069.20	2076.30	2056.20	2060.50	2059.50	2053.50	2063.20	2071.70
30	2067.10	---	2071.20	2075.10	2069.60	2076.50	2055.80	2060.20	2060.30	2053.90	2063.50	2072.10
31	2067.80	---	2071.40	---	2069.50	---	2056.00	2060.30	---	2054.20	---	2072.10

Table 6-4.12

BROWNLEE RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2072.20	2067.90	2059.30	2066.00	2057.40	2076.50	2076.60	2068.70	2056.10	2042.50	2041.30	2065.20
2	2072.30	2069.50	2058.50	2065.60	2057.20	2076.20	2076.20	2067.50	2055.40	2041.90	2041.20	2066.50
3	2072.20	2070.90	2057.00	2066.00	2057.30	2076.40	2076.50	2066.40	2054.60	2041.10	2042.00	2067.70
4	2072.20	2071.50	2055.40	2065.50	2057.60	2076.40	2076.40	2065.20	2054.70	2040.70	2043.00	2069.20
5	2071.40	2072.40	2054.00	2064.60	2057.50	2076.40	2076.40	2063.80	2054.80	2040.10	2043.40	2070.10
6	2071.10	2072.50	2052.80	2064.30	2057.50	2076.30	2076.10	2062.70	2054.20	2039.10	2044.30	2071.30
7	2070.70	2072.30	2051.30	2064.30	2057.80	2076.80	2076.20	2061.60	2053.60	2038.50	2044.80	2072.60
8	2070.70	2071.80	2049.10	2064.00	2059.00	2076.70	2076.40	2060.30	2053.00	2037.80	2045.30	2073.40
9	2070.80	2071.30	2047.40	2064.50	2060.20	2076.40	2076.40	2059.40	2052.40	2037.70	2046.30	2074.40
10	2070.90	2071.10	2046.30	2065.30	2061.60	2076.20	2076.20	2058.60	2052.60	2037.50	2046.80	2075.20
11	2071.00	2070.60	2046.20	2065.50	2063.00	2076.30	2076.30	2058.30	2052.70	2036.80	2047.50	2075.80
12	2072.00	2070.00	2047.10	2064.90	2064.50	2076.50	2076.20	2057.70	2052.20	2037.20	2049.00	2075.90
13	2072.70	2068.70	2048.40	2064.00	2066.70	2076.50	2076.30	2057.80	2051.70	2037.10	2050.00	2076.00
14	2072.60	2067.60	2049.60	2063.10	2068.80	2076.40	2076.50	2058.00	2051.00	2036.80	2050.90	2076.40
15	2073.40	2066.00	2050.80	2062.80	2070.10	2076.40	2076.20	2057.80	2050.40	2036.50	2051.90	2076.30
16	2072.90	2064.00	2052.70	2062.10	2071.40	2076.50	2076.10	2057.70	2050.00	2036.70	2052.80	2076.20
17	2072.10	2062.40	2054.80	2061.40	2071.60	2076.30	2076.30	2057.80	2049.60	2036.30	2053.80	2076.20
18	2071.20	2061.00	2056.90	2060.70	2072.40	2076.50	2076.30	2058.30	2049.80	2035.70	2054.70	2075.90
19	2070.60	2061.20	2058.70	2059.70	2073.20	2076.40	2076.10	2058.40	2049.40	2034.80	2055.60	2075.50
20	2069.80	2060.80	2061.30	2058.90	2073.70	2076.60	2075.90	2058.50	2048.80	2034.60	2056.40	2075.00
21	2068.80	2060.80	2063.10	2058.10	2073.80	2076.60	2075.60	2058.40	2048.20	2035.00	2057.20	2074.40
22	2068.30	2060.60	2064.20	2057.60	2073.60	2076.50	2075.80	2058.30	2047.60	2034.80	2057.80	2074.00
23	2067.50	2060.70	2065.30	2057.70	2074.10	2076.30	2076.10	2058.00	2047.20	2035.30	2059.10	2073.90
24	2066.80	2061.30	2065.90	2058.40	2074.80	2076.30	2076.40	2057.80	2046.80	2035.80	2059.80	2073.70
25	2066.70	2060.90	2066.20	2058.00	2075.20	2076.30	2076.40	2057.40	2046.30	2036.60	2060.50	2074.30
26	2067.00	2061.20	2066.60	2057.50	2075.90	2076.10	2075.70	2057.40	2045.90	2037.30	2060.90	2074.30
27	2067.10	2061.50	2067.10	2056.90	2076.50	2076.60	2074.30	2057.00	2045.40	2038.00	2061.50	2073.80
28	2067.50	2060.60	2067.10	2056.60	2076.40	2076.70	2072.80	2057.50	2044.40	2038.80	2062.50	2073.30
29	2067.60	---	2067.50	2056.00	2076.40	2076.30	2071.60	2057.00	2043.90	2039.30	2063.40	2073.10
30	2067.60	---	2067.40	2056.20	2076.20	2076.50	2070.60	2057.00	2043.10	2039.80	2064.20	2072.90
31	2067.60	---	2067.00	---	2076.70	---	2069.80	2056.60	---	2040.30	---	2072.90

Table 6-4.13

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1982

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.02	1799.90	1799.88	1798.95	1799.74	1802.33	1802.12	1800.44	1802.50	1802.27	1802.66	1801.58
2	1802.78	1801.24	1799.68	1797.76	1802.56	1799.86	1802.08	1800.86	1804.08	1799.98	1799.33	1801.51
3	1801.99	1801.50	1802.51	1800.36	1802.71	1802.72	1798.70	1801.08	1803.13	1799.73	1801.76	1800.04
4	1798.60	1802.47	1799.82	1799.39	1799.72	1802.62	1801.95	1802.24	1801.97	1800.59	1800.92	1801.43
5	1801.84	1802.33	1800.98	1801.29	1801.02	1801.77	1800.29	1800.90	1803.09	1801.45	1800.15	1799.76
6	1800.54	1801.19	1799.56	1801.34	1801.63	1802.75	1800.60	1801.23	1799.23	1802.67	1800.77	1802.43
7	1803.35	1800.79	1801.96	1798.45	1802.21	1801.70	1802.72	1802.13	1800.35	1798.71	1800.43	1802.20
8	1800.13	1800.47	1800.61	1800.36	1800.41	1802.19	1800.61	1801.64	1802.68	1800.10	1800.63	1801.04
9	1798.73	1803.15	1800.32	1800.17	1803.02	1803.68	1800.94	1801.54	1800.67	1800.96	1801.75	1802.21
10	1801.61	1800.51	1801.01	1800.88	1800.10	1803.54	1800.61	1801.03	1801.00	1801.15	1803.05	1801.95
11	1800.73	1803.40	1801.98	1800.91	1803.05	1803.77	1801.48	1802.19	1798.87	1799.11	1802.94	1802.56
12	1800.18	1803.14	1800.92	1800.66	1799.98	1803.51	1802.27	1802.06	1800.74	1802.74	1802.88	1800.34
13	1799.95	1802.84	1800.22	1802.06	1801.56	1803.85	1803.27	1801.19	1800.01	1800.38	1801.63	1801.43
14	1801.03	1801.88	1800.93	1801.00	1800.61	1803.05	1803.47	1802.42	1799.58	1802.38	1802.64	1800.74
15	1801.37	1800.39	1801.43	1802.46	1802.49	1803.39	1802.59	1803.84	1800.26	1801.53	1800.09	1801.99
16	1801.53	1800.59	1800.15	1799.62	1800.06	1801.42	1803.86	1802.84	1800.84	1801.21	1800.52	1800.57
17	1800.04	1801.01	1798.95	1801.74	1801.29	1803.41	1801.17	1803.62	1800.72	1802.73	1800.97	1799.81
18	1800.50	1803.00	1799.00	1801.46	1800.03	1801.62	1802.58	1802.24	1800.99	1802.44	1801.01	1800.21
19	1799.22	1802.20	1800.97	1799.98	1799.76	1800.54	1801.84	1802.19	1801.87	1802.06	1801.01	1801.45
20	1799.91	1799.80	1800.27	1799.02	1802.01	1801.21	1802.74	1802.02	1800.94	1803.11	1802.73	1804.15
21	1802.23	1802.11	1799.85	1803.43	1800.59	1803.46	1801.90	1801.81	1803.08	1800.60	1800.60	1802.21
22	1800.35	1802.87	1800.58	1800.13	1801.04	1801.87	1802.43	1802.31	1802.50	1802.45	1801.45	1800.37
23	1802.61	1802.87	1800.93	1800.90	1802.09	1801.95	1802.11	1802.08	1802.92	1802.39	1802.87	1802.06
24	1800.03	1800.90	1800.40	1801.00	1802.24	1801.70	1801.06	1801.43	1802.77	1802.18	1801.15	1799.20
25	1801.00	1799.87	1802.24	1800.40	1802.66	1801.34	1801.40	1803.27	1802.71	1800.55	1802.94	1802.06
26	1801.90	1800.05	1799.51	1800.75	1802.85	1803.22	1800.48	1801.53	1799.07	1799.51	1800.36	1803.60
27	1800.13	1799.65	1802.44	1800.05	1801.93	1802.22	1801.80	1802.18	1800.12	1802.10	1803.05	1800.44
28	1800.80	1801.60	1800.97	1800.50	1803.76	1800.83	1800.31	1802.17	1801.07	1800.75	1801.72	1801.46
29	1801.95	---	1801.36	1801.75	1802.31	1803.11	1801.59	1801.76	1801.12	1801.08	1802.90	1802.18
30	1802.09	---	1799.09	1801.55	1803.91	1800.91	1801.05	1802.17	1802.78	1800.96	1802.15	1800.62
31	1800.17	---	1800.56	---	1803.09	---	1800.25	1802.03	---	1802.23	---	1800.48

Table 6-5.1

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1800.98	1802.07	1802.00	1801.14	1801.66	1801.15	1800.77	1799.85	1802.35	1802.55	1796.22	1802.14
2	1802.04	1801.63	1800.41	1800.24	1800.92	1798.77	1799.45	1800.99	1801.58	1801.30	1799.80	1798.42
3	1799.77	1801.01	1800.91	1802.17	1799.92	1802.38	1801.64	1801.31	1801.32	1801.18	1803.26	1799.02
4	1800.54	1800.32	1801.73	1801.00	1800.03	1800.73	1802.36	1799.38	1802.92	1801.41	1802.25	1802.25
5	1800.12	1803.01	1800.76	1801.57	1801.21	1802.21	1799.81	1801.39	1802.23	1801.89	1802.13	1803.68
6	1803.82	1801.98	1801.67	1800.84	1800.64	1801.44	1800.34	1799.06	1801.71	1800.83	1801.00	1802.22
7	1798.98	1799.64	1801.60	1800.41	1800.09	1799.90	1801.28	1801.26	1802.77	1800.90	1802.75	1801.54
8	1798.57	1801.83	1801.95	1800.35	1799.35	1800.45	1802.57	1799.50	1802.39	1801.27	1801.84	1801.40
9	1802.58	1802.15	1802.73	1801.68	1799.45	1800.21	1801.70	1801.23	1803.13	1800.78	1802.82	1803.14
10	1801.62	1801.76	1802.07	1801.82	1800.89	1800.08	1799.50	1802.15	1801.77	1799.31	1801.76	1802.62
11	1801.47	1801.14	1799.25	1801.95	1799.28	1799.03	1802.20	1800.79	1802.64	1800.74	1801.61	1801.93
12	1801.84	1802.43	1801.21	1798.09	1800.70	1800.58	1801.95	1800.58	1802.91	1797.48	1800.90	1800.12
13	1799.45	1801.03	1800.26	1802.10	1802.55	1802.42	1802.50	1801.29	1803.03	1800.96	1802.51	1802.73
14	1803.23	1801.06	1800.91	1800.42	1798.68	1799.73	1803.42	1801.92	1801.61	1802.46	1801.61	1803.68
15	1801.78	1800.68	1801.16	1800.59	1800.34	1800.77	1802.92	1802.42	1802.11	1802.59	1803.41	1803.99
16	1803.05	1801.96	1801.31	1802.03	1798.60	1801.03	1803.47	1803.16	1802.65	1800.58	1801.64	1803.82
17	1801.24	1801.70	1801.50	1802.65	1799.30	1800.62	1802.79	1803.74	1801.81	1800.96	1801.68	1803.40
18	1803.18	1802.14	1799.51	1801.50	1802.41	1799.78	1803.23	1802.96	1803.02	1802.65	1802.29	1804.11
19	1800.21	1801.85	1800.74	1800.95	1799.85	1800.42	1803.96	1803.70	1803.37	1801.87	1800.87	1804.22
20	1801.05	1803.22	1801.52	1801.68	1800.03	1800.44	1800.89	1801.96	1802.25	1803.28	1804.22	1803.48
21	1801.85	1800.04	1801.87	1800.72	1800.40	1800.89	1801.36	1802.69	1801.18	1802.83	1803.97	1802.98
22	1800.45	1803.47	1798.77	1801.83	1800.83	1800.56	1801.24	1801.25	1803.01	1802.52	1803.32	1804.06
23	1802.22	1801.70	1800.46	1800.36	1801.57	1801.22	1801.38	1802.35	1802.09	1804.06	1803.02	1802.89
24	1802.39	1800.86	1801.51	1800.23	1801.05	1801.59	1800.06	1802.59	1802.92	1802.60	1801.09	1803.54
25	1802.78	1800.96	1801.45	1802.80	1800.52	1799.66	1802.08	1801.93	1803.06	1801.42	1800.86	1800.46
26	1800.76	1801.52	1799.62	1802.02	1799.67	1802.48	1801.11	1803.10	1802.70	1800.56	1801.59	1803.11
27	1801.42	1801.31	1802.23	1800.84	1802.67	1802.41	1801.40	1803.39	1802.97	1801.00	1804.39	1802.08
28	1801.92	1802.01	1800.90	1802.20	1801.96	1801.71	1800.83	1803.62	1801.51	1800.61	1803.45	1803.04
29	1800.76	---	1801.47	1801.35	1801.96	1801.44	1802.73	1804.12	1800.98	1801.19	1803.12	1802.16
30	1800.16	---	1799.65	1800.63	1800.86	1801.53	1801.13	1801.50	1802.40	1801.01	1801.72	1802.52
31	1803.01	---	1802.41	---	1799.17	---	1802.81	1801.96	---	1801.53	---	1803.05

Table 6-5.2

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.65	1800.42	1801.45	1802.39	1800.96	1801.97	1802.00	1802.42	1798.60	1803.48	1802.12	1803.19
2	1802.21	1801.63	1799.82	1802.81	1799.31	1801.60	1799.25	1798.42	1800.55	1801.14	1800.94	1802.26
3	1803.15	1801.29	1803.33	1801.78	1800.96	1801.88	1802.45	1802.50	1800.94	1799.97	1801.14	1803.73
4	1800.85	1799.90	1803.04	1801.74	1800.83	1801.93	1800.10	1802.50	1802.12	1799.77	1801.92	1803.73
5	1802.04	1802.23	1802.21	1800.38	1802.32	1800.38	1802.95	1802.20	1802.51	1800.55	1802.31	1802.41
6	1802.39	1800.01	1800.47	1800.20	1801.31	1800.41	1802.70	1802.30	1801.92	1802.12	1802.12	1800.45
7	1802.90	1798.93	1802.58	1802.20	1800.67	1799.14	1801.38	1802.85	1801.53	1799.97	1802.90	1801.09
8	1801.33	1801.46	1803.48	1801.53	1800.15	1801.29	1800.32	1802.85	1800.36	1801.53	1800.55	1800.75
9	1802.92	1801.47	1802.19	1802.08	1800.12	1800.80	1799.87	1803.29	1796.84	1799.18	1801.92	1801.63
10	1802.03	1799.45	1803.47	1801.67	1801.31	1799.83	1803.28	1801.30	1797.62	1800.75	1802.31	1802.51
11	1801.25	1802.36	1802.67	1800.15	1800.51	1802.20	1801.30	1802.55	1801.72	1800.16	1801.71	1801.01
12	1799.53	1801.92	1801.67	1801.60	1799.68	1803.23	1802.65	1802.40	1802.90	1799.38	1801.53	1801.24
13	1799.02	1801.41	1802.14	1800.83	1800.46	1802.33	1801.70	1802.60	1802.12	1801.38	1802.13	1802.85
14	1799.29	1800.40	1802.75	1802.23	1800.17	1800.02	1803.70	1800.94	1800.94	1799.97	1801.05	1801.82
15	1802.74	1801.57	1803.66	1801.84	1801.67	1802.00	1803.60	1801.80	1799.38	1801.87	1802.51	1802.85
16	1800.76	1802.53	1800.59	1802.18	1802.09	1799.30	1803.05	1802.00	1802.12	1802.70	1800.75	1800.50
17	1801.57	1801.46	1800.63	1802.47	1801.80	1800.99	1803.50	1801.90	1802.51	1803.48	1801.92	1799.72
18	1801.68	1803.15	1803.16	1801.29	1802.13	1801.75	1803.30	1802.51	1802.90	1801.92	1801.14	1802.07
19	1799.89	1802.11	1801.06	1799.67	1801.78	1801.77	1803.50	1802.51	1803.09	1800.75	1802.31	1800.75
20	1800.89	1802.29	1798.74	1801.69	1801.47	1800.97	1803.70	1802.65	1802.31	1802.31	1802.31	1800.65
21	1803.23	1803.22	1803.93	1802.00	1800.09	1799.10	1802.60	1800.94	1800.75	1803.09	1800.36	1802.70
22	1803.03	1802.80	1801.96	1803.32	1801.87	1798.50	1799.25	1800.55	1799.18	1801.92	1802.51	1801.33
23	1801.32	1801.96	1802.74	1802.48	1801.62	1799.35	1797.95	1800.36	1800.75	1803.09	1801.72	1799.97
24	1802.10	1800.82	1801.95	1801.57	1802.42	1800.20	1801.05	1803.48	1799.97	1801.92	1804.07	1798.99
25	1802.27	1803.42	1801.44	1801.06	1801.24	1798.67	1803.30	1802.12	1803.00	1802.70	1802.51	1802.21
26	1801.48	1802.01	1800.56	1800.13	1801.10	1801.28	1804.35	1802.12	1802.31	1803.09	1802.60	1800.16
27	1802.74	1802.52	1800.68	1799.23	1800.96	1802.17	1803.00	1802.90	1802.31	1800.94	1802.90	1802.99
28	1801.17	1803.45	1798.49	1800.16	1801.69	1800.80	1804.00	1801.33	1802.31	1800.16	1802.12	1800.60
29	1802.57	1802.70	1800.91	1800.25	1801.83	1801.70	1799.40	1800.16	1802.90	1801.33	1799.77	1802.02
30	1802.65	---	1801.15	1798.67	1801.44	1799.85	1802.70	1802.12	1802.51	1800.16	1801.72	1801.53
31	1800.51	---	1798.84	---	1802.13	---	1801.93	1803.29	---	1802.12	---	1802.21

Table 6-5.3

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1802.12	1800.01	1800.26	1801.58	1802.26	1802.70	1803.43	1801.97	1799.48	1803.63	1800.80	1801.92
2	1803.14	1800.45	1799.92	1799.04	1801.38	1802.51	1803.68	1802.65	1798.60	1802.70	1802.85	1802.41
3	1802.46	1799.23	1800.21	1798.60	1801.82	1800.06	1803.87	1802.65	1799.97	1802.21	1801.92	1801.43
4	1801.82	1800.80	1801.19	1799.48	1799.67	1803.19	1803.14	1801.92	1800.16	1803.78	1800.21	1803.87
5	1802.80	1801.48	1802.02	1800.01	1802.46	1801.48	1803.14	1803.39	1799.72	1801.92	1801.82	1803.53
6	1801.92	1799.57	1802.75	1799.09	1801.33	1801.63	1802.90	1803.53	1803.04	1802.31	1803.78	1802.85
7	1802.12	1800.94	1803.24	1802.60	1803.24	1803.29	1803.48	1802.99	1800.89	1800.36	1801.92	1802.75
8	1801.04	1799.82	1800.85	1800.31	1802.65	1800.85	1802.99	1802.46	1803.09	1802.70	1799.23	1802.55
9	1802.51	1797.33	1801.63	1800.06	1802.90	1803.78	1802.55	1800.31	1800.55	1803.19	1801.63	1801.87
10	1802.26	1800.85	1800.65	1800.36	1803.34	1799.57	1802.95	1800.80	1802.75	1802.21	1803.04	1803.14
11	1800.65	1801.14	1800.11	1800.16	1803.29	1803.53	1802.02	1800.70	1803.04	1801.58	1801.72	1803.34
12	1800.75	1799.87	1800.31	1802.75	1801.04	1802.55	1803.09	1801.63	1803.24	1801.53	1803.29	1800.85
13	1802.65	1801.43	1802.36	1802.36	1800.50	1800.85	1803.58	1801.43	1802.75	1800.99	1802.41	1799.23
14	1801.68	1801.38	1801.87	1800.60	1803.53	1802.16	1800.65	1801.82	1803.78	1800.55	1800.31	1799.04
15	1800.55	1803.48	1799.53	1802.26	1802.99	1802.75	1800.60	1802.12	1802.41	1801.38	1803.04	1799.72
16	1801.63	1800.79	1802.36	1801.04	1801.33	1802.31	1803.78	1800.45	1802.99	1800.55	1802.70	1800.41
17	1801.13	1802.26	1799.72	1802.12	1801.38	1802.12	1802.60	1801.72	1802.85	1802.46	1799.57	1802.36
18	1801.33	1801.87	1794.64	1801.92	1803.29	1803.68	1803.29	1801.43	1804.12	1803.58	1800.31	1802.85
19	1802.65	1802.77	1796.40	1802.12	1802.90	1803.39	1802.46	1801.82	1803.58	1802.85	1799.33	1801.97
20	1801.97	1801.63	1799.04	1801.43	1802.12	1802.36	1801.97	1802.51	1803.43	1802.65	1803.78	1800.60
21	1800.99	1801.43	1798.94	1800.89	1802.31	1802.85	1801.48	1802.12	1802.07	1803.58	1802.51	1801.87
22	1801.28	1802.80	1800.55	1802.65	1804.31	1803.14	1801.14	1801.43	1801.68	1800.65	1802.55	1802.07
23	1801.04	1802.12	1801.24	1802.07	1803.91	1802.60	1801.92	1800.99	1801.38	1802.80	1802.80	1800.21
24	1801.72	1799.97	1800.99	1802.07	1802.65	1803.63	1800.89	1801.87	1803.73	1800.65	1802.46	1802.36
25	1802.70	1800.65	1799.04	1803.34	1801.58	1799.62	1802.85	1801.19	1803.39	1802.65	1802.51	1800.36
26	1802.12	1802.21	1801.68	1800.75	1803.43	1798.84	1803.04	1801.28	1803.87	1800.60	1801.04	1799.57
27	1803.48	1801.33	1801.48	1798.50	1803.48	1801.09	1802.70	1801.77	1803.29	1800.41	1800.26	1802.51
28	1802.60	1801.24	1802.55	1801.04	1802.80	1802.80	1803.04	1802.02	1801.97	1800.70	1801.14	1803.39
29	1800.11	---	1799.43	1802.31	1802.00	1803.63	1801.68	1801.43	1803.04	1802.80	1800.55	1802.80
30	1800.21	---	1800.11	1801.63	1803.14	1802.95	1803.24	1803.29	1802.26	1802.80	1799.87	1799.38
31	1800.31	---	1801.77	---	1802.51	---	1801.58	1800.80	---	1802.36	---	1801.87

Table 6-5.4

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1800.36	1802.55	1802.60	1801.14	1801.77	1803.14	1802.75	1803.04	1802.36	1802.00	1802.55	1802.36
2	1801.04	1803.43	1803.29	1802.31	1801.96	1802.75	1803.34	1802.36	1802.31	1803.39	1803.97	1802.26
3	1801.24	1803.73	1803.09	1802.36	1802.07	1803.29	1800.60	1802.21	1802.55	1802.70	1803.73	1801.82
4	1802.75	1802.36	1802.46	1803.09	1801.48	1802.31	1801.48	1803.39	1803.14	1802.90	1800.21	1800.60
5	1801.87	1802.12	1802.31	1801.68	1802.70	1801.87	1799.92	1800.21	1802.16	1803.39	1799.23	1801.63
6	1803.04	1802.12	1801.19	1802.55	1802.02	1803.48	1803.34	1801.38	1803.24	1802.85	1804.02	1801.58
7	1802.46	1803.24	1802.95	1802.36	1802.80	1801.97	1802.55	1802.26	1803.53	1801.97	1800.50	1803.68
8	1801.97	1802.90	1802.36	1802.65	1800.60	1802.55	1802.85	1802.36	1802.99	1802.95	1800.36	1802.60
9	1801.77	1803.39	1802.36	1801.63	1801.24	1802.36	1802.95	1803.24	1802.90	1803.29	1804.02	1801.24
10	1800.94	1801.82	1801.43	1802.31	1802.99	1800.41	1802.85	1803.24	1802.80	1802.95	1801.19	1803.14
11	1802.65	1802.70	1801.43	1801.92	1801.33	1803.63	1803.14	1802.90	1802.75	1802.26	1803.92	1801.58
12	1801.48	1802.51	1802.31	1802.36	1802.60	1802.95	1802.85	1802.02	1802.26	1802.31	1801.72	1799.33
13	1802.75	1802.26	1802.12	1801.68	1801.97	1802.70	1802.07	1802.12	1801.68	1803.63	1801.97	1803.53
14	1802.90	1800.45	1802.46	1802.95	1801.48	1801.48	1802.46	1803.63	1800.60	1800.55	1800.80	1802.70
15	1803.29	1801.53	1802.26	1802.26	1802.41	1803.14	1803.34	1804.26	1802.46	1802.75	1802.51	1802.65
16	1801.72	1802.99	1801.82	1801.58	1800.99	1802.16	1801.38	1801.38	1802.85	1803.24	1800.94	1802.02
17	1802.12	1803.29	1801.63	1801.77	1801.14	1802.41	1801.04	1802.26	1802.36	1802.41	1800.94	1801.92
18	1801.33	1802.90	1801.38	1802.85	1802.26	1802.70	1802.85	1803.34	1802.26	1802.36	1802.02	1801.19
19	1801.92	1801.19	1801.97	1800.85	1801.97	1802.41	1801.97	1802.85	1801.43	1803.63	1803.83	1801.09
20	1802.99	1802.65	1803.09	1802.60	1802.41	1803.63	1801.38	1802.95	1801.68	1803.43	1803.53	1798.55
21	1802.41	1801.60	1800.65	1802.41	1800.99	1802.85	1801.72	1803.68	1802.46	1802.80	1801.92	1801.24
22	1802.95	1802.10	1800.85	1803.09	1802.07	1801.38	1802.12	1802.46	1801.24	1802.99	1801.53	1802.31
23	1802.26	1800.80	1801.53	1802.02	1801.68	1803.34	1802.07	1802.99	1802.21	1802.75	1803.09	1800.75
24	1803.58	1802.46	1801.19	1800.94	1800.41	1803.53	1802.70	1803.09	1803.58	1803.48	1800.99	1801.63
25	1803.92	1801.97	1801.48	1802.26	1803.73	1803.53	1802.36	1803.39	1800.26	1803.43	1801.19	1802.21
26	1804.22	1800.50	1802.55	1801.43	1803.19	1803.34	1802.21	1802.90	1801.33	1803.78	1800.50	1801.82
27	1801.97	1801.58	1800.21	1803.48	1802.80	1803.34	1803.19	1802.55	1804.07	1803.29	1801.68	1801.33
28	1804.02	1802.26	1801.38	1801.33	1802.07	1800.45	1802.31	1803.53	1802.02	1803.04	1800.80	1801.33
29	1801.48	---	1803.63	1801.53	1802.07	1802.80	1802.51	1803.04	1801.72	1803.68	1801.68	1803.04
30	1801.09	---	1801.38	1801.82	1803.92	1802.75	1803.58	1801.97	1800.26	1801.92	1802.16	1802.70
31	1803.09	---	1802.26	---	1803.63	---	1803.43	1802.95	---	1802.55	---	1801.33

Table 6-5.5

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
. CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1802.80	1802.54	1803.63	1800.55	1801.63	1804.75	1801.92	1801.53	1802.85	1802.31	1801.14	1802.85
2	1801.58	1802.75	1801.48	1802.85	1802.36	1803.68	1802.95	1800.99	1804.02	1801.38	1801.43	1803.39
3	1801.97	1801.63	1800.99	1802.02	1801.53	1803.92	1802.51	1803.04	1802.70	1802.46	1803.92	1803.58
4	1801.72	1801.77	1802.16	1802.95	1802.16	1803.09	1802.36	1803.92	1803.53	1803.43	1803.29	1803.19
5	1802.41	1802.99	1802.80	1802.55	1803.78	1802.95	1803.14	1802.41	1803.63	1802.26	1804.22	1801.24
6	1801.28	1800.89	1802.26	1800.89	1802.90	1803.58	1802.26	1803.63	1803.92	1804.22	1804.51	1802.99
7	1802.07	1803.29	1802.80	1803.09	1802.65	1802.95	1802.21	1803.87	1803.53	1802.70	1802.31	1799.57
8	1803.78	1802.55	1802.75	1803.14	1803.19	1803.24	1803.43	1802.90	1803.24	1803.04	1800.89	1802.16
9	1800.16	1802.36	1804.26	1802.70	1803.04	1803.04	1804.17	1803.68	1803.24	1802.41	1801.77	1802.95
10	1801.92	1803.83	1802.21	1803.48	1802.70	1803.14	1802.21	1802.51	1802.26	1802.26	1803.14	1802.41
11	1804.26	1802.51	1803.43	1802.46	1800.06	1803.92	1801.58	1804.07	1803.73	1803.24	1804.26	1803.83
12	1803.78	1802.51	1801.92	1803.34	1802.70	1804.66	1802.46	1802.90	1801.72	1803.14	1803.43	1804.07
13	1802.16	1803.29	1802.60	1800.99	1800.16	1803.73	1804.41	1801.53	1803.92	1802.80	1803.14	1803.63
14	1802.51	1802.55	1804.02	1800.50	1801.58	1802.99	1802.51	1801.24	1804.41	1802.75	1802.90	1802.90
15	1801.33	1800.99	1802.46	1800.60	1804.75	1802.80	1804.26	1803.04	1803.63	1802.46	1803.09	1804.17
16	1804.26	1803.73	1801.43	1803.09	1803.63	1802.85	1803.29	1801.77	1803.29	1804.17	1802.75	1801.68
17	1804.26	1802.75	1803.24	1803.29	1803.63	1803.19	1802.60	1801.68	1803.68	1800.60	1802.55	1802.75
18	1802.85	1801.24	1802.46	1802.65	1803.39	1803.09	1801.68	1803.04	1803.63	1802.75	1803.68	1803.87
19	1799.82	1802.65	1801.77	1803.14	1803.24	1803.97	1803.73	1803.43	1803.78	1802.31	1803.14	1801.24
20	1800.41	1801.87	1803.92	1800.60	1803.24	1802.65	1802.46	1802.07	1803.39	1801.58	1803.97	1802.41
21	1801.28	1801.87	1802.07	1803.04	1801.58	1804.22	1803.83	1804.12	1801.92	1802.85	1801.14	1801.28
22	1802.02	1801.09	1802.85	1802.70	1803.68	1802.85	1802.21	1803.97	1802.51	1802.45	1800.80	1802.80
23	1803.24	1800.89	1801.48	1802.07	1803.63	1803.83	1804.31	1804.17	1803.83	1802.65	1802.85	1802.07
24	1801.33	1803.04	1800.70	1804.22	1803.43	1804.31	1804.07	1803.39	1803.68	1803.09	1802.90	1803.09
25	1801.24	1801.92	1802.36	1803.39	1803.43	1803.87	1803.73	1803.34	1801.63	1803.97	1803.09	1801.97
26	1799.62	1802.36	1801.68	1802.36	1802.95	1803.97	1803.87	1802.51	1803.58	1801.68	1803.87	1802.55
27	1801.77	1803.43	1801.77	1801.58	1803.14	1804.12	1803.29	1803.14	1803.19	1802.55	1801.43	1802.70
28	1801.58	1803.73	1801.92	1803.29	1802.95	1802.41	1804.17	1803.53	1801.82	1801.82	1801.82	1803.48
29	1802.60	---	1803.39	1802.46	1804.46	1802.41	1802.07	1803.63	1803.09	1804.12	1803.29	1800.85
30	1803.29	---	1801.72	1802.46	1804.17	1803.53	1802.46	1802.55	1803.78	1803.29	1801.72	1801.53
31	1800.06	---	1801.72		1804.36		1803.14	1802.95		1802.70		1802.12

Table 6-5.6

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.92	1800.36	1802.60	1800.36	1802.99	1803.53	1803.29	1803.68	1802.65	1802.36	1802.46	1804.02
2	1798.84	1802.70	1802.80	1798.60	1802.02	1803.09	1803.83	1802.75	1801.77	1801.68	1802.85	1802.75
3	1803.83	1803.97	1801.72	1799.18	1802.02	1803.39	1802.85	1802.75	1802.75	1803.24	1802.51	1801.09
4	1802.02	1801.24	1803.34	1799.48	1802.99	1801.53	1803.14	1802.99	1800.85	1802.85	1802.60	1801.68
5	1801.48	1802.60	1802.80	1801.72	1802.99	1804.02	1802.80	1803.92	1802.70	1802.85	1802.41	1800.80
6	1803.53	1804.22	1802.51	1802.02	1803.19	1802.21	1804.36	1803.68	1802.46	1803.14	1803.87	1800.75
7	1802.65	1801.09	1802.31	1801.72	1800.80	1800.94	1803.04	1802.46	1803.68	1802.55	1803.29	1800.85
8	1804.07	1799.72	1803.29	1802.70	1800.65	1801.43	1803.04	1802.31	1802.55	1802.95	1804.07	1802.70
9	1802.95	1801.04	1801.63	1802.36	1798.21	1801.48	1803.92	1802.51	1802.31	1803.14	1801.72	1802.70
10	1802.70	1803.24	1804.02	1802.95	1801.48	1803.34	1803.09	1804.02	1802.55	1803.14	1802.12	1802.90
11	1802.95	1802.65	1804.12	1802.26	1801.92	1801.92	1803.04	1803.24	1802.36	1803.34	1802.90	1801.43
12	1803.58	1802.99	1803.53	1801.77	1804.17	1802.21	1802.85	1803.48	1800.89	1803.24	1801.82	1802.12
13	1802.12	1801.97	1802.46	1802.16	1803.29	1801.43	1802.99	1803.48	1803.14	1803.63	1802.70	1802.41
14	1802.55	1802.02	1802.70	1801.58	1802.51	1803.09	1802.21	1802.16	1802.75	1803.39	1802.46	1802.02
15	1803.83	1802.02	1802.90	1802.65	1802.07	1801.68	1802.60	1803.14	1801.87	1804.02	1803.63	1802.60
16	1802.70	1803.58	1801.97	1802.75	1802.80	1800.55	1801.87	1802.26	1801.28	1803.24	1804.12	1803.19
17	1799.77	1803.25	1801.48	1803.19	1800.89	1801.82	1802.26	1803.68	1802.65	1802.07	1802.26	1802.36
18	1799.77	1802.99	1802.46	1802.21	1801.58	1801.43	1802.36	1802.99	1802.55	1803.83	1802.85	1803.58
19	1802.51	1802.51	1801.28	1803.78	1802.26	1801.72	1801.48	1802.41	1802.26	1804.02	1802.16	1802.80
20	1803.87	1802.21	1800.31	1801.24	1802.26	1801.82	1803.53	1803.87	1802.07	1803.43	1803.43	1803.24
21	1803.24	1801.92	1800.01	1803.29	1804.17	1803.48	1803.43	1802.07	1801.19	1801.38	1803.24	1802.80
22	1803.78	1801.72	1800.06	1802.51	1803.97	1802.31	1802.80	1802.46	1801.82	1802.60	1802.65	1803.04
23	1801.53	1801.53	1800.75	1802.07	1804.41	1800.85	1803.04	1802.41	1802.36	1803.09	1803.34	1801.77
24	1801.92	1803.09	1802.60	1801.43	1803.04	1802.41	1802.21	1802.55	1802.41	1802.90	1803.83	1802.07
25	1799.48	1802.12	1801.24	1803.97	1802.75	1801.77	1802.12	1803.68	1803.78	1802.41	1801.38	1802.85
26	1802.55	1802.46	1800.85	1802.02	1802.21	1799.72	1802.85	1802.99	1804.26	1802.99	1803.97	1802.65
27	1803.83	1801.24	1800.94	1800.80	1801.28	1801.92	1801.48	1802.85	1802.21	1801.82	1802.21	1803.83
28	1804.61	1800.36	1800.75	1801.19	1801.04	1801.43	1800.65	1802.31	1801.92	1802.90	1803.58	1802.75
29	1802.55	1800.26	1802.51	1801.92	1801.24	1803.43	1802.51	1802.85	1801.87	1802.51	1803.48	1802.26
30	1802.41	---	1802.90	1801.82	1801.48	1802.80	1804.07	1803.68	1802.16	1801.97	1803.09	1801.09
31	1802.41	---	1801.82	---	1801.68	---	1803.43	1803.39	---	1802.46	---	1802.65

Table 6-5.7

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1802.26	1802.02	1803.34	1801.87	1802.41	1802.85	1803.09	1802.46	1800.80	1801.97	1801.43	1803.24
2	1803.14	1804.02	1800.80	1803.04	1803.48	1801.97	1802.70	1801.97	1803.29	1801.28	1803.04	1803.09
3	1802.85	1804.02	1803.34	1802.07	1803.19	1803.39	1802.02	1801.58	1801.14	1803.58	1801.58	1803.68
4	1802.85	1802.46	1802.12	1803.87	1802.99	1802.21	1802.31	1800.11	1801.92	1804.07	1802.80	1801.53
5	1802.07	1800.21	1802.51	1803.19	1802.41	1802.90	1801.82	1801.53	1802.41	1801.53	1801.43	1802.07
6	1801.72	1795.81	1800.26	1802.70	1800.65	1801.92	1802.90	1802.12	1801.92	1802.70	1801.82	1803.87
7	1802.21	1798.89	1802.46	1804.02	1802.31	1801.53	1802.75	1802.51	1802.90	1801.97	1802.31	1802.95
8	1802.60	1800.89	1802.95	1804.51	1803.78	1801.97	1801.72	1801.53	1802.21	1802.07	1802.70	1802.55
9	1801.04	1802.16	1801.77	1802.65	1802.99	1802.36	1802.90	1801.33	1800.45	1802.41	1802.70	1803.29
10	1802.99	1798.55	1802.26	1802.55	1803.39	1802.60	1801.82	1800.99	1801.82	1802.75	1801.82	1802.99
11	1802.70	1801.14	1802.99	1801.38	1801.87	1801.92	1802.51	1802.16	1801.63	1803.78	1801.72	1803.78
12	1802.02	1797.33	1804.75	1801.77	1802.51	1801.82	1801.97	1802.21	1802.21	1802.16	1801.72	1802.99
13	1803.48	1800.55	1803.09	1802.85	1802.99	1802.31	1802.85	1802.90	1800.70	1801.77	1801.14	1802.60
14	1802.51	1801.48	1802.90	1800.36	1802.99	1802.70	1803.04	1800.65	1800.50	1802.46	1802.90	1803.19
15	1803.29	1800.60	1799.38	1800.85	1802.51	1803.19	1802.16	1802.02	1801.68	1801.48	1803.24	1801.48
16	1800.55	1801.87	1803.19	1803.58	1801.72	1801.82	1801.28	1801.19	1803.48	1802.07	1802.21	1802.70
17	1801.04	1802.07	1803.78	1801.48	1802.41	1802.55	1802.31	1802.31	1802.51	1803.78	1803.48	1802.70
18	1801.53	1801.33	1804.51	1804.22	1802.46	1803.83	1803.34	1802.99	1801.72	1802.41	1803.63	1803.78
19	1803.19	1801.24	1802.80	1801.68	1802.85	1803.34	1803.34	1802.99	1802.12	1802.02	1802.75	1802.99
20	1803.48	1803.19	1802.31	1799.72	1803.63	1803.58	1802.85	1800.75	1802.31	1803.09	1802.75	1803.09
21	1802.12	1801.72	1802.41	1801.09	1802.46	1802.80	1802.26	1801.63	1802.90	1800.99	1802.12	1803.19
22	1802.12	1800.85	1802.60	1803.63	1803.34	1802.21	1803.29	1802.12	1803.04	1802.90	1802.99	1802.90
23	1802.21	1801.53	1801.58	1801.87	1802.26	1802.60	1802.21	1799.48	1803.63	1801.92	1803.14	1803.24
24	1803.29	1802.80	1800.70	1801.58	1802.36	1803.92	1801.72	1801.33	1803.73	1802.99	1801.77	1803.24
25	1802.60	1803.24	1799.23	1803.24	1803.83	1803.73	1802.31	1800.45	1803.83	1803.58	1800.85	1801.38
26	1802.12	1803.53	1803.92	1802.95	1802.55	1802.16	1803.09	1802.36	1804.22	1803.43	1803.58	1801.68
27	1803.39	1803.14	1801.48	1802.95	1802.60	1804.31	1801.33	1802.46	1802.65	1803.63	1802.99	1801.68
28	1801.09	1803.63	1802.07	1801.97	1802.21	1803.24	1802.51	1802.85	1802.55	1803.83	1802.70	1802.46
29	1801.97	---	1803.53	1803.19	1803.29	1802.55	1801.38	1802.46	1802.70	1802.95	1803.48	1802.31
30	1801.77	---	1802.95	1803.09	1802.80	1802.65	1801.77	1803.24	1802.80	1801.87	1801.58	1803.39
31	1800.85	---	1803.53	---	1802.41	---	1802.85	1803.04	---	1802.21	---	1802.51

Table 6-5.8

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.43	1802.65	1803.43	1802.75	1799.77	1803.34	1801.77	1803.09	1801.48	1802.51	1803.39	1800.60
2	1802.70	1802.60	1802.65	1803.43	1802.55	1802.16	1801.58	1803.48	1799.72	1802.75	1803.09	1801.72
3	1802.36	1802.16	1802.75	1802.46	1803.48	1801.38	1801.09	1802.70	1802.90	1802.21	1802.95	1802.70
4	1803.04	1803.14	1802.55	1803.39	1804.12	1802.75	1800.80	1802.80	1803.29	1802.60	1803.39	1800.85
5	1803.19	1802.95	1803.43	1802.02	1802.36	1803.58	1801.87	1803.09	1802.65	1803.24	1802.31	1800.75
6	1802.85	1802.65	1802.46	1802.90	1803.43	1803.14	1802.95	1801.53	1802.51	1803.43	1803.24	1801.43
7	1801.68	1802.46	1802.46	1803.68	1801.87	1802.16	1801.09	1802.80	1803.14	1803.63	1803.04	1801.81
8	1802.26	1802.46	1802.21	1803.09	1802.80	1801.28	1803.68	1802.99	1802.21	1804.31	1801.82	1802.20
9	1801.43	1802.41	1800.99	1803.39	1801.87	1801.87	1802.31	1803.04	1803.09	1802.51	1801.53	1801.00
10	1802.31	1803.24	1802.95	1803.09	1803.19	1801.87	1803.73	1803.04	1803.09	1802.60	1802.75	1801.50
11	1802.12	1803.09	1802.46	1802.12	1803.53	1802.55	1801.58	1803.58	1802.51	1801.24	1803.53	1801.32
12	1803.24	1800.45	1802.65	1802.70	1802.46	1803.92	1803.53	1802.65	1802.60	1802.21	1800.94	1803.45
13	1802.46	1801.82	1803.09	1803.87	1803.14	1803.73	1803.53	1802.51	1802.36	1802.51	1803.87	1802.60
14	1803.43	1802.16	1804.22	1803.24	1801.97	1804.02	1802.60	1800.41	1801.43	1801.97	1802.12	1801.98
15	1801.97	1802.55	1802.55	1803.83	1803.63	1803.39	1802.65	1802.70	1802.12	1802.02	1802.65	1801.94
16	1803.43	1802.16	1802.95	1802.36	1803.83	1803.87	1801.58	1803.14	1803.24	1802.65	1803.43	1802.25
17	1802.70	1802.60	1801.72	1802.85	1802.85	1802.60	1801.72	1802.51	1802.51	1802.55	1802.07	1802.49
18	1803.53	1801.63	1803.29	1802.07	1803.34	1803.97	1802.80	1801.63	1802.12	1804.17	1802.16	1801.59
19	1802.12	1803.29	1800.26	1802.95	1802.75	1802.21	1801.68	1799.28	1802.65	1802.60	1803.14	1802.36
20	1803.92	1802.12	1803.19	1803.43	1801.19	1803.58	1803.63	1802.60	1801.82	1802.31	1802.75	1801.01
21	1802.85	1802.41	1803.92	1802.12	1800.89	1803.73	1802.80	1801.43	1801.43	1802.63	1801.28	1803.26
22	1803.04	1802.80	1803.24	1802.80	1801.92	1802.55	1801.63	1802.60	1801.92	1802.85	1801.92	1800.01
23	1802.55	1801.87	1803.14	1801.04	1801.97	1801.33	1803.39	1802.51	1803.87	1803.87	1801.63	1800.78
24	1803.58	1802.95	1803.04	1801.19	1803.19	1801.77	1802.51	1801.33	1802.60	1802.36	1800.80	1801.97
25	1802.21	1803.19	1802.80	1803.92	1802.85	1802.65	1801.82	1802.80	1803.04	1802.31	1802.75	1802.27
26	1803.04	1801.72	1802.80	1803.39	1802.99	1800.41	1801.24	1802.46	1802.07	1802.70	1800.60	1801.44
27	1802.21	1801.63	1802.60	1802.41	1801.82	1802.90	1803.48	1802.55	1802.51	1803.14	1802.75	1799.47
28	1802.60	1802.16	1803.04	1803.14	1802.90	1803.04	1802.80	1802.95	1803.87	1802.51	1802.16	1801.85
29	1801.33	---	1801.72	1802.85	1802.31	1801.68	1802.60	1803.04	1802.21	1803.39	1800.89	1801.14
30	1803.14	---	1802.95	1802.55	1804.17	1802.46	1803.73	1802.55	1803.78	1803.48	1801.48	1803.93
31	1803.09	---	1802.95	---	1803.29	---	1802.85	1802.51	---	1802.46	---	1800.03

Table 6-5.9

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---	---	---	---
3	---	---	---	---	---	---	---	---	---	---	---	---
4	---	---	---	---	---	---	---	---	---	---	---	---
5	---	---	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	---	---	---	---	---
7	---	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	---	---	---	---
10	---	---	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	---	---	---	---	---
12	---	---	---	---	---	---	---	---	---	---	---	---
13	---	---	---	---	---	---	---	---	---	---	---	---
14	---	---	---	---	---	---	---	---	---	---	---	---
15	---	---	---	---	---	---	---	---	---	---	---	---
16	---	---	---	---	---	---	---	---	---	---	---	---
17	---	---	---	---	---	---	---	---	---	---	---	---
18	---	---	---	---	---	---	---	---	---	---	---	---
19	---	---	---	---	---	---	---	---	---	---	---	---
20	---	---	---	---	---	---	---	---	---	---	---	---
21	---	---	---	---	---	---	---	---	---	---	---	---
22	---	---	---	---	---	---	---	---	---	---	---	---
23	---	---	---	---	---	---	---	---	---	---	---	---
24	---	---	---	---	---	---	---	---	---	---	---	---
25	---	---	---	---	---	---	---	---	---	---	---	---
26	---	---	---	---	---	---	---	---	---	---	---	---
27	---	---	---	---	---	---	---	---	---	---	---	---
28	---	---	---	---	---	---	---	---	---	---	---	---
29	---	---	---	---	---	---	---	---	---	---	---	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

Table 6-5.10

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.92	1803.04	1802.59	1802.41	1803.49	1800.04	1802.10	1802.60	1801.70	1804.07	1803.04	1803.09
2	1802.58	1801.87	1802.51	1801.56	1800.96	1801.06	1802.43	1803.50	1801.96	1803.52	1804.28	1803.41
3	1802.55	1802.77	1802.38	1801.24	1801.64	1802.56	1802.93	1803.18	1802.27	1803.48	1803.99	1802.51
4	1803.65	1803.29	1803.29	1802.29	1802.90	1802.20	1802.62	1802.50	1802.27	1802.90	1803.77	1802.53
5	1803.69	1802.55	1802.91	1802.29	1801.66	1801.98	1803.40	1802.60	1803.59	1802.46	1801.91	1801.92
6	1801.92	1802.25	1802.02	1800.31	1803.04	1802.08	1802.80	1803.06	1802.81	1803.90	1802.74	1801.78
7	1802.98	1802.22	1803.32	1801.89	1803.51	1802.20	1803.95	1802.75	1803.01	1802.64	1802.88	1801.46
8	1803.07	1803.61	1802.57	1802.61	1803.19	1801.83	1803.40	1802.59	1802.55	1802.80	1803.17	1802.96
9	1802.58	1802.59	1802.64	1801.58	1802.92	1802.48	1801.78	1802.36	1802.30	1802.92	1802.74	1802.31
10	1803.60	1801.33	1803.03	1802.10	1801.93	1802.32	1803.13	1802.55	1802.39	1803.60	1803.07	1801.59
11	1802.32	1802.95	1803.43	1802.40	1802.20	1801.89	1802.25	1803.69	1802.53	1803.74	1802.85	1802.65
12	1803.42	1803.27	1802.54	1802.00	1802.54	1802.16	1800.78	1802.58	1803.34	1802.52	1801.90	1802.74
13	1802.95	1803.02	1803.46	1801.13	1803.61	1801.38	1803.32	1802.90	1803.12	1802.70	1802.63	1804.11
14	1803.15	1801.82	1802.20	1802.87	1803.28	1801.84	1802.49	1802.91	1803.13	1803.02	1802.53	1802.90
15	1803.45	1803.98	1802.69	1802.99	1802.71	1802.06	1802.39	1802.88	1803.08	1802.62	1802.84	1801.77
16	1801.61	1802.28	1802.15	1803.24	1801.96	1801.03	1801.95	1802.21	1802.06	1802.98	1802.34	1803.32
17	1802.79	1802.42	1803.56	1801.82	1802.46	1800.52	1803.26	1801.62	1803.64	1803.67	1803.06	1802.90
18	1801.68	1802.94	1803.13	1801.13	1802.42	1801.95	1802.79	1803.18	1802.40	1804.09	1802.90	1802.90
19	1803.11	1803.09	1803.22	1801.90	1803.15	1800.99	1802.55	1803.37	1802.89	1803.08	1803.04	1802.60
20	1802.96	1803.33	1801.05	1801.20	1801.90	1802.67	1802.85	1802.82	1802.10	1802.76	1802.96	1803.72
21	1802.43	1803.44	1802.27	1801.03	1802.00	1803.53	1802.27	1802.51	1802.29	1803.01	1803.18	1801.78
22	1803.83	1802.84	1803.31	1802.47	1802.37	1801.88	1802.39	1801.90	1802.80	1803.80	1803.18	1801.59
23	1803.00	1803.48	1802.63	1802.09	1802.17	1802.84	1802.28	1802.42	1803.27	1802.90	1802.34	1802.56
24	1803.20	1801.99	1804.34	1802.43	1802.43	1801.80	1802.92	1801.85	1802.18	1803.82	1804.46	1802.21
25	1803.68	1803.38	1803.56	1802.65	1802.53	1801.12	1802.69	1801.50	1802.12	1804.05	1802.33	1803.24
26	1802.81	1803.54	1802.98	1804.09	1803.59	1802.02	1802.54	1802.79	1801.73	1803.44	1801.91	1803.26
27	1802.53	1803.30	1802.89	1802.74	1802.51	1802.32	1802.38	1803.63	1802.87	1802.76	1802.66	1802.81
28	1802.07	1802.58	1802.20	1803.06	1801.94	1802.18	1803.78	1803.05	1803.19	1803.51	1802.25	1801.71
29	1802.96	1802.36	1802.23	1802.35	1801.65	1801.46	1802.68	1803.39	1803.58	1803.73	1802.75	1802.68
30	1803.15	---	1802.95	1802.60	1801.89	1802.29	1802.67	1802.20	1801.74	1803.07	1802.11	1802.04
31	1803.58	---	1801.77	---	1801.47	---	1802.83	1803.28	---	1803.60	---	1802.56

Table 6-5.11

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1803.34	1801.79	1802.01	1801.11	1803.20	1801.70	1802.93	1800.64	1802.75	1803.00	1801.80	1801.90
2	1801.98	1802.75	1803.07	1803.10	1803.40	1800.57	1803.91	1802.73	1802.90	1803.90	1803.40	1801.30
3	1802.76	1802.87	1802.22	1801.67	1802.29	1802.66	1802.51	1803.06	1802.70	1802.00	1803.00	1802.00
4	1801.59	1801.95	1802.99	1803.03	1803.05	1801.79	1801.20	1803.40	1802.40	1804.10	1801.40	1802.30
5	1802.99	1802.99	1802.64	1804.20	1803.76	1804.16	1802.32	1803.06	1802.60	1803.20	1802.50	1801.20
6	1801.57	1803.18	1802.44	1802.56	1802.53	1802.55	1801.57	1802.60	1803.30	1802.80	1801.90	1802.00
7	1801.90	1803.06	1803.03	1802.25	1803.36	1802.10	1801.59	1802.79	1803.00	1803.20	1801.10	1800.70
8	1803.40	1803.55	1804.16	1801.87	1803.33	1802.86	1801.69	1801.99	1801.10	1802.70	1802.20	1801.50
9	1802.19	1803.00	1803.11	1803.19	1802.87	1801.27	1802.68	1803.57	1803.20	1803.30	1802.60	1801.30
10	1802.72	1802.37	1803.48	1803.71	1802.87	1803.73	1801.61	1803.25	1802.80	1802.80	1801.20	1801.60
11	1802.36	1803.36	1801.93	1803.52	1802.44	1802.64	1801.23	1797.02	1803.40	1802.90	1802.00	1800.70
12	1802.69	1803.27	1804.46	1803.53	1803.66	1800.74	1803.54	1798.99	1803.30	1803.10	1799.10	1802.30
13	1802.39	1803.58	1804.16	1803.92	1803.30	1803.24	1802.92	1802.54	1802.50	1803.80	1800.80	1802.50
14	1801.59	1802.62	1802.14	1803.86	1802.25	1802.56	1802.16	1803.50	1801.50	1802.10	1802.00	1803.10
15	1802.61	1803.59	1803.69	1803.08	1802.60	1800.73	1802.35	1803.66	1802.70	1803.30	1798.90	1802.60
16	1802.40	1802.83	1801.74	1803.15	1802.91	1803.00	1801.14	1803.56	1803.30	1802.20	1800.95	1801.30
17	1802.10	1802.43	1802.64	1801.33	1803.17	1802.21	1802.65	1803.39	1803.10	1801.90	1799.90	1801.40
18	1803.07	1803.41	1802.14	1802.04	1802.92	1803.58	1801.24	1803.66	1801.80	1803.30	1800.00	1801.40
19	1802.53	1803.32	1802.04	1802.85	1802.72	1803.59	1802.40	1803.25	1801.80	1803.20	1802.90	1802.00
20	1802.69	1803.49	1804.19	1803.15	1803.55	1801.76	1803.09	1802.49	1803.20	1802.90	1800.80	1802.70
21	1802.44	1803.24	1802.38	1803.20	1802.40	1802.41	1802.81	1802.72	1802.90	1802.50	1800.00	1802.40
22	1802.14	1803.57	1803.59	1802.41	1802.38	1803.18	1802.01	1803.63	1802.10	1804.20	1799.80	1802.10
23	1802.60	1802.68	1801.26	1803.60	1802.32	1802.06	1802.68	1802.60	1802.90	1802.00	1800.50	1803.40
24	1802.90	1802.96	1803.69	1802.62	1802.48	1802.26	1801.88	1802.63	1802.70	1802.30	1799.40	1802.50
25	1802.29	1802.63	1803.47	1803.71	1801.98	1803.22	1803.39	1803.76	1803.30	1802.60	1799.30	1801.90
26	1801.75	1802.22	1799.59	1802.06	1801.02	1803.27	1803.74	1802.84	1801.50	1801.90	1801.80	1800.60
27	1802.06	1802.23	1801.78	1801.70	1802.10	1802.56	1803.27	1803.02	1801.90	1802.20	1802.00	1802.60
28	1802.17	1802.34	1802.14	1802.34	1803.80	1802.11	1802.98	1802.25	1803.60	1802.00	1799.30	1803.50
29	1803.36	---	1801.00	1802.27	1803.71	1802.65	1802.53	1803.37	1802.80	1802.80	1798.90	1802.50
30	1803.57	---	1801.55	1803.28	1804.13	1803.04	1802.81	1803.53	1801.40	1802.10	1800.70	1802.40
31	1803.22	---	1802.16	---	1803.68	---	1802.22	1803.19	---	1803.30	---	1801.40

Table 6-5.12

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1801.60	1802.90	1803.40	1803.30	1802.20	1800.30	1802.00	1801.30	1802.30	1803.40	1802.00	1801.80
2	1800.20	1802.80	1802.20	1803.90	1803.60	1803.70	1800.80	1801.20	1803.00	1801.90	1802.10	1802.40
3	1799.40	1802.50	1804.00	1802.90	1803.00	1803.30	1802.20	1802.00	1800.50	1799.70	1801.90	1799.10
4	1801.40	1802.70	1802.40	1802.80	1801.60	1802.60	1802.70	1803.40	1802.30	1800.80	1802.90	1801.80
5	1800.20	1803.90	1802.80	1803.30	1802.30	1803.60	1802.10	1802.40	1800.90	1802.30	1801.70	1801.50
6	1803.50	1802.10	1802.60	1802.60	1801.50	1803.20	1801.50	1802.80	1802.70	1802.50	1800.60	1801.90
7	1802.00	1802.00	1799.30	1803.20	1803.40	1802.60	1803.00	1803.40	1802.50	1803.00	1801.90	1802.30
8	1801.60	1802.00	1800.60	1803.10	1802.80	1801.60	1802.90	1802.20	1802.80	1802.80	1799.20	1802.30
9	1803.10	1801.70	1801.80	1802.50	1804.20	1803.10	1802.60	1802.00	1802.40	1802.20	1800.10	1803.30
10	1801.30	1801.90	1803.30	1801.30	1803.30	1802.20	1803.00	1802.40	1803.10	1803.00	1801.20	1801.40
11	1802.90	1801.70	1802.40	1803.30	1803.20	1803.10	1801.00	1802.00	1803.00	1803.20	1801.60	1800.00
12	1802.20	1803.45	1803.00	1802.60	1803.10	1802.50	1802.10	1803.00	1801.70	1803.40	1803.60	1802.20
13	1801.30	1803.00	1802.30	1802.50	1803.60	1803.10	1800.80	1802.10	1803.40	1802.00	1802.00	1801.20
14	1802.60	1801.70	1802.10	1803.20	1802.20	1802.70	1801.50	1803.10	1802.20	1801.90	1803.90	1801.10
15	1802.40	1802.30	1802.00	1802.80	1803.00	1802.10	1802.90	1801.40	1803.00	1803.40	1802.00	1803.70
16	1803.00	1803.90	1803.00	1802.30	1800.60	1802.50	1802.80	1803.80	1802.50	1803.80	1801.00	1803.10
17	1803.90	1800.80	1802.20	1802.50	1801.60	1801.30	1803.40	1802.00	1803.10	1803.50	1803.10	1802.10
18	1802.20	1801.80	1800.90	1801.80	1802.30	1803.20	1803.80	1802.80	1801.70	1803.50	1802.50	1802.50
19	1803.80	1802.80	1802.20	1802.40	1802.00	1802.20	1802.90	1802.50	1800.70	1803.20	1803.60	1802.40
20	1801.90	1802.90	1802.40	1802.10	1803.30	1802.10	1802.70	1803.00	1802.20	1802.40	1801.40	1801.60
21	1801.30	1802.70	1801.90	1803.00	1802.00	1801.30	1802.50	1801.40	1802.70	1801.70	1802.60	1801.80
22	1801.20	1803.00	1797.40	1803.40	1802.80	1801.60	1801.00	1802.50	1803.10	1801.70	1803.30	1802.00
23	1802.50	1803.30	1801.70	1801.90	1803.00	1801.50	1801.20	1802.60	1803.00	1802.10	1801.50	1803.10
24	1803.10	1802.80	1803.00	1802.80	1803.80	1802.30	1801.80	1803.20	1803.70	1801.70	1801.70	1802.60
25	1802.80	1802.50	1802.50	1800.90	1802.90	1802.30	1800.90	1802.30	1802.70	1802.70	1801.50	1800.20
26	1803.00	1803.10	1801.10	1801.40	1803.00	1801.50	1801.10	1802.00	1802.60	1801.90	1802.40	1803.10
27	1802.70	1803.50	1802.10	1802.60	1803.00	1800.20	1802.20	1803.30	1802.20	1801.50	1802.30	1801.20
28	1803.20	1801.50	1802.00	1802.50	1802.10	1802.30	1802.70	1802.30	1802.40	1801.80	1803.30	1801.90
29	1801.90	---	1800.20	1802.60	1802.70	1803.50	1801.50	1802.30	1803.00	1802.60	1802.60	1802.10
30	1803.10	---	1802.70	1801.70	1802.40	1803.40	1802.30	1801.80	1800.50	1802.20	1801.80	1802.60
31	1802.30	---	1802.50	---	1803.20	---	1802.20	1802.00	---	1802.00	---	1802.20

Table 6-5.13

Table 6-5.14

OXBOW RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1802.70	1801.70	1803.30	1803.30	1801.60	1803.00	1802.90	1802.10	1802.60	1803.50	1800.00	1802.50
2	1801.20	1802.40	1802.80	1803.80	1801.80	1802.80	1803.00	1802.10	1802.90	1802.90	1802.30	1802.50
3	1801.80	1803.30	1801.60	---	1802.50	1801.60	1803.30	1802.20	1803.40	1802.00	1801.30	1803.00
4	1801.10	1802.60	1802.60	1801.50	1803.30	1802.30	1803.20	1802.50	1802.20	1801.00	1802.30	1802.50
5	1802.50	1802.80	1803.00	1803.70	1804.30	1803.00	1802.90	1802.30	1800.60	1801.50	1801.20	1801.90
6	1802.40	1802.50	1801.90	1803.70	1802.20	1803.00	1803.80	1802.10	1801.70	1803.00	1800.80	1801.70
7	1803.20	1802.70	1801.20	1802.40	1802.50	1803.00	1803.10	1801.90	1802.70	1802.90	1801.30	1801.60
8	1802.30	1802.60	1801.60	1803.10	1800.20	1803.40	1803.90	1802.40	1802.90	1803.00	1802.00	1801.80
9	1802.40	1802.30	1802.60	1802.70	1800.60	1801.70	1802.90	1802.10	1803.80	1803.20	1801.10	1802.70
10	1802.50	1802.20	1803.00	1802.40	1801.10	1803.50	1803.40	1801.80	1802.70	1803.20	1803.00	1801.70
11	1803.00	1802.70	1803.00	1801.50	1802.70	1803.30	1802.70	1801.60	1801.20	1802.10	1803.20	1801.80
12	1801.90	1801.80	1803.10	1801.30	1803.60	1802.50	1801.40	1804.30	1802.20	1803.00	1801.30	1801.70
13	1801.90	1803.10	1803.00	1802.60	1801.20	1803.20	1803.50	1802.40	1802.40	1802.60	1801.40	1802.30
14	1803.10	1802.30	1800.90	1802.60	1801.10	1802.90	1802.40	1802.80	1801.50	1802.80	1801.10	1801.40
15	1802.50	1802.00	1803.50	1800.90	1803.50	1803.50	1803.60	1802.20	1802.20	1802.70	1801.90	1801.90
16	1802.10	1801.70	1803.50	1802.10	1800.30	1800.90	1802.10	1803.70	1802.40	1803.30	1802.10	1800.10
17	1803.70	1801.40	1803.30	1802.70	1803.90	1802.80	1802.90	1802.80	1802.80	1801.50	1801.80	1801.10
18	1802.70	1803.30	1801.80	1802.70	1801.90	1802.30	1803.00	1802.00	1802.50	1802.30	1800.80	1800.30
19	1802.10	1800.40	1801.90	1802.80	1801.30	1802.50	1800.90	1802.10	1802.90	1802.90	1801.60	1800.20
20	1802.70	1801.20	1802.10	1803.30	1800.70	1802.70	1801.20	1802.80	1802.50	1802.20	1801.90	1801.60
21	1803.20	1802.40	1801.50	1802.00	1803.00	1803.50	1803.20	1802.70	1802.60	1801.20	1801.00	1802.20
22	1801.20	1803.20	1801.30	1802.10	1802.80	1801.90	1802.50	1802.50	1803.00	1801.50	1801.20	1803.30
23	1802.90	1803.30	1802.30	1802.80	1800.30	1803.20	1803.20	1802.40	1802.50	1801.00	1799.70	1802.70
24	1803.60	1802.10	1800.80	1801.00	1801.00	1803.30	1803.10	1802.70	1802.60	1802.20	1801.40	1804.30
25	1802.20	1803.40	1802.40	1802.30	1802.30	1803.20	1801.50	1802.00	1803.30	1801.20	1801.70	1802.70
26	1800.80	1802.30	1802.10	1801.50	1800.30	1802.90	1801.60	1803.50	1802.80	1801.90	1802.00	1802.50
27	1801.60	1801.40	1801.90	1802.80	1803.00	1801.30	1801.20	1803.50	1802.10	1802.10	1803.30	1802.20
28	1803.00	1802.60	1800.50	1801.50	1803.10	1803.30	1801.80	1802.20	1802.90	1802.50	1802.30	1802.00
29	1802.80	---	1801.10	1803.00	1802.80	1803.50	1802.90	1802.60	1802.40	1803.20	1802.50	1801.00
30	1802.80	---	1800.80	1802.30	1802.60	1803.20	1801.50	1802.90	1801.00	1802.90	1803.00	1801.00
31	1802.40	---	1802.30	---	1802.00	---	1802.90	1803.00	---	1803.50	---	1803.70

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HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1982

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1684.75	1686.87	1680.86	1680.96	1684.05	1685.14	1685.48	1686.30	1686.25	1685.08	1686.46	1686.07
2	1685.71	1686.71	1681.09	1681.58	1686.21	1685.91	1685.35	1686.49	1687.17	1684.46	1684.35	1682.99
3	1686.23	1686.80	1680.77	1682.70	1684.92	1686.15	1686.05	1684.59	1686.16	1684.15	1683.86	1682.91
4	1685.92	1686.96	1681.06	1684.35	1685.03	1686.28	1686.22	1684.15	1686.82	1684.88	1684.65	1685.10
5	1686.09	1687.00	1681.46	1683.98	1685.96	1685.95	1685.29	1685.30	1685.69	1685.00	1683.14	1684.64
6	1683.81	1686.95	1680.69	1682.78	1686.33	1685.80	1685.28	1685.64	1685.67	1686.53	1684.30	1684.26
7	1682.94	1686.73	1681.18	1681.86	1685.44	1685.77	1685.83	1686.19	1684.00	1683.68	1684.96	1683.40
8	1685.12	1687.16	1680.87	1683.34	1685.54	1686.28	1685.15	1686.62	1685.87	1684.62	1684.53	1683.10
9	1685.01	1686.19	1680.91	1685.45	1685.91	1686.03	1685.09	1686.75	1684.92	1683.66	1684.52	1683.95
10	1686.40	1686.55	1680.84	1684.01	1686.02	1685.16	1684.87	1686.26	1683.56	1684.43	1683.87	1684.45
11	1686.30	1684.54	1681.03	1684.08	1685.96	1684.96	1684.90	1685.08	1683.33	1682.78	1684.79	1683.70
12	1685.25	1685.51	1681.11	1684.34	1685.62	1685.89	1685.92	1686.10	1684.21	1685.70	1684.91	1684.20
13	1684.80	1685.26	1680.79	1684.52	1685.04	1687.10	1685.25	1686.07	1684.14	1685.45	1684.06	1683.70
14	1683.66	1685.12	1681.27	1683.56	1685.66	1685.93	1685.84	1686.34	1684.30	1684.89	1684.03	1683.37
15	1684.84	1686.43	1681.51	1682.92	1685.54	1686.89	1685.56	1686.66	1685.44	1686.04	1684.19	1683.36
16	1684.10	1686.35	1681.30	1683.26	1685.37	1686.44	1686.17	1686.85	1685.10	1685.56	1684.14	1682.84
17	1686.50	1687.04	1680.45	1684.45	1685.08	1686.06	1686.00	1686.53	1684.57	1685.67	1684.32	1682.59
18	1685.92	1686.90	1680.85	1684.71	1685.24	1686.34	1686.64	1686.63	1686.19	1684.03	1682.97	1684.92
19	1685.86	1685.15	1681.67	1684.21	1685.18	1685.74	1686.82	1686.20	1685.65	1685.92	1683.69	1685.07
20	1686.08	1686.20	1680.85	1683.33	1686.26	1685.58	1685.86	1685.80	1683.94	1686.87	1685.75	1685.31
21	1686.40	1686.37	1680.83	1683.23	1685.91	1685.66	1685.99	1685.29	1685.91	1685.60	1684.95	1684.56
22	1686.52	1686.42	1680.97	1683.55	1685.18	1685.22	1686.67	1685.49	1685.80	1685.90	1684.73	1685.90
23	1685.20	1685.60	1681.15	1682.90	1685.79	1684.86	1684.71	1685.72	1686.23	1686.72	1684.44	1686.06
24	1686.45	1681.10	1681.10	1682.40	1685.95	1685.15	1684.73	1685.71	1686.81	1684.94	1684.88	1685.15
25	1686.40	1681.22	1681.46	1682.20	1685.67	1686.21	1683.34	1686.92	1684.80	1684.16	1684.20	1684.65
26	1682.70	1681.17	1681.02	1683.40	1685.17	1685.22	1683.93	1684.95	1684.49	1684.11	1684.79	1685.70
27	1686.64	1680.71	1681.73	1683.85	1686.76	1685.50	1686.06	1683.78	1684.23	1685.56	1684.30	1685.56
28	1686.10	1680.85	1680.87	1685.10	1686.18	1685.79	1686.09	1685.43	1682.54	1686.22	1684.62	1685.68
29	1686.75	---	1680.64	1684.30	1686.77	1686.05	1685.70	1685.87	1684.34	1686.12	1684.99	1686.04
30	1686.18	---	1681.82	1685.03	1685.74	1686.43	1684.74	1684.37	1686.87	1684.89	1686.79	1686.16
31	1686.39	---	1680.91	---	1684.82	---	1686.43	1684.12	---	1684.77	---	1686.19

Table 6-6.1

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1983

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1685.65	1686.09	1685.32	1685.60	1684.30	1683.90	1684.02	1685.00	1686.54	1685.41	1680.49	1682.47
2	1685.21	1685.33	1685.32	1684.56	1684.70	1684.79	1683.56	1685.53	1686.03	1685.16	1680.07	1683.02
3	1685.17	1685.16	1685.24	1684.83	1684.60	1684.59	1684.29	1683.31	1685.74	1682.37	1679.61	1682.75
4	1683.86	1685.68	1685.82	1684.92	1685.44	1684.43	1685.25	1682.65	1685.54	1683.03	1679.72	1682.82
5	1683.69	1686.14	1685.68	1682.66	1685.79	1684.90	1685.89	1684.29	1685.69	1683.88	.	1684.38
6	1682.66	1686.16	1685.36	1681.48	1683.14	1684.09	1684.00	1683.29	1685.91	1683.89	1680.33	1684.47
7	1684.87	1685.40	1685.54	1684.64	1682.18	1683.16	1684.23	1683.92	1685.21	1684.06	1680.68	1684.54
8	1683.60	1684.98	1685.87	1685.99	1682.59	1682.85	1684.23	1685.08	1685.35	1683.97	1684.15	1684.43
9	1685.50	1685.27	1685.44	1685.53	1683.29	1683.76	1684.60	1685.86	1686.36	1683.73	1685.38	1683.02
10	1685.54	1684.72	1684.71	1684.85	1682.94	1684.03	1685.19	1684.67	1685.72	1684.27	1684.67	1681.32
11	1686.31	1684.98	1683.90	1684.68	1682.97	1684.45	1684.25	1684.61	1686.49	1685.32	1685.67	1682.66
12	1685.31	1685.12	1685.20	1684.96	1683.28	1684.07	1685.11	1684.90	1686.29	1683.86	1685.84	1682.05
13	1685.08	1685.21	1685.85	1684.07	1683.23	1683.79	1686.18	1684.06	1686.87	1683.97	1684.60	1683.48
14	1684.10	1685.52	1685.09	1684.61	1681.87	1682.42	1685.30	1685.53	1686.19	1685.16	1683.97	1683.89
15	1684.23	1685.80	1682.69	1685.21	1683.75	1683.70	1685.03	1685.27	1686.44	1686.20	1684.45	1685.00
16	1684.96	1685.80	1682.23	1686.62	1682.62	1684.49	1685.36	1686.14	1686.58	1685.63	1685.10	1686.54
17	1685.75	1686.27	1682.70	1685.42	1682.97	1685.67	1684.89	1686.82	1685.87	1684.29	1685.62	1686.74
18	1685.89	1686.07	1682.17	1684.45	1683.85	1683.88	1685.67	1686.74	1685.12	1683.58	1686.31	1686.89
19	1685.96	1686.28	1682.56	1684.57	1684.24	1683.54	1686.65	1686.62	1687.24	1684.85	1685.47	1686.88
20	1685.60	1685.65	1684.59	1685.76	1683.42	1683.27	1686.17	1686.44	1686.24	1684.66	1684.50	1686.54
21	1685.29	1684.84	1686.10	1686.15	1684.73	1683.36	1685.75	1685.81	1686.45	1684.52	1683.40	1686.68
22	1685.32	1685.53	1683.25	1686.03	1685.24	1682.93	1685.77	1684.00	1686.44	1683.28	1682.75	1685.52
23	1685.49	1686.45	1682.41	1686.17	1684.57	1684.15	1685.36	1686.44	1684.99	1684.72	1682.18	1684.51
24	1684.98	1686.32	1684.15	1685.42	1684.29	1685.23	1686.20	1686.47	1685.61	1686.40	1681.73	1685.07
25	1685.54	1685.96	1684.08	1684.81	1685.06	1685.04	1685.41	1685.12	1685.97	1684.95	1680.46	1686.16
26	1686.20	1684.95	1683.00	1684.08	1685.76	1685.40	1685.54	1685.68	1686.13	1684.27	1680.06	1685.78
27	1685.80	1684.72	1683.40	1684.22	1685.43	1686.47	1684.34	1685.26	1685.56	1684.59	1680.55	1684.44
28	1685.43	1684.93	1683.85	1684.07	1685.63	1684.18	1686.05	1684.35	1685.36	1684.75	1681.12	1683.68
29	1685.34	---	1684.41	1685.22	1685.85	1684.22	1686.42	1684.24	1684.53	1684.74	1681.77	1685.55
30	1685.57	---	1684.42	1684.90	1685.93	1684.36	1686.43	1683.89	1685.86	1684.17	1682.57	1686.98
31	1685.28	---	1686.05	---	1684.87	---	1685.49	1686.62	---	1685.38	---	1686.47

Table 6-6.2

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1984

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.73	1685.03	1686.55	1685.67	1683.58	1686.16	1684.95	1686.55	1684.14	1683.16	1685.51	1685.75
2	1685.36	1684.90	1685.47	1685.60	1684.25	1686.13	1684.10	1684.40	1684.92	1684.92	1685.90	1686.24
3	1685.37	1685.34	1685.68	1685.63	1685.31	1685.85	1686.60	1684.72	1685.70	1684.53	1685.70	1685.75
4	1685.47	1685.14	1686.42	1685.29	1684.46	1685.71	1686.80	1684.80	1686.29	1685.90	1686.09	1685.80
5	1685.11	1685.00	1685.51	1685.04	1686.64	1685.58	1686.70	1686.48	1685.51	1682.77	1686.09	1685.60
6	1682.58	1684.69	1686.11	1684.33	1684.55	1685.06	1686.30	1686.60	1686.09	1683.55	1686.29	1685.75
7	1683.61	1684.34	1683.50	1684.42	1684.73	1684.83	1685.95	1686.48	1686.09	1682.38	1685.12	1685.36
8	1686.30	1684.42	1684.90	1684.55	1685.82	1684.69	1685.50	1686.87	1686.09	1683.94	1684.72	1685.55
9	1685.48	1685.19	1685.02	1685.93	1684.87	1683.96	1685.00	1686.87	1682.97	1682.38	1685.51	1685.60
10	1686.15	1686.18	1686.17	1686.07	1684.81	1683.87	1683.75	1685.70	1684.92	1683.16	1683.36	1684.97
11	1685.80	1686.30	1686.75	1684.50	1684.34	1685.09	1686.35	1686.00	1685.31	1683.16	1684.90	1683.97
12	1685.46	1686.19	1685.60	1685.06	1684.24	1686.25	1685.90	1686.80	1685.31	1682.77	1685.30	1685.75
13	1684.77	1685.98	1686.18	1685.46	1684.28	1686.30	1686.40	1686.60	1686.09	1683.40	1685.70	1685.99
14	1684.29	1685.65	1686.49	1685.86	1684.71	1685.30	1685.92	1685.70	1685.70	1681.99	1685.60	1685.70
15	1684.85	1685.09	1686.97	1686.07	1684.93	1686.00	1686.80	1685.31	1685.70	1683.00	1684.72	1686.14
16	1685.16	1685.01	1685.26	1685.74	1685.83	1686.30	1686.20	1685.65	1684.92	1684.92	1685.70	1685.55
17	1685.57	1685.26	1685.64	1686.04	1685.66	1686.00	1685.60	1685.35	1684.14	1686.48	1685.31	1685.21
18	1685.68	1685.64	1686.43	1685.25	1685.03	1686.40	1686.30	1684.72	1684.53	1685.90	1685.31	1684.43
19	1685.45	1685.57	1685.58	1684.02	1684.79	1686.35	1685.10	1685.12	1686.09	1685.12	1684.53	1685.51
20	1684.96	1685.84	1684.42	1684.69	1684.90	1686.40	1685.35	1685.12	1684.92	1683.36	1684.53	1685.60
21	1685.63	1686.22	1686.85	1684.50	1684.22	1685.00	1684.40	1684.33	1686.09	1684.92	1684.53	1685.80
22	1685.09	1685.71	1686.05	1684.48	1684.41	1683.85	1684.50	1685.90	1685.90	1686.48	1684.92	1685.31
23	1684.77	1685.27	1683.76	1685.12	1684.95	1684.00	1683.20	1685.12	1685.51	1686.68	1685.70	1684.97
24	1685.14	1684.88	1683.44	1685.00	1684.46	1684.80	1683.70	1686.29	1685.12	1685.90	1684.92	1685.07
25	1686.09	1684.28	1684.55	1683.55	1683.78	1685.35	1685.50	1685.31	1684.72	1685.50	1686.09	1685.31
26	1684.57	1684.20	1683.54	1683.92	1683.68	1685.65	1686.70	1685.31	1683.94	1686.29	1686.48	1683.75
27	1684.36	1683.90	1684.56	1684.14	1684.55	1685.35	1686.75	1686.09	1685.51	1685.51	1684.53	1684.68
28	1684.93	1686.37	1685.09	1683.57	1685.44	1686.42	1685.40	1685.70	1684.72	1685.12	1684.53	1685.26
29	1685.66	1686.31	1684.81	1683.18	1686.25	1686.90	1685.55	1685.70	1683.94	1685.12	1684.55	1685.65
30	1686.28	---	1685.00	1682.99	1685.52	1685.20	1686.45	1685.90	1683.94	1686.68	1685.31	1685.70
31	1686.07	---	1685.20	---	1685.41	---	1686.38	1686.87	---	1685.90	---	1685.85

Table 6-6.3

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1985

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1685.85	1686.04	1684.97	1684.53	1684.58	1685.99	1686.97	1686.39	1684.04	1687.17	1684.97	1684.97
2	1685.95	1685.21	1685.02	1685.12	1686.92	1685.99	1687.02	1686.68	1685.31	1685.55	1686.48	1685.60
3	1686.29	1685.12	1685.16	1685.70	1686.53	1684.72	1685.36	1686.68	1683.41	1686.04	1684.87	1685.60
4	1685.90	1685.51	1685.55	1685.95	1685.36	1684.68	1685.70	1685.80	1684.19	1686.73	1683.45	1687.66
5	1684.97	1685.21	1685.02	1685.99	1685.36	1685.01	1685.36	1686.68	1685.60	1686.48	1685.70	1686.92
6	1685.41	1685.95	1684.82	1685.95	1686.14	1686.63	1685.99	1687.07	1684.63	1686.48	1686.78	1686.09
7	1685.70	1685.36	1684.53	1686.04	1686.14	1686.34	1686.43	1686.78	1684.09	1684.72	1686.63	1686.53
8	1685.46	1685.16	1685.75	1685.99	1686.48	1686.39	1686.53	1686.83	1684.77	1686.53	1685.65	1686.34
9	1686.14	1684.82	1684.53	1685.41	1686.39	1686.58	1686.87	1685.46	1684.68	1686.83	1686.58	1686.14
10	1686.14	1684.53	1684.92	1684.92	1686.63	1686.48	1686.24	1685.36	1686.48	1686.14	1686.63	1686.43
11	1685.75	1684.14	1685.41	1684.14	1686.14	1686.14	1686.87	1686.34	1686.83	1683.75	1686.58	1686.78
12	1685.85	1684.43	1684.77	1685.75	1685.65	1686.58	1686.68	1686.09	1686.39	1684.19	1686.87	1686.34
13	1684.87	1683.16	1683.99	1686.04	1685.85	1686.58	1686.04	1684.63	1685.70	1685.90	1686.09	1685.02
14	1685.36	1685.07	1684.87	1685.55	1686.53	1685.16	1685.26	1685.41	1685.90	1685.55	1686.39	1684.58
15	1684.96	1684.68	1685.36	1685.07	1686.73	1685.31	1684.97	1685.21	1686.58	1685.99	1686.43	1683.16
16	1685.12	1685.45	1685.31	1685.75	1686.48	1686.92	1686.92	1686.48	1685.80	1685.99	1686.73	1685.41
17	1685.12	1685.55	1685.90	1686.29	1685.51	1686.73	1686.73	1685.70	1686.87	1685.70	1684.82	1686.58
18	1685.46	1685.65	1686.78	1685.80	1686.97	1685.26	1686.48	1685.85	1687.26	1686.58	1683.94	1686.43
19	1685.02	1684.77	1684.04	1685.21	1686.68	1685.51	1686.19	1685.16	1686.63	1686.58	1684.09	1685.16
20	1684.53	1685.07	1683.65	1684.58	1686.43	1686.29	1686.78	1684.33	1687.17	1686.53	1686.97	1684.28
21	1685.02	1686.09	1684.33	1685.36	1686.39	1686.09	1685.90	1684.97	1686.34	1686.73	1686.78	1685.60
22	1686.04	1686.48	1685.46	1686.14	1686.58	1685.60	1684.92	1686.19	1685.36	1685.95	1686.68	1685.31
23	1685.75	1686.53	1685.12	1685.65	1687.20	1686.29	1683.94	1684.38	1686.14	1686.53	1684.87	1686.09
24	1686.78	1685.16	1685.02	1684.82	1686.78	1686.34	1684.63	1683.89	1687.22	1685.41	1686.48	1686.04
25	1686.68	1685.31	1685.07	1684.09	1685.85	1686.58	1687.07	1686.04	1687.22	1685.85	1685.75	1683.60
26	1686.63	1686.14	1684.68	1684.77	1686.58	1685.36	1686.73	1684.77	1687.02	1685.41	1685.75	1683.60
27	1685.75	1685.55	1686.34	1685.36	1685.41	1685.21	1685.75	1684.77	1687.51	1684.24	1685.36	1685.46
28	1685.26	1685.07	1686.43	1686.04	1685.60	1684.62	1686.24	1685.12	1686.83	1684.97	1684.28	1686.53
29	1685.99	---	1685.90	1686.34	1686.65	1686.29	1685.75	1685.41	1685.31	1686.58	1684.77	1686.14
30	1685.99	---	1685.31	1686.43	1686.73	1686.48	1686.34	1683.89	1684.63	1685.75	1684.48	1684.53
31	1686.34	---	1684.82	---	1685.95	---	1685.36	1683.45	---	1685.65	---	1684.48

Table 6-6.4

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1986

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1684.53	1684.87	1684.53	1685.60	1686.83	1686.83	1686.63	1686.97	1686.43	1685.25	1685.99	1686.09
2	1684.63	1686.29	1684.77	1685.80	1686.58	1687.07	1686.48	1686.14	1686.58	1684.28	1684.77	1685.36
3	1686.34	1685.85	1684.72	1686.39	1686.53	1687.07	1686.73	1686.24	1686.14	1686.48	1684.38	1685.99
4	1686.78	1685.90	1684.48	1686.29	1686.63	1686.68	1685.51	1684.33	1686.09	1686.39	1685.07	1686.29
5	1686.58	1684.09	1684.58	1686.14	1686.63	1686.58	1683.80	1683.31	1685.70	1686.92	1684.38	1684.68
6	1686.34	1684.28	1684.48	1686.14	1687.02	1687.12	1687.22	1684.53	1686.09	1686.24	1681.84	1683.65
7	1685.26	1683.94	1685.46	1685.16	1686.48	1686.92	1686.68	1685.95	1686.39	1687.02	1684.87	1681.06
8	1686.53	1683.80	1685.75	1685.90	1686.63	1685.55	1685.75	1686.19	1686.83	1686.68	1685.21	1686.09
9	1685.60	1684.72	1685.60	1686.53	1686.92	1686.14	1687.26	1684.92	1686.04	1687.46	1685.90	1682.33
10	1685.41	1685.90	1684.63	1685.75	1685.90	1686.04	1685.99	1686.53	1686.58	1685.80	1685.31	1685.99
11	1685.12	1685.02	1685.85	1685.85	1685.90	1685.26	1686.09	1686.24	1686.43	1685.41	1684.82	1683.21
12	1685.51	1685.75	1686.29	1686.43	1686.29	1685.99	1686.24	1686.73	1686.14	1686.43	1684.14	1685.46
13	1686.09	1685.65	1685.36	1686.14	1686.53	1685.85	1686.09	1686.43	1685.80	1685.55	1685.51	1686.78
14	1686.43	1684.43	1684.92	1686.24	1686.58	1685.95	1686.24	1686.73	1684.63	1685.70	1685.07	1686.39
15	1686.34	1685.21	1685.21	1685.51	1685.60	1685.95	1686.29	1687.07	1685.70	1685.85	1684.77	1686.97
16	1685.99	1685.85	1685.46	1685.31	1686.09	1686.34	1686.48	1686.04	1686.29	1686.63	1684.72	1684.72
17	1685.75	1686.63	1686.29	1685.41	1685.99	1685.60	1685.80	1686.39	1686.04	1686.48	1685.51	1686.09
18	1686.43	1686.97	1686.24	1686.19	1686.78	1685.41	1685.46	1686.58	1685.16	1686.09	1686.34	1683.41
19	1686.29	1686.04	1686.48	1685.29	1686.29	1686.09	1685.90	1686.92	1684.53	1687.22	1685.31	1682.97
20	1685.21	1686.34	1686.68	1685.95	1686.29	1686.48	1685.65	1686.09	1685.65	1686.19	1685.75	1683.01
21	1685.60	1685.36	1684.58	1685.36	1687.41	1686.48	1685.12	1686.63	1685.02	1686.63	1684.77	1682.33
22	1686.43	1686.29	1685.75	1685.46	1687.12	1686.29	1686.53	1686.43	1684.82	1686.83	1686.19	1683.41
23	1687.02	1686.78	1685.65	1686.53	1687.12	1685.70	1686.04	1686.14	1684.77	1686.48	1686.43	1684.72
24	1685.60	1687.12	1685.95	1685.55	1686.24	1686.92	1685.99	1686.48	1685.26	1686.68	1685.36	1684.43
25	1684.82	1684.72	1685.46	1686.19	1687.22	1686.43	1685.85	1685.75	1685.07	1686.39	1685.55	1685.51
26	1684.82	1684.68	1685.70	1686.43	1687.02	1686.34	1686.34	1686.97	1686.39	1686.87	1685.31	1686.24
27	1685.26	1685.16	1685.90	1686.83	1687.41	1686.92	1686.29	1686.19	1687.66	1686.83	1685.55	1685.80
28	1685.31	1684.92	1685.90	1685.65	1686.29	1686.97	1686.58	1685.85	1685.75	1686.58	1684.63	1685.36
29	1685.07	---	1686.34	1686.83	1686.58	1685.90	1686.43	1686.19	1683.55	1686.63	1685.02	1685.95
30	1684.43	---	1685.85	1687.12	1686.73	1686.63	1687.22	1686.29	1683.50	1686.39	1684.33	1685.70
31	1685.36	---	1686.04	---	1686.92	---	1686.43	1686.29	---	1685.65	---	1686.63

Table 6-6.5

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1987

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1685.85	1686.73	1686.19	1685.55	1685.95	1688.00	1686.83	1686.63	1686.78	1687.02	1684.38	1686.97
2	1686.19	1687.66	1685.36	1686.43	1686.24	1687.26	1685.75	1685.65	1687.02	1686.63	1685.02	1686.63
3	1685.70	1686.87	1686.58	1687.31	1686.58	1686.83	1684.63	1686.83	1686.63	1687.61	1687.60	1686.29
4	1686.39	1686.53	1686.19	1686.39	1686.34	1687.75	1686.39	1687.07	1686.92	1687.02	1687.07	1686.73
5	1686.09	1686.48	1685.80	1686.34	1686.29	1686.68	1685.65	1687.46	1687.22	1684.63	1686.92	1687.31
6	1685.21	1685.85	1686.97	1686.53	1686.87	1686.63	1686.04	1687.02	1687.17	1687.31	1687.66	1685.60
7	1685.85	1686.68	1686.97	1687.36	1686.92	1686.87	1686.83	1687.22	1687.56	1687.31	1686.92	1683.65
8	1685.75	1687.31	1686.78	1687.80	1687.22	1686.39	1687.36	1687.26	1687.22	1686.97	1686.29	1685.65
9	1686.34	1687.12	1687.12	1686.92	1686.19	1687.17	1687.22	1687.56	1687.41	1687.07	1685.31	1685.75
10	1685.90	1686.19	1685.16	1687.02	1686.48	1687.66	1686.83	1687.22	1686.78	1686.83	1686.53	1687.41
11	1685.75	1686.87	1685.60	1686.43	1686.87	1687.51	1687.12	1687.41	1686.92	1686.92	1686.53	1687.31
12	1686.34	1686.78	1686.04	1686.78	1687.80	1686.58	1686.24	1686.09	1686.48	1687.02	1686.53	1687.75
13	1686.04	1686.83	1686.58	1685.65	1687.22	1686.87	1686.78	1685.95	1687.22	1686.14	1687.17	1687.31
14	1685.31	1686.68	1686.39	1685.36	1686.39	1686.34	1687.75	1685.02	1687.51	1685.16	1686.63	1687.61
15	1685.75	1685.85	1685.75	1686.97	1686.92	1687.02	1687.95	1686.48	1686.68	1686.19	1687.02	1685.85
16	1685.55	1686.87	1686.19	1687.17	1687.51	1686.78	1686.78	1686.39	1686.29	1687.75	1687.56	1686.92
17	1685.55	1687.02	1686.73	1686.43	1687.51	1686.78	1685.95	1684.04	1687.17	1685.80	1686.87	1687.07
18	1686.97	1684.63	1686.92	1687.12	1687.80	1687.41	1685.99	1683.99	1686.53	1686.63	1687.56	1687.41
19	1685.46	1686.14	1685.75	1687.07	1687.02	1687.36	1687.95	1684.19	1686.83	1685.16	1686.83	1686.58
20	1684.77	1687.26	1685.55	1685.31	1687.41	1686.34	1686.92	1686.73	1686.73	1685.55	1686.73	1687.66
21	1686.43	1684.82	1686.58	1686.19	1686.83	1686.73	1687.02	1687.31	1686.43	1686.14	1687.12	1687.41
22	1686.73	1686.34	1686.83	1686.58	1686.19	1686.34	1686.97	1686.83	1686.92	1685.40	1686.97	1686.83
23	1686.34	1685.80	1686.63	1687.12	1687.70	1687.75	1687.41	1686.63	1687.02	1685.65	1686.48	1687.66
24	1686.92	1687.02	1686.97	1686.87	1686.92	1686.92	1687.46	1686.34	1687.46	1686.24	1686.78	1687.07
25	1686.48	1686.53	1685.12	1686.68	1687.75	1686.97	1687.17	1687.17	1686.29	1687.46	1687.56	1687.02
26	1685.85	1686.92	1685.36	1686.53	1687.17	1687.41	1686.43	1687.66	1686.87	1687.41	1686.97	1686.87
27	1684.87	1686.97	1686.34	1685.95	1687.56	1687.51	1686.68	1687.51	1687.26	1687.02	1685.90	1686.68
28	1687.02	1685.99	1685.60	1687.51	1687.46	1686.83	1686.09	1686.73	1685.55	1686.53	1686.63	1687.46
29	1687.22	---	1686.04	1686.63	1687.66	1686.29	1686.83	1687.31	1685.90	1688.00	1685.55	1686.92
30	1685.85	---	1685.75	1686.78	1687.85	1687.02	1687.02	1686.83	1686.73	1687.31	1686.63	1686.34
31	1685.95	---	1685.99	---	1687.80	---	1686.39	1685.55	---	1686.78	---	1687.07

Table 6-6.6

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.48	1685.26	1685.07	1687.02	1687.80	1686.34	1687.61	1687.26	1686.63	1685.26	1687.07	1687.75
2	1685.99	1687.31	1686.39	1684.04	1686.58	1687.17	1687.80	1687.66	1685.95	1686.43	1686.87	1687.17
3	1687.90	1686.68	1686.68	1682.53	1687.26	1687.36	1687.26	1686.43	1686.63	1686.97	1687.07	1687.36
4	1687.46	1687.31	1687.12	1682.72	1686.43	1687.41	1686.48	1686.43	1685.70	1687.22	1686.92	1685.21
5	1687.46	1687.31	1687.41	1683.99	1687.22	1687.46	1687.56	1687.51	1686.83	1687.41	1686.48	1686.53
6	1687.56	1686.53	1687.41	1684.43	1687.22	1687.26	1687.31	1686.87	1687.31	1686.78	1687.56	1686.34
7	1687.07	1686.34	1686.04	1684.24	1685.31	1686.53	1687.22	1685.80	1687.07	1687.61	1687.36	1686.92
8	1687.70	1685.51	1686.87	1684.43	1685.12	1687.31	1687.22	1686.43	1686.19	1687.26	1687.26	1686.87
9	1686.87	1687.12	1687.26	1686.68	1684.24	1686.24	1687.46	1687.17	1685.80	1687.26	1686.73	1687.31
10	1687.07	1687.80	1686.63	1687.17	1684.48	1686.92	1687.70	1687.61	1686.73	1686.97	1686.73	1686.87
11	1687.17	1686.29	1684.77	1685.55	1686.09	1686.53	1685.95	1687.17	1684.63	1687.46	1685.60	1685.60
12	1687.41	1687.61	1686.14	1686.58	1687.90	1687.07	1687.36	1687.36	1683.99	1687.70	1686.53	1686.53
13	1687.02	1687.02	1687.61	1686.83	1687.26	1686.58	1687.75	1687.02	1682.97	1687.61	1686.04	1685.75
14	1687.12	1687.26	1686.04	1687.56	1686.09	1687.41	1686.78	1686.73	1683.41	1688.05	1687.12	1685.16
15	1687.66	1686.78	1685.46	1687.07	1685.46	1686.53	1686.19	1686.58	1685.75	1687.12	1687.70	1686.14
16	1686.92	1687.95	1686.04	1687.26	1684.19	1686.43	1686.97	1686.97	1686.83	1687.51	1687.61	1687.41
17	1686.14	1687.56	1686.58	1686.92	1686.73	1685.99	1685.65	1687.46	1685.95	1687.66	1686.34	1686.09
18	1686.04	1686.58	1686.97	1686.34	1686.34	1685.21	1686.43	1687.90	1686.24	1687.66	1686.68	1685.70
19	1686.73	1686.29	1686.39	1687.51	1686.68	1685.21	1686.63	1686.48	1685.46	1687.90	1686.97	1685.90
20	1687.36	1687.26	1685.07	1687.07	1686.78	1687.22	1687.02	1687.12	1686.48	1687.85	1687.31	1686.53
21	1686.78	1687.36	1682.48	1687.36	1686.53	1687.26	1686.34	1686.43	1685.90	1687.56	1687.31	1686.68
22	1687.31	1685.70	1683.45	1686.83	1687.17	1687.80	1686.92	1685.02	1685.75	1687.02	1687.61	1686.68
23	1686.53	1686.24	1684.14	1686.58	1687.75	1687.22	1687.31	1685.26	1686.53	1685.95	1686.73	1685.55
24	1686.34	1686.83	1685.85	1686.87	1687.12	1686.29	1686.78	1685.55	1685.65	1687.12	1687.41	1686.63
25	1685.26	1687.41	1687.02	1687.26	1687.17	1686.24	1686.04	1687.90	1686.83	1687.02	1686.83	1687.02
26	1686.63	1687.12	1686.68	1686.83	1686.29	1685.31	1686.43	1687.31	1687.41	1686.53	1687.75	1687.66
27	1687.56	1686.68	1684.33	1686.43	1686.09	1684.63	1685.46	1687.61	1686.92	1686.87	1686.78	1687.66
28	1687.51	1684.33	1683.70	1685.41	1687.61	1686.43	1685.46	1687.31	1686.63	1686.83	1686.53	1686.97
29	1686.83	1683.70	1686.39	1685.99	1686.24	1687.90	1685.51	1686.83	1686.24	1686.04	1687.66	1686.58
30	1687.02	---	1687.85	1686.34	1685.75	1687.07	1687.07	1687.46	1686.43	1686.53	1687.66	1686.78
31	1687.02	---	1687.46	---	1683.93	---	1687.51	1687.36	---	1686.68	---	1687.46

Table 6-6.7

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1989

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.58	1685.80	1679.94	1686.87	1687.02	1685.51	1687.07	1687.07	1686.19	1686.43	1686.63	1687.75
2	1687.17	1685.65	1684.28	1687.66	1686.29	1686.29	1686.87	1687.31	1686.58	1686.24	1687.51	1686.63
3	1687.07	1682.87	1686.39	1687.46	1685.95	1687.56	1687.26	1686.63	1686.97	1686.78	1687.70	1687.51
4	1687.36	1681.99	1687.46	1686.04	1685.75	1686.87	1685.99	1685.80	1687.22	1686.53	1686.78	1686.87
5	1686.78	1684.28	1686.97	1686.43	1685.85	1687.75	1686.43	1687.12	1687.22	1686.34	1687.26	1687.07
6	1686.43	1685.80	1686.87	1686.53	1686.14	1686.58	1687.51	1686.19	1686.14	1687.70	1687.46	1687.36
7	1687.07	1686.83	1686.48	1686.68	1686.68	1686.97	1686.58	1685.99	1687.85	1687.07	1687.31	1687.12
8	1687.02	1686.68	1686.87	1686.87	1687.51	1685.99	1686.19	1686.29	1685.90	1686.58	1687.41	1687.90
9	1686.43	1686.39	1686.92	1687.07	1687.70	1687.46	1686.53	1686.68	1686.53	1685.99	1687.31	1687.46
10	1686.53	1687.02	1686.83	1686.97	1686.73	1686.43	1685.07	1686.63	1686.73	1686.92	1686.83	1687.75
11	1686.83	1686.48	1687.61	1686.73	1687.26	1686.53	1687.07	1686.09	1687.41	1686.97	1686.92	1687.75
12	1686.04	1685.46	1688.00	1686.68	1686.87	1687.26	1687.07	1686.73	1685.90	1685.90	1686.83	1687.17
13	1687.41	1685.99	1687.31	1686.48	1686.68	1687.36	1687.12	1685.55	1685.51	1685.60	1685.36	1685.85
14	1686.87	1685.85	1686.63	1686.48	1687.26	1687.36	1686.34	1687.22	1685.26	1686.29	1685.55	1686.48
15	1686.87	1686.19	1686.43	1687.02	1687.36	1687.51	1686.68	1685.90	1686.04	1686.87	1687.51	1687.75
16	1686.73	1687.12	1686.53	1687.70	1687.07	1687.46	1686.04	1687.17	1686.68	1687.17	1686.63	1687.90
17	1686.78	1686.87	1687.51	1687.12	1687.07	1686.63	1684.28	1686.68	1685.99	1686.92	1686.97	1686.39
18	1686.73	1686.78	1687.85	1687.61	1687.12	1687.75	1687.12	1686.48	1685.36	1686.97	1687.41	1687.56
19	1687.26	1685.90	1686.78	1687.80	1687.41	1687.36	1687.12	1687.31	1686.09	1686.63	1687.02	1687.56
20	1685.80	1687.26	1684.43	1687.36	1688.10	1686.39	1686.48	1686.53	1686.14	1686.87	1687.75	1687.17
21	1686.87	1686.58	1685.02	1687.02	1687.12	1686.24	1686.48	1683.65	1686.58	1687.66	1686.92	1687.07
22	1685.90	1686.87	1685.51	1686.68	1687.56	1685.85	1686.63	1683.16	1686.34	1685.80	1687.61	1687.17
23	1685.70	1686.97	1684.77	1687.75	1687.85	1685.85	1686.73	1685.46	1687.02	1686.97	1687.46	1687.22
24	1686.92	1686.04	1684.77	1687.07	1687.17	1687.61	1687.66	1683.75	1687.31	1687.31	1687.36	1686.68
25	1686.78	1685.99	1685.85	1687.46	1687.61	1687.31	1686.58	1684.82	1686.87	1687.26	1685.36	1686.87
26	1685.21	1685.70	1687.12	1686.83	1686.83	1687.41	1686.83	1687.61	1686.73	1687.80	1685.95	1686.48
27	1683.99	1685.70	1687.51	1685.55	1686.83	1686.83	1686.24	1687.26	1687.22	1685.55	1686.63	1687.66
28	1685.07	1682.38	1686.92	1686.39	1686.92	1687.02	1687.12	1687.31	1686.83	1687.90	1687.12	1687.36
29	1686.09	---	1687.85	1687.02	1687.26	1686.83	1686.83	1687.22	1687.46	1687.12	1687.80	1686.29
30	1686.24	---	1687.46	1687.61	1686.58	1687.80	1686.92	1687.51	1687.90	1687.26	1687.17	1687.36
31	1685.85	---	1687.26	---	1684.92	---	1687.31	1686.78	---	1686.68	---	1687.26

Table 6-6.8

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1990

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1687.12	1686.09	1686.29	1686.92	1685.60	1687.95	1686.48	1686.83	1687.02	1686.92	1685.41	1685.02
2	1686.34	1685.31	1687.17	1687.85	1687.41	1687.26	1685.75	1685.85	1687.31	1685.70	1687.26	1687.17
3	1686.87	1686.73	1687.80	1687.22	1687.51	1686.39	1685.55	1686.92	1686.83	1686.87	1686.29	1687.41
4	1687.17	1686.92	1686.92	1687.51	1687.12	1686.68	1685.21	1686.92	1686.87	1687.31	1686.83	1687.07
5	1686.97	1687.46	1686.04	1687.46	1687.12	1687.17	1684.28	1687.26	1685.55	1687.46	1687.56	1687.17
6	1687.12	1686.58	1687.41	1686.04	1687.36	1686.48	1684.33	1686.68	1685.75	1687.12	1687.56	1687.36
7	1686.92	1687.75	1686.19	1687.80	1686.73	1685.75	1686.04	1685.60	1686.53	1687.12	1686.73	1686.77
8	1686.97	1687.66	1686.14	1686.73	1687.22	1686.34	1686.53	1686.34	1686.68	1687.17	1687.22	1687.27
9	1686.43	1687.02	1686.29	1687.02	1686.63	1686.09	1686.39	1685.95	1686.43	1686.73	1687.07	1684.15
10	1687.22	1687.41	1686.39	1687.90	1685.46	1687.31	1687.36	1685.99	1687.31	1686.43	1686.68	1683.82
11	1687.61	1685.90	1686.78	1687.02	1685.95	1687.26	1687.17	1686.24	1687.12	1686.73	1687.36	1683.95
12	1686.97	1684.77	1686.97	1687.36	1686.19	1687.51	1687.85	1686.53	1686.73	1686.73	1685.41	1686.81
13	1687.41	1687.31	1687.07	1687.70	1687.17	1687.36	1686.73	1684.92	1687.22	1685.16	1687.17	1687.23
14	1687.17	1686.43	1687.17	1687.46	1687.26	1687.90	1686.19	1684.92	1686.58	1684.43	1687.17	1686.97
15	1685.02	1687.12	1686.97	1687.66	1687.31	1687.12	1685.60	1686.58	1686.53	1684.25	1687.36	1687.66
16	1686.68	1687.12	1686.39	1686.29	1687.07	1687.07	1685.41	1686.58	1687.26	1686.38	1686.78	1686.77
17	1687.56	1687.26	1686.92	1687.07	1687.26	1687.07	1685.65	1686.39	1685.07	1686.97	1687.02	1687.51
18	1687.56	1686.87	1687.61	1686.87	1686.63	1687.22	1685.95	1686.39	1685.90	1686.78	1686.29	1687.19
19	1686.73	1686.87	1685.46	1687.12	1686.14	1687.41	1686.48	1685.12	1686.29	1686.34	1687.36	1687.09
20	1687.02	1685.80	1686.92	1687.70	1686.19	1687.51	1687.26	1686.19	1685.80	1686.87	1686.83	1687.59
21	1685.99	1686.58	1687.02	1686.58	1684.53	1686.14	1685.99	1684.92	1685.07	1686.62	1687.56	1684.48
22	1687.46	1687.26	1687.95	1686.24	1685.12	1686.29	1685.85	1686.63	1687.51	1686.34	1686.58	1686.09
23	1687.36	1686.73	1687.31	1685.75	1685.85	1685.80	1684.97	1685.99	1687.46	1686.39	1684.53	1687.55
24	1685.02	1687.26	1687.56	1685.95	1687.56	1686.53	1686.04	1685.80	1686.92	1686.78	1685.02	1688.05
25	1687.31	1687.51	1687.46	1686.39	1686.58	1686.43	1685.36	1685.51	1687.56	1686.48	1685.70	1687.27
26	1687.26	1685.02	1687.66	1686.78	1686.78	1686.78	1684.28	1686.24	1687.26	1686.09	1683.70	1687.69
27	1686.83	1685.12	1687.12	1686.73	1686.92	1686.87	1685.95	1686.83	1686.43	1685.41	1686.04	1687.23
28	1687.51	1686.63	1687.85	1687.51	1686.34	1686.04	1687.46	1687.26	1686.24	1686.29	1686.29	1687.27
29	1687.22	---	1687.46	1686.97	1687.02	1685.99	1686.73	1685.26	1686.87	1687.17	1685.85	1685.96
30	1687.07	---	1687.26	1687.36	1687.75	1685.99	1687.36	1686.87	1687.51	1687.36	1686.04	1687.37
31	1687.07	---	1687.22	---	1687.22	---	1686.78	1686.83	---	1685.70	---	1687.86

Table 6-6.9

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1991

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1687.33	1686.39	1687.82	1684.60	1687.41	1686.24	1687.32	1687.55	1687.03	1687.21	1686.84	1687.81
2	1687.04	1687.06	1687.62	1684.34	1687.50	1687.18	1686.64	1687.34	1686.42	1686.42	1686.85	1685.67
3	1687.78	1686.71	1687.22	1684.89	1686.88	1687.16	1686.91	1687.53	1685.76	1685.21	1686.11	1686.35
4	1687.98	1686.18	1687.35	1686.46	1686.58	1687.23	1686.98	1686.80	1687.12	1687.41	1684.09	1687.15
5	1687.58	1686.46	1687.26	1687.38	1687.45	1686.76	1685.43	1684.89	1687.27	1686.99	1685.63	1686.65
6	1687.17	1687.62	1687.27	1687.19	1687.30	1687.15	1686.57	1685.35	1687.47	1687.56	1686.27	1685.90
7	1687.68	1686.90	1687.02	1687.38	1686.68	1686.76	1687.00	1686.28	1687.14	1687.16	1685.53	1686.72
8	1687.41	1687.23	1685.87	1686.00	1687.17	1687.82	1686.89	1687.01	1687.03	1687.46	1686.20	1686.20
9	1686.53	1687.35	1687.23	1686.96	1687.43	1687.91	1686.75	1686.45	1686.72	1687.06	1686.91	1686.26
10	1687.53	1685.23	1685.87	1687.21	1687.25	1687.41	1686.75	1686.39	1686.86	1687.23	1687.34	1687.54
11	1687.21	1684.83	1682.58	1685.96	1687.22	1687.69	1687.01	1686.13	1686.65	1687.57	1686.51	1686.95
12	1687.64	1687.29	1685.41	1685.50	1687.85	1687.02	1687.40	1685.70	1686.41	1687.29	1686.40	1687.21
13	1686.81	1686.27	1686.51	1684.62	1687.31	1686.77	1687.10	1687.12	1687.59	1687.11	1687.09	1686.65
14	1685.95	1687.22	1686.81	1685.39	1687.24	1686.38	1686.97	1687.26	1686.40	1686.37	1687.14	1687.01
15	1687.62	1686.03	1687.13	1683.25	1687.15	1687.07	1686.83	1687.00	1685.80	1687.22	1686.75	1687.20
16	1687.31	1686.56	1686.67	1683.14	1687.51	1687.40	1687.24	1686.25	1686.63	1687.46	1687.70	1687.00
17	1687.81	1687.29	1686.82	1687.06	1686.67	1687.41	1687.00	1686.50	1687.20	1685.82	1686.08	1686.47
18	1687.34	1686.91	1686.84	1686.63	1687.15	1686.47	1685.75	1686.75	1687.82	1687.73	1684.81	1687.20
19	1687.66	1686.93	1685.07	1686.07	1687.15	1686.25	1687.15	1687.77	1687.44	1687.17	1686.18	1687.02
20	1687.13	1686.98	1687.42	1686.00	1687.62	1687.62	1687.25	1686.55	1686.98	1685.86	1685.39	1686.77
21	1686.69	1687.23	1685.43	1685.44	1685.96	1687.23	1687.19	1687.28	1687.00	1684.36	1685.45	1687.21
22	1687.07	1686.81	1684.98	1684.58	1687.06	1687.01	1687.62	1687.33	1686.84	1684.71	1686.20	1686.23
23	1687.17	1686.39	1686.70	1684.83	1687.51	1686.98	1686.86	1687.27	1687.91	1684.80	1687.24	1685.44
24	1687.12	1687.08	1686.81	1686.63	1687.23	1687.56	1686.74	1686.96	1687.19	1685.10	1687.23	1685.83
25	1686.75	1686.14	1683.33	1686.75	1687.11	1687.06	1687.20	1684.92	1687.07	1685.89	1686.22	1685.25
26	1687.96	1685.52	1686.79	1686.85	1687.25	1687.37	1686.58	1685.33	1686.98	1686.95	1686.06	1684.91
27	1687.53	1687.54	1685.76	1687.55	1686.56	1686.76	1687.12	1685.20	1686.55	1685.52	1684.97	1686.84
28	1687.60	1686.65	1686.30	1687.07	1687.37	1687.07	1687.60	1684.25	1686.98	1686.05	1687.30	1687.51
29	1687.66	---	1684.84	1686.21	1686.60	1686.84	1686.61	1685.69	1686.43	1687.01	1687.05	1686.62
30	1687.39	---	1685.87	1686.72	1686.66	1687.34	1687.12	1688.23	1685.66	1685.88	1686.78	1686.05
31	1686.63	---	1685.90	---	1686.67	---	1687.48	1687.05	---	1686.39	---	1687.22

Table 6-6.10

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1992

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1687.17	1686.59	1686.52	1685.29	1686.95	1685.09	1685.64	1685.27	1686.91	1687.16	1687.40	1686.78
2	1686.62	1684.69	1687.01	1685.75	1686.47	1685.68	1686.13	1686.48	1687.01	1686.88	1686.20	1685.99
3	1687.20	1683.28	1687.17	1686.64	1686.39	1685.96	1687.30	1687.40	1686.65	1685.47	1686.65	1685.97
4	1686.74	1685.62	1687.43	1687.14	1686.85	1685.98	1686.23	1686.95	1685.93	1683.68	1687.32	1686.65
5	1686.57	1686.15	1687.00	1686.62	1686.40	1686.15	1685.24	1685.64	1686.50	1680.13	1686.68	1686.58
6	1686.75	1685.50	1687.15	1685.00	1685.30	1685.48	1686.21	1684.29	1686.75	1678.54	1686.81	1687.02
7	1687.16	1686.80	1687.20	1685.43	1686.50	1684.79	1687.21	1684.61	1685.26	1678.31	1686.88	1685.38
8	1686.70	1686.94	1686.63	1686.41	1687.13	1684.56	1686.89	1686.07	1684.85	1678.18	1686.78	1686.56
9	1686.52	1686.95	1685.36	1686.89	1686.28	1684.95	1686.21	1686.41	1686.52	1678.37	1687.41	1685.39
10	1687.57	1685.29	1686.61	1687.00	1684.93	1685.15	1687.09	1686.89	1686.65	1678.24	1687.14	1686.47
11	1686.63	1686.79	1686.06	1686.66	1683.07	1684.72	1686.90	1686.91	1685.24	1678.56	1687.27	1686.67
12	1687.32	1686.69	1686.21	1685.23	1683.88	1686.31	1684.78	1686.82	1685.94	1678.62	1686.36	1687.13
13	1686.34	1687.25	1687.00	1683.68	1685.94	1686.86	1686.22	1686.76	1686.83	1678.27	1686.27	1687.15
14	1686.82	1685.77	1686.83	1685.33	1687.09	1685.80	1686.26	1686.81	1685.55	1678.42	1686.19	1686.15
15	1686.89	1687.66	1686.71	1685.84	1686.42	1683.62	1685.75	1687.23	1687.17	1678.63	1686.24	1686.39
16	1686.52	1687.25	1686.38	1686.40	1686.18	1682.29	1686.43	1686.40	1686.26	1679.16	1686.50	1686.97
17	1686.56	1686.91	1686.85	1686.66	1685.82	1684.34	1686.61	1684.49	1686.27	1679.83	1686.74	1687.32
18	1686.88	1687.00	1686.81	1685.32	1684.85	1685.96	1687.31	1685.05	1685.29	1681.38	1686.55	1686.82
19	1687.11	1686.81	1686.67	1686.77	1687.23	1687.04	1686.37	1686.47	1686.68	1682.49	1686.26	1686.27
20	1687.14	1686.67	1685.62	1684.09	1686.66	1687.18	1686.50	1686.81	1685.68	1683.23	1686.79	1686.34
21	1686.97	1687.45	1686.77	1683.09	1686.09	1686.66	1686.43	1686.39	1685.27	1684.17	1685.92	1686.19
22	1686.95	1686.81	1687.15	1686.72	1687.02	1685.27	1686.19	1686.23	1686.08	1684.07	1686.25	1685.53
23	1686.22	1687.60	1687.33	1686.66	1686.64	1686.32	1686.84	1685.16	1686.92	1684.68	1685.29	1686.94
24	1687.38	1686.64	1686.30	1686.64	1685.86	1686.75	1685.73	1686.02	1686.89	1685.74	1686.69	1686.57
25	1687.39	1686.91	1684.93	1686.16	1685.34	1685.73	1686.82	1685.71	1686.21	1687.12	1686.37	1685.77
26	1685.94	1687.14	1685.54	1687.52	1686.90	1685.46	1687.12	1685.90	1686.58	1686.54	1686.01	1686.42
27	1686.42	1686.99	1687.16	1686.56	1687.02	1685.84	1685.08	1686.37	1686.47	1686.28	1684.79	1687.62
28	1686.68	1686.14	1687.18	1687.40	1686.65	1685.91	1686.03	1686.98	1686.82	1687.53	1685.49	1687.41
29	1686.17	1686.30	1685.88	1686.67	1686.43	1684.44	1686.06	1686.20	1686.97	1687.08	1685.04	1686.28
30	1686.93	---	1683.89	1686.54	1686.88	1683.72	1685.98	1686.64	1686.98	1687.08	1685.87	1686.77
31	1686.60	---	1684.49	---	1686.29	---	1685.51	1686.11	---	1686.83	---	1687.22

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1993

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.76	1686.26	1686.17	1684.81	1685.48	1684.79	1686.47	1685.53	1685.75	1686.30	1683.00	1684.00
2	1686.02	1684.20	1685.80	1686.24	1686.40	1685.64	1687.38	1686.84	1686.60	1687.40	1684.80	1684.20
3	1686.86	1686.08	1685.88	1686.81	1687.26	1686.13	1687.00	1686.68	1685.70	1686.40	1685.60	1684.40
4	1686.91	1684.86	1686.00	1686.22	1685.14	1686.94	1686.27	1686.98	1686.70	1687.30	1683.30	1685.10
5	1686.44	1685.87	1686.36	1686.35	1685.71	1686.37	1686.39	1686.26	1687.60	1685.00	1685.90	1685.00
6	1686.64	1686.85	1686.62	1686.69	1687.05	1687.32	1686.69	1686.11	1686.40	1686.60	1686.50	1685.10
7	1685.86	1686.12	1687.32	1684.74	1687.12	1686.95	1685.75	1685.87	1687.00	1685.40	1685.60	1685.20
8	1686.99	1685.21	1687.41	1684.53	1687.04	1686.42	1685.21	1684.55	1686.70	1685.80	1683.50	1685.70
9	1686.44	1684.31	1686.47	1685.03	1686.82	1686.23	1686.15	1687.08	1685.90	1685.80	1685.80	1686.20
10	1685.97	1685.34	1687.45	1684.56	1686.61	1686.35	1686.98	1687.00	1686.60	1685.80	1686.60	1685.40
11	1686.49	1687.01	1687.08	1685.44	1686.82	1685.77	1685.60	1686.39	1686.50	1687.20	1684.80	1684.40
12	1686.73	1686.98	1687.27	1686.47	1686.36	1686.98	1686.35	1685.86	1686.70	1686.30	1684.30	1681.50
13	1686.55	1686.73	1687.08	1686.65	1687.28	1685.79	1686.84	1685.29	1686.50	1687.10	1684.20	1684.60
14	1686.55	1686.00	1685.46	1686.68	1686.93	1686.20	1686.74	1687.00	1686.30	1686.60	1685.00	1686.30
15	1686.11	1685.91	1685.89	1686.04	1684.69	1686.42	1684.88	1687.06	1685.80	1686.20	1684.60	1686.60
16	1686.49	1687.14	1685.43	1685.97	1684.69	1685.80	1685.60	1686.86	1686.40	1685.90	1685.30	1685.80
17	1686.22	1686.66	1686.05	1684.74	1685.23	1686.08	1686.52	1686.86	1686.50	1686.00	1684.50	1685.60
18	1686.93	1686.75	1687.20	1686.30	1685.60	1686.15	1686.41	1687.53	1687.20	1685.90	1682.80	1686.60
19	1686.68	1686.84	1685.80	1686.53	1685.45	1686.14	1686.56	1686.80	1686.30	1685.90	1681.70	1686.20
20	1686.03	1687.04	1685.23	1685.49	1685.32	1685.96	1686.33	1686.83	1685.40	1686.70	1684.80	1686.80
21	1686.20	1686.87	1686.41	1685.89	1685.09	1686.37	1686.23	1686.20	1685.10	1685.90	1683.70	1686.20
22	1685.69	1687.71	1685.65	1686.06	1684.82	1685.70	1686.47	1686.46	1684.70	1686.30	1683.60	1686.20
23	1686.40	1687.09	1685.00	1686.21	1684.90	1686.81	1686.13	1685.70	1686.70	1685.80	1683.00	1685.70
24	1686.51	1686.82	1685.58	1686.35	1685.25	1686.06	1685.05	1686.12	1686.20	1684.60	1683.40	1686.30
25	1686.18	1687.13	1686.40	1686.12	1686.11	1686.63	1685.09	1686.93	1686.40	1683.90	1686.40	1686.30
26	1685.81	1687.06	1685.88	1686.56	1685.37	1685.53	1687.21	1684.92	1686.40	1683.90	1685.80	1684.80
27	1686.18	1686.15	1684.77	1685.49	1685.55	1685.54	1686.06	1686.10	1686.30	1685.90	1685.20	1686.40
28	1686.26	1686.84	1684.82	1685.88	1684.43	1686.02	1686.85	1684.68	1685.80	1685.70	1684.00	1686.30
29	1686.87	---	1684.79	1686.09	1685.37	1686.89	1685.47	1685.91	1684.90	1686.20	1682.90	1686.30
30	1686.38	---	1684.99	1685.41	1686.38	1686.25	1686.80	1686.41	1684.70	1686.40	1683.20	1685.80
31	1686.58	---	1685.13	---	1685.81	---	1686.67	1686.81	---	1684.70	---	1686.84

Table 6-6.12

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1994

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.80	1686.30	1685.10	1686.90	1685.90	1685.90	1685.90	1684.20	1685.90	1686.90	1685.70	1684.90
2	1684.00	1686.10	1685.10	1686.00	1685.50	1686.40	1685.40	1684.90	1686.00	1685.40	1685.50	1685.60
3	1684.40	1685.50	1687.00	1685.00	1686.40	1687.30	1685.30	1686.20	1685.70	1683.00	1685.40	1685.10
4	1684.00	1686.40	1686.70	1684.80	1685.90	1687.10	1685.60	1686.80	1685.40	1683.20	1685.40	1684.20
5	1685.30	1686.30	1687.30	1686.40	1685.00	1686.80	1685.40	1686.70	1683.00	1685.90	1686.10	1684.40
6	1686.70	1686.20	1686.00	1686.00	1685.20	1687.00	1684.00	1686.70	1684.90	1686.90	1683.80	1685.00
7	1686.10	1686.30	1685.30	1686.60	1685.80	1686.30	1685.40	1686.40	1686.70	1686.70	1680.40	1685.50
8	1686.10	1686.10	1685.90	1686.40	1685.80	1685.60	1686.10	1685.40	1686.40	1686.20	1681.30	1685.80
9	1686.30	1686.80	1685.00	1686.00	1685.80	1685.70	1686.00	1686.40	1686.30	1685.40	1682.30	1686.30
10	1685.30	1684.70	1685.00	1687.10	1685.80	1685.90	1685.60	1686.00	1685.80	1686.60	1682.30	1685.40
11	1684.80	1686.70	1687.00	1686.40	1686.20	1686.00	1684.30	1686.00	1685.90	1686.30	1682.60	1685.00
12	1685.00	1686.30	1686.70	1687.20	1687.00	1686.50	1683.40	1686.50	1683.90	1686.00	1686.70	1684.60
13	1686.60	1686.80	1686.30	1686.90	1687.30	1685.60	1684.60	1686.80	1686.40	1686.10	1687.20	1684.10
14	1686.30	1686.40	1686.70	1686.80	1686.90	1686.40	1686.20	1686.60	1686.40	1686.30	1687.00	1684.80
15	1686.20	1685.80	1685.40	1686.80	1687.40	1685.90	1686.50	1686.40	1686.80	1687.50	1685.90	1686.40
16	1686.70	1687.30	1686.40	1685.90	1684.80	1686.30	1686.30	1686.60	1686.70	1686.80	1686.80	1686.10
17	1687.10	1685.60	1687.10	1686.60	1686.40	1686.60	1686.40	1686.40	1686.50	1686.70	1686.60	1686.30
18	1686.00	1685.60	1684.30	1685.80	1686.40	1686.70	1686.30	1686.70	1685.70	1687.00	1686.50	1685.20
19	1686.80	1686.80	1685.20	1686.30	1686.30	1686.40	1686.80	1685.90	1684.50	1686.40	1687.00	1685.40
20	1685.80	1685.90	1682.60	1686.90	1686.50	1684.80	1685.90	1686.60	1686.10	1686.20	1685.10	1686.20
21	1685.80	1686.60	1682.40	1686.90	1686.80	1685.90	1686.70	1685.80	1686.90	1686.30	1685.10	1686.70
22	1685.44	1686.60	1679.60	1687.10	1686.50	1684.90	1686.40	1685.50	1686.30	1685.60	1685.70	1686.40
23	1685.50	1686.60	1684.50	1686.20	1685.90	1684.20	1685.20	1686.50	1686.70	1685.30	1686.40	1686.20
24	1685.30	1686.00	1686.10	1686.60	1686.60	1685.40	1685.20	1686.00	1686.80	1684.60	1685.20	1686.20
25	1685.90	1686.40	1686.30	1685.70	1686.40	1685.50	1684.90	1686.30	1686.40	1686.50	1684.40	1685.40
26	1686.80	1686.10	1686.00	1686.10	1686.20	1686.00	1685.50	1686.70	1685.50	1685.40	1685.00	1684.20
27	1686.80	1686.50	1686.00	1686.60	1686.40	1684.70	1686.60	1685.30	1686.20	1685.00	1685.30	1682.10
28	1686.00	1685.60	1685.00	1686.30	1684.90	1685.60	1686.30	1686.60	1686.30	1686.80	1684.40	1684.30
29	1686.50	---	1684.80	1686.00	1686.20	1687.10	1685.70	1686.50	1686.80	1685.70	1684.90	1685.70
30	1686.80	---	1685.40	1685.60	1685.70	1686.60	1685.40	1686.20	1685.50	1685.20	1685.20	1686.50
31	1686.00	---	1686.70	---	1685.60	---	1684.70	1685.30	---	1685.50	---	1686.20

Table 6-6.13

HELLS CANYON RESERVOIR: RESERVOIR SURFACE ELEVATION @ MIDNIGHT
CALENDAR YEAR 1995

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1686.00	1687.40	1686.90	1686.60	1686.90	1687.60	1686.00	1685.30	1686.10	1686.70	1686.10	1687.00
2	1685.60	1686.10	1686.10	1686.60	1687.30	1686.60	1687.30	1685.90	1686.20	1686.80	1687.10	1686.60
3	1686.60	1686.60	1684.60	1685.50	1685.00	1686.80	1686.60	1686.10	1686.10	1686.10	1686.20	1686.40
4	1684.20	1686.20	1685.40	1686.60	1686.60	1686.50	1686.90	1685.50	1685.80	1686.00	1684.60	1686.40
5	1685.50	1686.70	1686.90	1686.90	1686.50	1687.40	1686.90	1686.30	1685.60	1684.90	1685.70	1687.40
6	1685.40	1686.20	1686.50	1686.70	1685.90	1687.40	1687.00	1685.70	1686.20	1686.30	1685.20	1687.10
7	1686.20	1686.00	1686.00	1686.00	1686.50	1686.70	1687.10	1685.10	1686.50	1686.70	1685.30	1685.80
8	1685.80	1686.60	1685.80	1686.30	1686.50	1686.50	1686.70	1685.90	1685.50	1687.30	1686.30	1686.30
9	1684.90	1686.60	1686.60	1686.70	1687.20	1686.60	1686.20	1685.30	1687.10	1687.10	1685.90	1686.50
10	1686.20	1686.30	1685.70	1686.70	1687.50	1686.50	1686.10	1683.90	1684.90	1686.80	1686.40	1687.50
11	1686.50	1686.00	1686.70	1686.90	1686.30	1687.20	1686.50	1684.70	1685.10	1686.80	1687.10	1685.80
12	1686.00	1686.30	1687.00	1687.00	1685.30	1687.10	1686.60	1686.90	1685.90	1685.90	1685.70	1685.40
13	1685.90	1685.50	1686.45	1686.10	1684.60	1687.10	1686.20	1686.70	1686.00	1686.50	1684.70	1685.70
14	1686.50	1685.50	1686.90	1686.20	1687.10	1686.60	1687.30	1686.10	1686.10	1686.40	1685.60	1687.00
15	1686.50	1686.00	1687.00	1686.70	1687.50	1686.70	1687.20	1686.90	1685.10	1687.10	1685.40	1686.70
16	1686.70	1685.90	1687.10	1686.60	1686.70	1687.10	1687.40	1687.00	1685.30	1686.90	1686.00	1686.40
17	1685.90	1685.20	1686.90	1686.00	1686.50	1687.10	1687.30	1687.00	1686.60	1685.80	1685.70	1684.90
18	1686.30	1685.50	1686.80	1685.80	1686.60	1687.20	1686.40	1686.80	1687.20	1686.10	1686.20	1684.50
19	1686.70	1683.10	1686.30	1685.60	1686.70	1687.10	1685.90	1685.80	1686.90	1686.30	1684.70	1684.10
20	1686.70	1686.80	1686.70	1684.90	1687.00	1686.90	1686.00	1685.60	1685.60	1685.20	1685.50	1685.60
21	1686.70	1686.20	1685.40	1685.90	1687.30	1687.20	1686.30	1686.30	1685.80	1685.60	1685.60	1684.50
22	1686.80	1686.00	1684.40	1685.70	1687.50	1686.00	1686.70	1686.60	1686.50	1686.60	1686.80	1685.80
23	1687.00	1686.40	1685.80	1686.10	1686.90	1686.80	1686.00	1686.80	1686.60	1686.40	1685.30	1685.70
24	1686.00	1685.20	1686.40	1686.80	1686.50	1686.90	1686.70	1686.50	1686.60	1686.70	1684.40	1687.20
25	1686.00	1686.60	1686.30	1686.00	1686.40	1686.90	1684.60	1687.30	1686.20	1686.20	1684.90	1686.00
26	1686.60	1686.50	1686.30	1687.00	1687.30	1687.50	1682.50	1685.90	1686.30	1686.00	1686.30	1686.80
27	1686.60	1685.70	1686.20	1685.80	1686.80	1686.50	1684.20	1687.50	1686.00	1686.50	1687.10	1686.50
28	1685.60	1685.10	1685.90	1686.00	1687.40	1685.70	1685.30	1687.20	1687.00	1685.90	1686.60	1686.30
29	1686.40	---	1685.00	1685.30	1686.70	1687.20	1685.30	1687.30	1686.60	1686.90	1686.30	1685.20
30	1686.50	---	1686.60	1686.50	1686.90	1686.70	1684.90	1686.40	1686.40	1687.20	1686.80	1686.30
31	1685.60	---	1685.10	---	1686.60	---	1683.60	1686.70	---	1686.90	---	1686.40

Table 6-6.14

Table 8-1 **Water column parameters of interest to describe trophic state and general column quality within the study area and an indication of whether the measures would be sampled in profile (P), or at the surface only (S), and at one point in the reservoir (N), or at multiple points located longitudinally down through the reservoir (Y).**

Parameter	Profile/Surface	Longitudinal (Yes or No)
Calcium	S	N
Iron	S	N
Magnesium	S	N
Manganese	S	N
Potassium	S	N
Silica	S	N
Sodium	S	N
Sulfate	S	N
Ammonia	P	Y
Nitrate	P	Y
Total P	P	Y
Ortho phosphate	P	Y
Total organic carbon	P	Y
Water temperature	P	Y
Dissolved oxygen	P	Y
pH	P	Y
Conductivity	P	Y
Total Dissolved solids	S	Y
Chlorophyll a	P	Y
Fecal coliform	S	Y
Total dissolved gas	S	Y
Light attenuation	P	Y
Turbidity	P	Y
Secchi depth	S	Y

Table 8-2 Contaminant parameters proposed to be monitored in the tissue of aquatic biota at five sites in the Snake River in July or August 1997.

Organochlorine insecticides
- o,p-DDD
- p,p-DDD
- p,p-DDE
- o,p-DDT
- p,p-DDT
- HCB
- Alpha BHC
- Beta BHC
- Dieldrin
- Hepatchlor epoxide
- Hepatchlor
- Nonachlor, trans
- Alpha endosulfan
- Beta endosulfan
- Endosulfan sulfate
- Lindane (Gamma BHC)
- Delta BHC
- Aldrin
- Endrin
- Endrin aldehyde
- Methoxychlor
- Chlordane
- Toxaphene

Polychlorinated biphenols
- Total PCB

Trace Elements
- Aluminum
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Selenium
- Zinc
- Strontium

Table 8-3 Parameters to be measured in sediment samples to be collected in the deposition area of Brownlee Reservoir near Rock Creek during August 1997.

Arsenic
Boron
Cadmium
Chromium
Copper
Lead
Mercury
Molybdenum
Selenium
Uranium
Vanadium
Zinc

Aldrin
Chlordane
DDE
DDD
DDT
Dieldrin
Endosulfan
Endrin
PCB
PCN
Heptachlor
Hepatachlor epoxide
Lindane
Methoxychlor
Mirex
Perthane
Toxaphene

Table 8-4 Summary of biota and specific tissues to be sampled for contaminants within the Snake River from C.J. Strike Dam downstream to the Hells Canyon Dam tailrace.

Species	Tissue	Level of Concern
Sturgeon	gonad	compare w/ Kootenia and mid snake
Sucker	liver	
Invertebrates	whole body	
Carp	liver	
White crappie	fillet	
Smallmouth bass	fillet	
Channel catfish	fillet	

Table 8-5 Summary of sampling schedule and methodologies proposed for sampling in the Oxbow bypassed reach of the Snake River during 1997.

Parameter	Method	Beneficial Use	Frequency	Time	Criteria
Substrate size	IFIM	salmonid spawning	once	July	suitability curve
Water velocity	IFIM	salmonid spawning	NA	NA	suitability curve
Water temperature	thermistor	cold water biota salmonid spawning	continuous	April-October	19 C and 22 C
Dissolved oxygen	polarographic membrane electrode	cold water biota salmonid spawning	continuous	April-October	6 mg/l 90% saturation
pH	electrometric	cold water biota	weekly	April-October	6.5-9.5
Phytoplankton blooms	visual	recreation	weekly	April-October	presence
Phytoplankton (chlorophyll a)	spectrophotometric	recreation	weekly	April - October	15µg/l
Fecal coliform	direct count	recreation	weekly	April-October	500 and 200/100ml
Total dissolved gas	potentiometer	cold water biota	weekly	April-October	110% saturation
Ammonia	colorimetric	cold water biota	weekly	April-October	varies (State standard)
Attached algae slimes	visual	recreation	weekly	April-October	presence

Table 8-6 Summary of white sturgeon angling and regulations for the Snake River in Idaho, 1943 to present (Cochnauer 1983).

Year	Bag Limit	Other regulations
1943-47	2 in possession, no yearly limit	Commercial fishing prohibited
1948-49	1 in possession, no yearly limit	1 setline permitted
1950-54	1 in possession, 76.0 cm minimum, no yearly limit	1 setline permitted
1955	1 in possession, 102.0 cm minimum	Setline allowed except in Hells Canyon
1956-58	1 in possession, 102.0 cm minimum, 2 fish per year	Setlines prohibited
1959-60	1 in possession, 102.0 cm minimum, 2 fish per year	
1961-63	3 in possession or annually in boundary waters, 2 fish elsewhere, 91.5 to 183.0 cm	
1964-69	1 fish in possession, 91.5 to 183.0 cm, 2 fish per year	
1970	Catch and release for entire Snake River	

Table 8-7 Completion dates of mainstem hydroprojects on the lower Columbia and Snake Rivers.

Date	Project	Location	Rivermile	Passage Design
1901	Swan Falls	Snake River	458.0	weir-type ladder[1]
1910	Lower Salmon	Snake River	573.0	weir-type ladder
1910	Upper Salmon	Snake River	580.0	weir-type ladder[1]
1938	Bonneville	Columbia River	145.5	weir-type ladder
1941	Bliss	Snake River	560.0	-
1951	C.J. Strike	Snake River	494.0	-
1954	McNary	Columbia River	292.0	weir-type ladder
1957	The Dalles	Columbia River	191.7	weir-type ladder
1957	Brownlee	Snake River	284.6	-
1958	Oxbow	Snake River	272.2	-
1962	Ice Harbor	Snake River	334.0	weir-type ladder
1965	Hells Canyon	Snake River	247.0	-
1968	John Day	Columbia River	215.6	weir-type ladder
1969	Lower Monumental	Snake River	366.0	weir-type ladder
1970	Little Goose	Snake River	395.0	weir-type ladder
1975	Lower Granite	Snake River	432.0	weir-type ladder

[1]Currently not in use.

Table 8-8 Summary status of white sturgeon in the Snake River from Swan Falls to Lower Granite Dam.

Reach	Years of Impoundment	Length of Study Area	Survey Year	Survey Catch	Pop. Estimate	Reference
Swan Falls (1901) to Brownlee (1957)	39	173.5 miles; 55.4 miles of reservoir	1979-81	1	N/A	Cochnauer 1983
			1992	1	N/A	Kruse-Malle 1993
Brownlee (1957) to Oxbow (1958)	38	12 miles; 11 miles of reservoir	1992	2	N/A	IDFG (unpublished)
Oxbow (1958) to Hells Canyon (1965)	27	26 miles; 22 miles of reservoir	1992	7	N/A	ODFW (unpublished)
Hells Canyon (1965) to Lower Granite (1975)	21	140 miles; 33 miles of reservoir	1972-75	881	8,000 - 12,000	Coon 1977
Hells Canyon Dam to Lewiston, ID.	-	107 miles; free-flowing river	1982-83	331	4,275	Lukens 1984
Lower Granite Reservoir (1975)	21	33 miles; reservoir	1990-92	946	946-2,166	Lepla 1994

Table 8-9 Categories of sexual development of white sturgeon.

Category	Sex	Description of Development
0	Unknown	Gonad tissue not visible.
1	Female	Previtellogenic: no visual signs of vitellogenesis; eggs present but have an average diameter < 0.5 mm
2	Female	Early vitellogenic: eggs are cream to gray; average diameter 0.6 to 2.1 mm
3	Female	Late vitellogenic: eggs are pigmented and attached to ovarian tissue; average diameter 2.2 to 2.9 mm
4	Female	Ripe: eggs are fully pigmented and detached from ovarian tissue; average diameter 3.0 to 3.4 mm
5	Female	Spent: gonads are flaccid and contain some residual fully pigmented eggs
6	Female	Previtellogenic with attritic oocytes; eggs present but have an average diameter of 0.5 mm; dark pigmented tissue present that may be reabsorbed eggs
7	Male	Non-reproductive: testes translucent smokey pigmentation
8	Male	Reproductive: testes white with folds and lobes
9	Male	Ripe: milt flowing; large and lobular testes

Table 8-10 Hells Canyon Complex white sturgeon study plan schedule.

PROJECT REACH		PROJECT TASK
Brownlee Reservoir; Swan Falls Reach	1996 Aug–Sep	Synoptic survey of Swan Falls Dam to RM 320.0 in Brownlee Reservoir.
	1996 Oct – 1997 Feb	Data analysis
	1997 Feb	White Sturgeon Technical Advisory Meeting (WSTAC)
	1997 Mar–Jun	Effort focused on upper Brownlee Res. and Swan Falls Reach in areas where sturgeon concentrations were identified from survey.
Hells Canyon Complex (Hells Canyon Dam - Salmon River; Oxbow/Hells Canyon Res.)	1997 Jul–Oct	Preliminary scoping/sampling below Hells Canyon Dam; initiate preparation for 1998 field activities.
	1997 Oct – 1998 Feb	Data analysis
	1998 Feb/Mar	WSTAC
	1998 Mar–Oct	Collect population status, habitat use, spawning, movement data
	1998 Nov – 1999 Feb	Data analysis
	1999 Feb/Mar	WSTAC
	1999 Mar–Oct	Collect population status, habitat, spawning, movement data
	1999 Nov – 2000 Feb	Data analysis
	2000 Feb	WSTAC
	2000 Mar–Oct	Complete population status, habitat, data collections for Hells Canyon Complex.
	2000 Nov – 2001 Mar	Data analysis
	2001 Mar–May	Complete spawning, movement data collections for Hells Canyon Complex.
	2001 Jun–Dec	Complete data analysis for Hells Canyon Complex.
	2001 Oct	WSTAC
	2001 Nov/Dec	Draft Report
Swan Falls Reach	2002–2005	Continue population status, habitat, spawning, movement data collections.

Hells Canyon Formal
Consultation Package

XII.
Figures

LIST OF FIGURES

(Figures are presented in Volume III, Section XII.)

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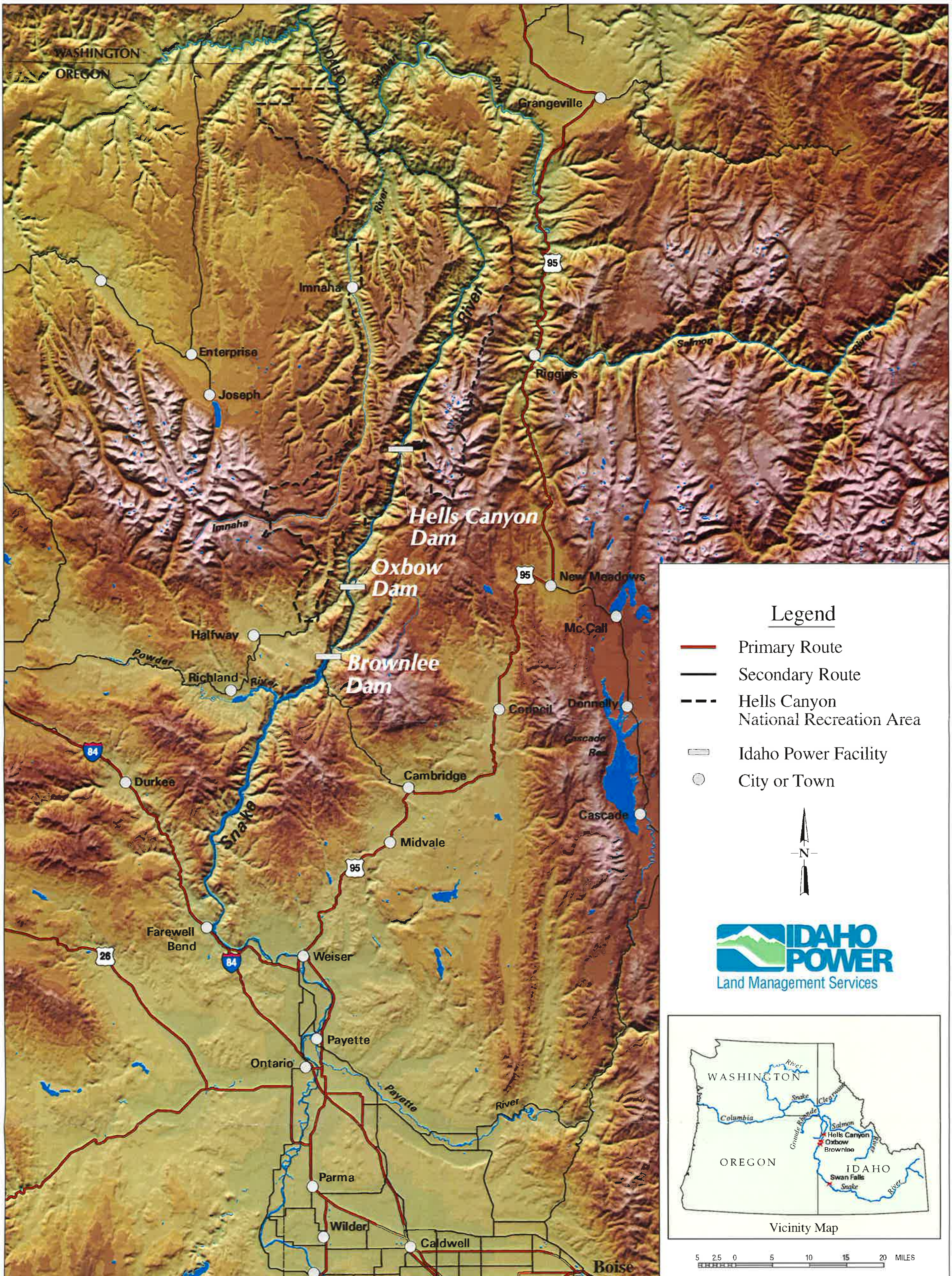


FIGURE 2-1

HELLS CANYON COMPLEX

PROJECT LOCATION MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

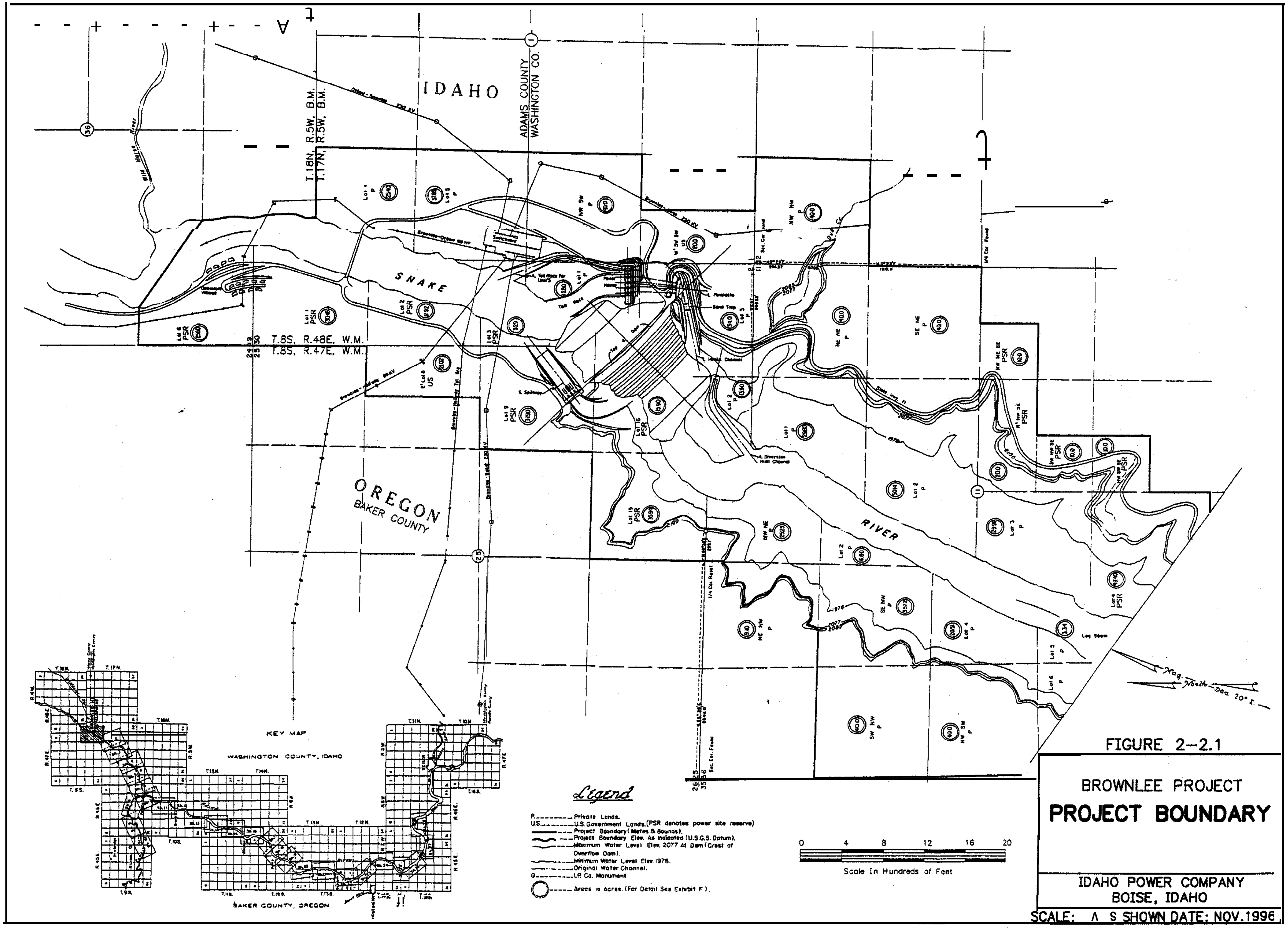


FIGURE 2–2.1

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

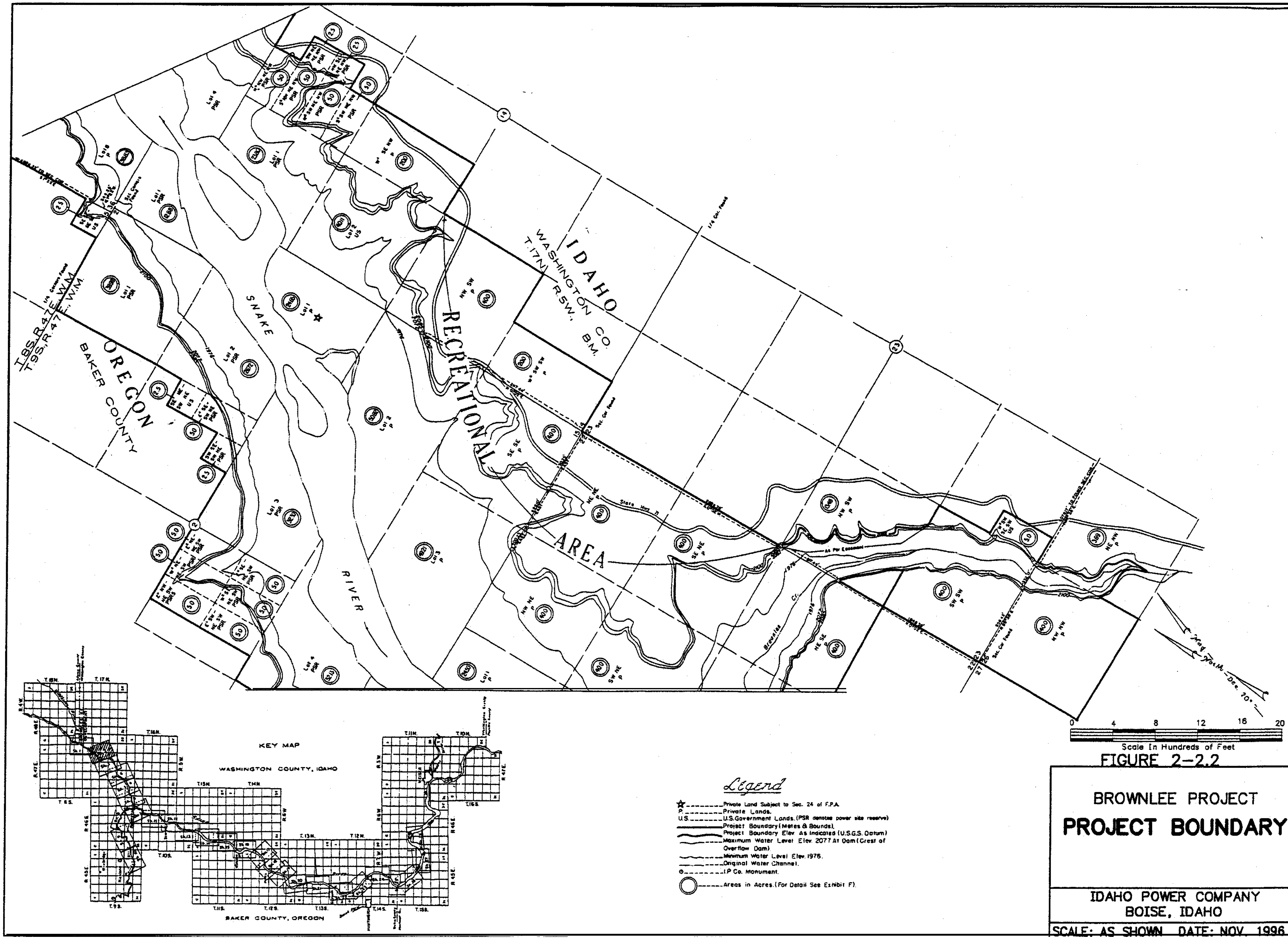


FIGURE 2-2.2

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

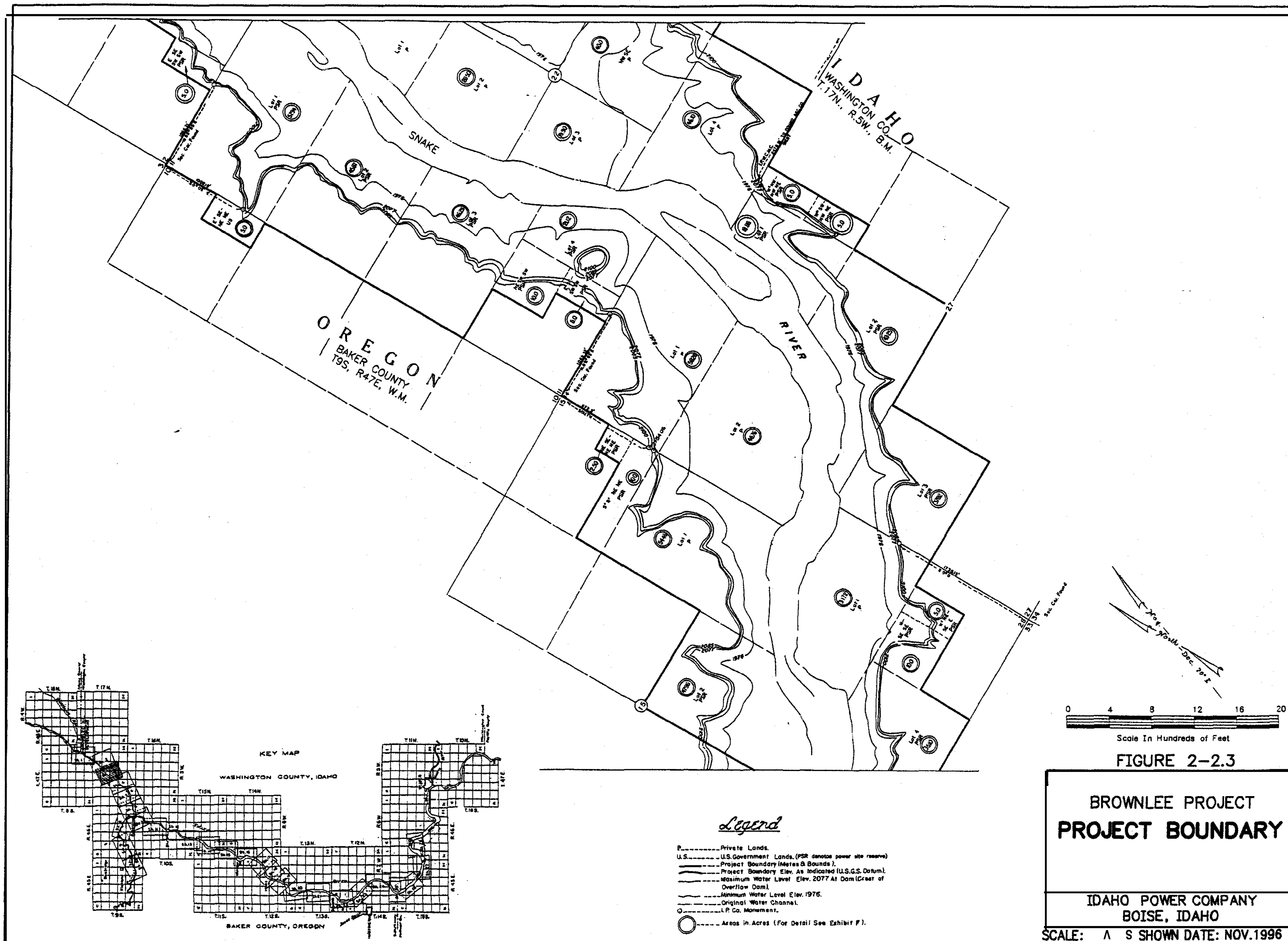


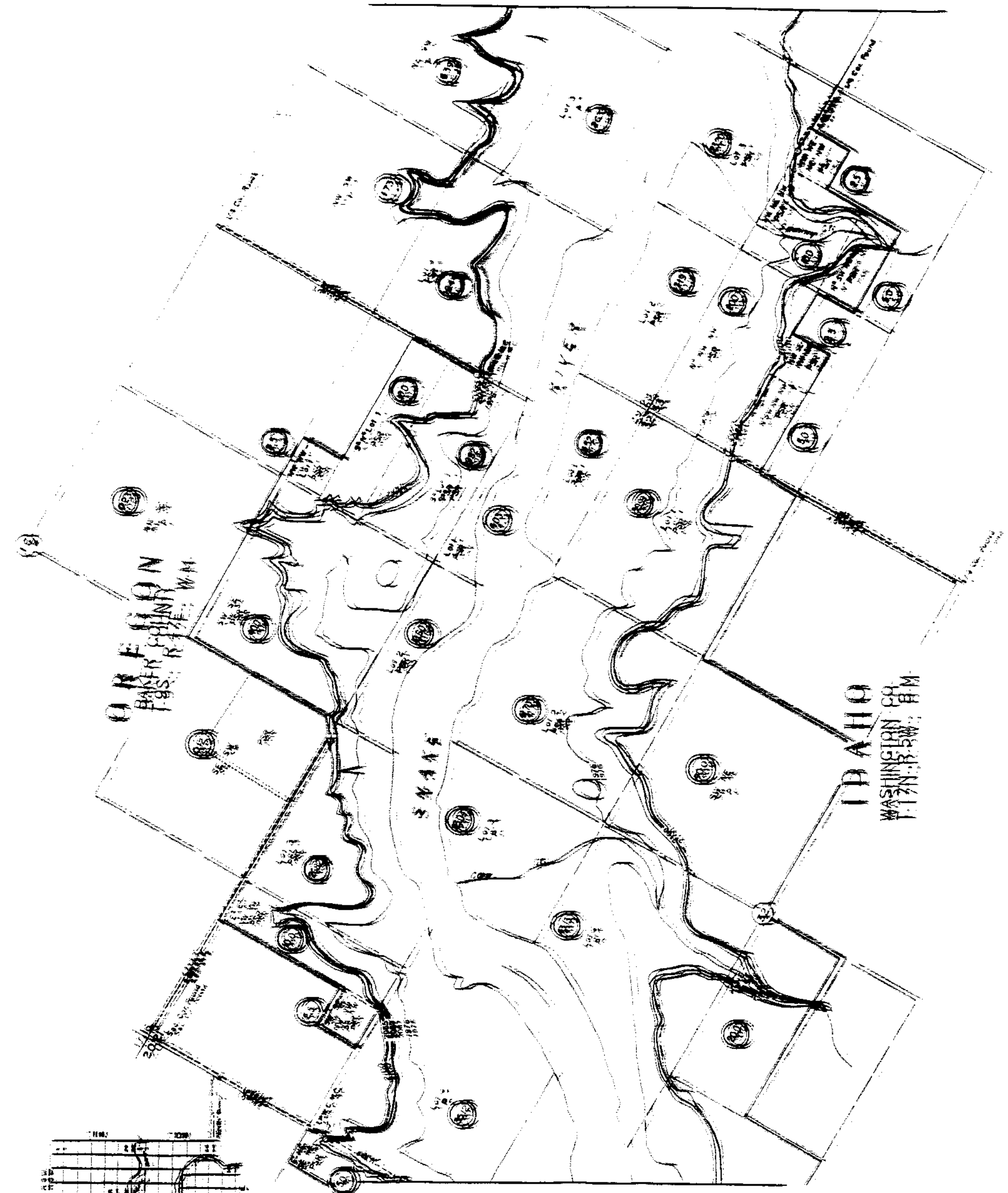
FIGURE 2-2.3

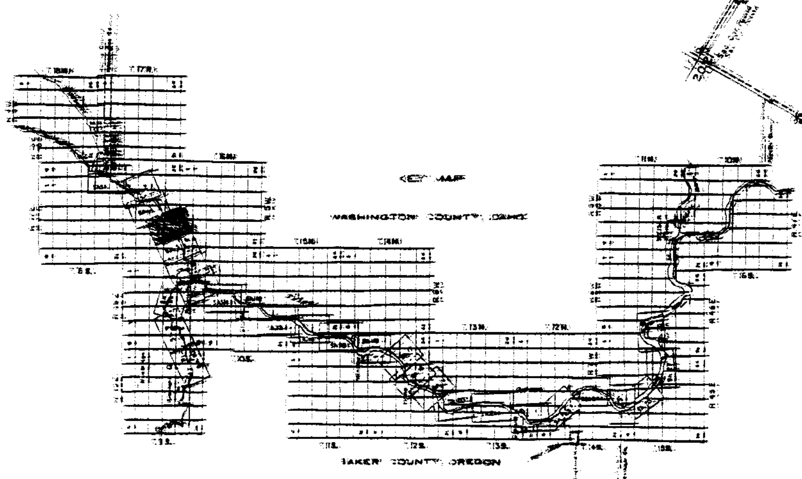
BROWNLEE PROJECT

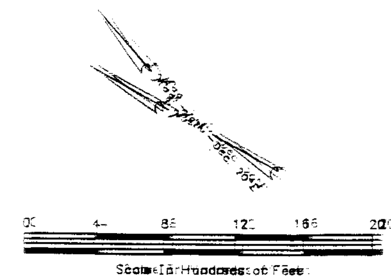
PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996







Legend

P ———— Private Lands.
U.S. ———— U.S. Government Lands (PSR denotes power site reserve)
———— Project Boundary (Metes & Bounds).
———— Project Boundary Elev. As Indicated (U.S.G.S. Datum)
———— Maximum Water Level Elev. 2077 At Dam (Crest of Overflow Dam)
———— Minimum Water Level Elev. 1975.
———— Original Water Channel.
———— I.P. Co. Monument.
○ ———— Areas in Acres (For Detail See Exhibit F)

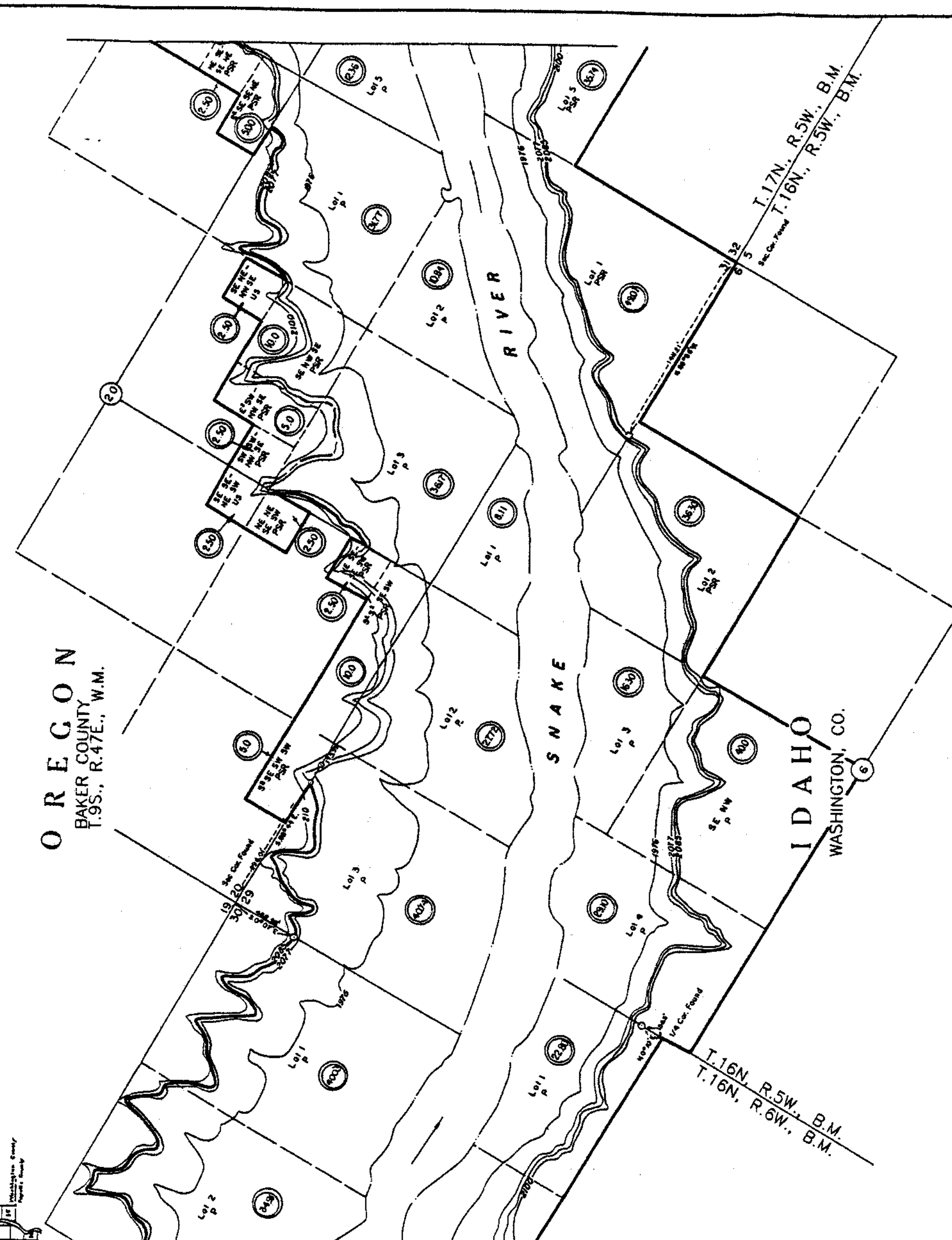
FIGURE 2-24

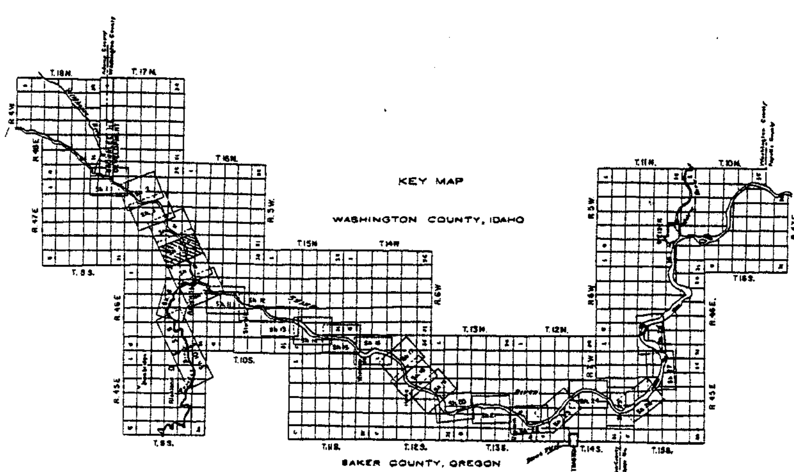
BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1998





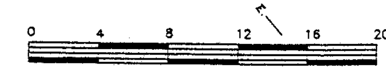


FIGURE 2–2.5

Legend

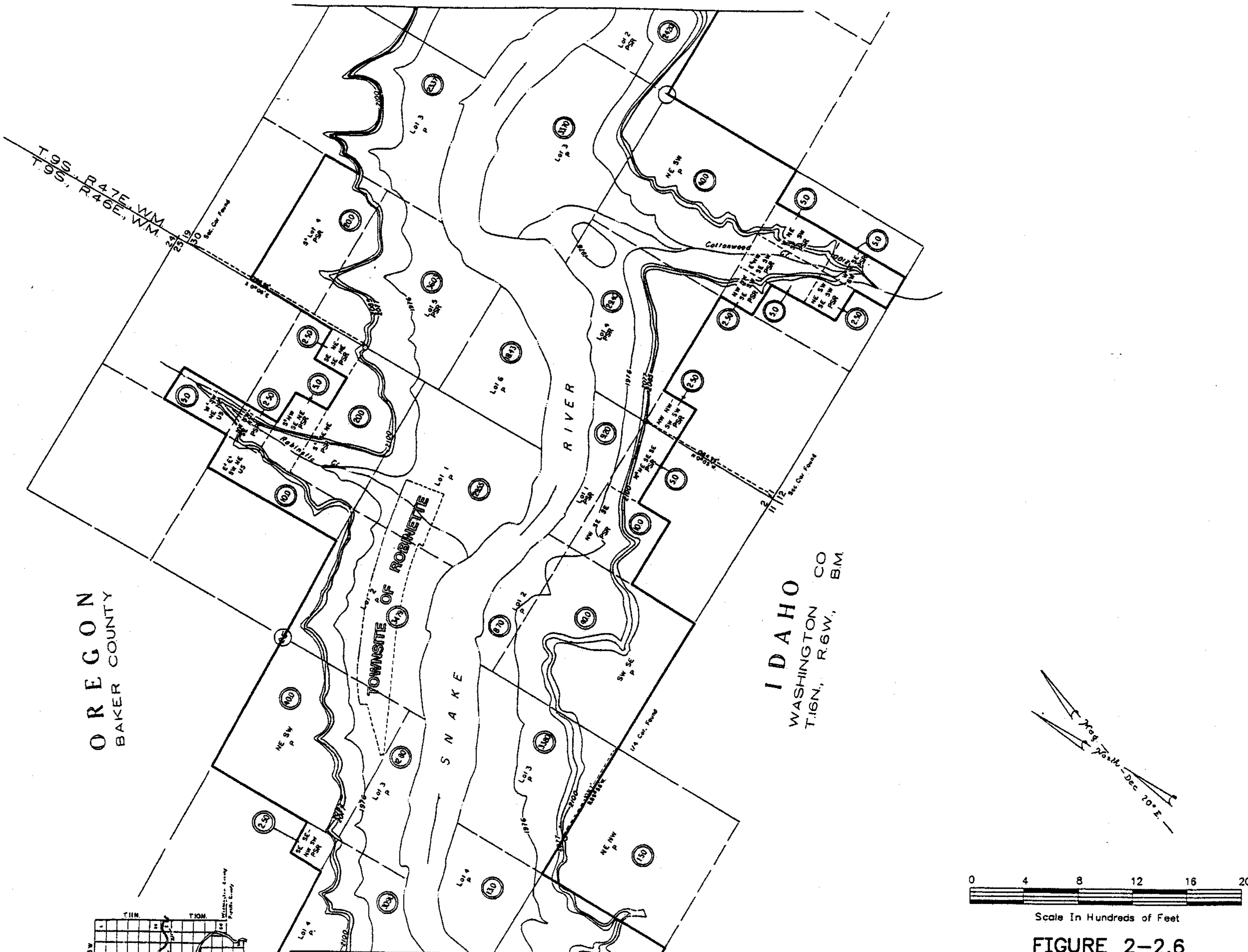
- P. — Private Lands.
- U.S. — U.S. Government Lands. (PSR denotes power site reserve)
- Project Boundary (Metes & Bounds).
- Project Boundary Elev. As indicated (U.S.G.S. Datum).
- Maximum Water Level Elev. 2077 At Dam (Crest of Overflow Dam).
- Minimum Water Level Elev. 1976.
- Original Water Channel.
- I.P. Co. Monument.
- Areas in Acres. (For Detail See Exhibit F).

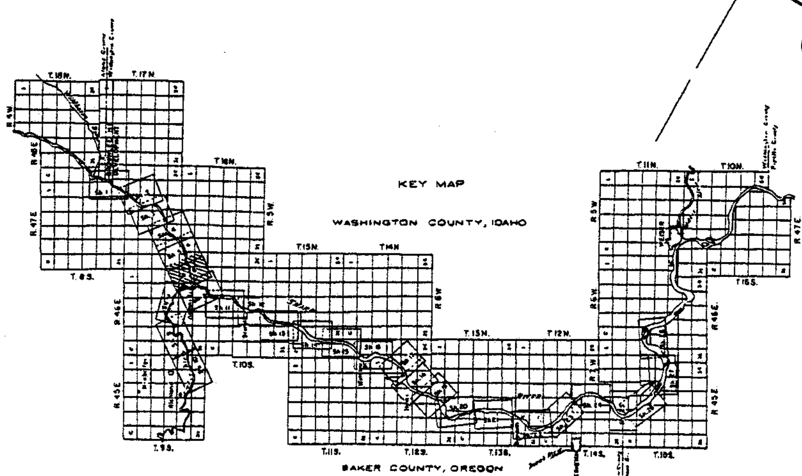
BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996





Legend

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- Minimum Water Level Elev. 1976.
- Original Water Channel.
- O — I.P.Co. Monument.
- ◯ — Areas in Acres (For Detail See Exhibit F).

FIGURE 2-2.6

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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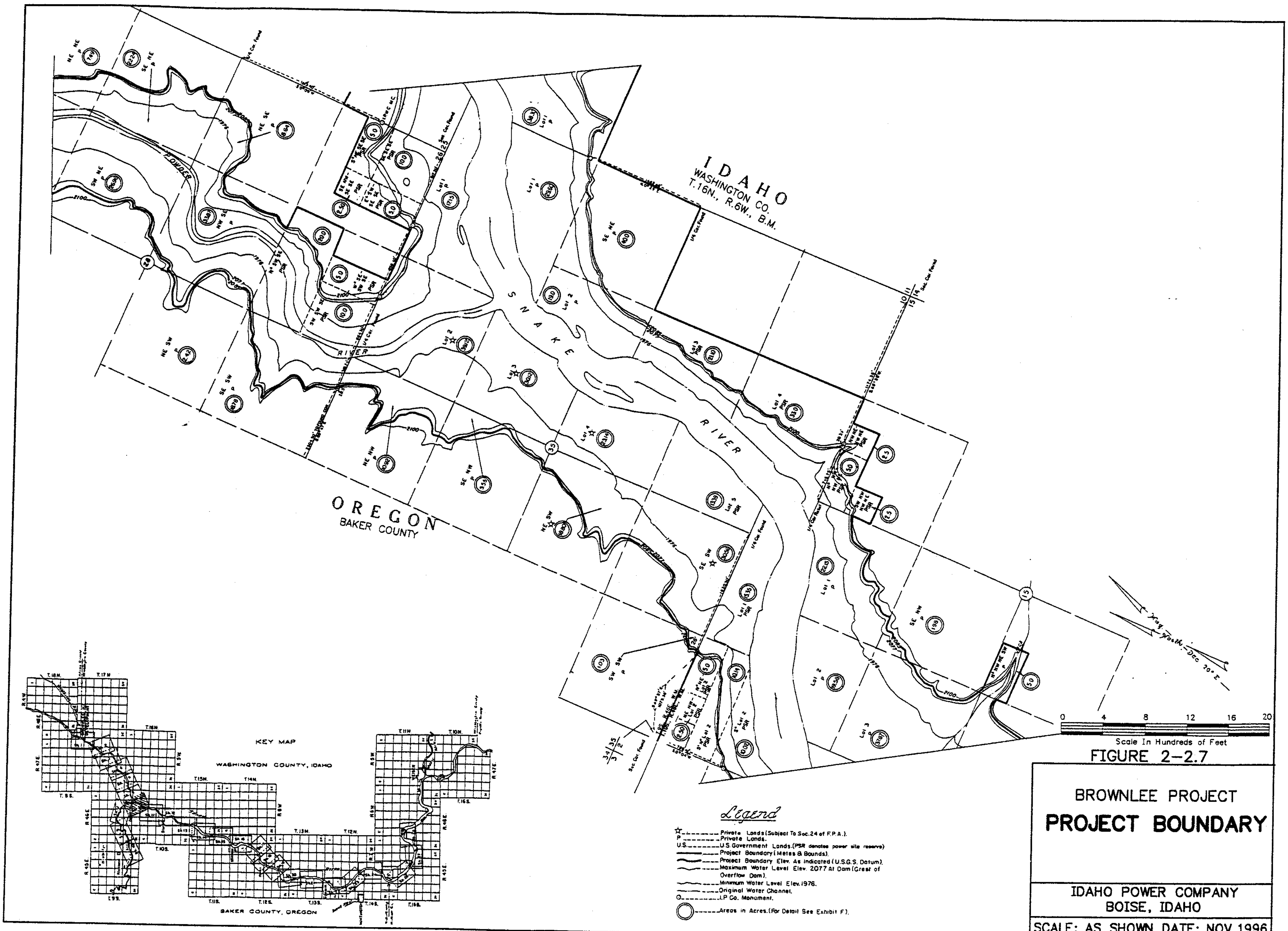

FIGURE 2-2.7

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

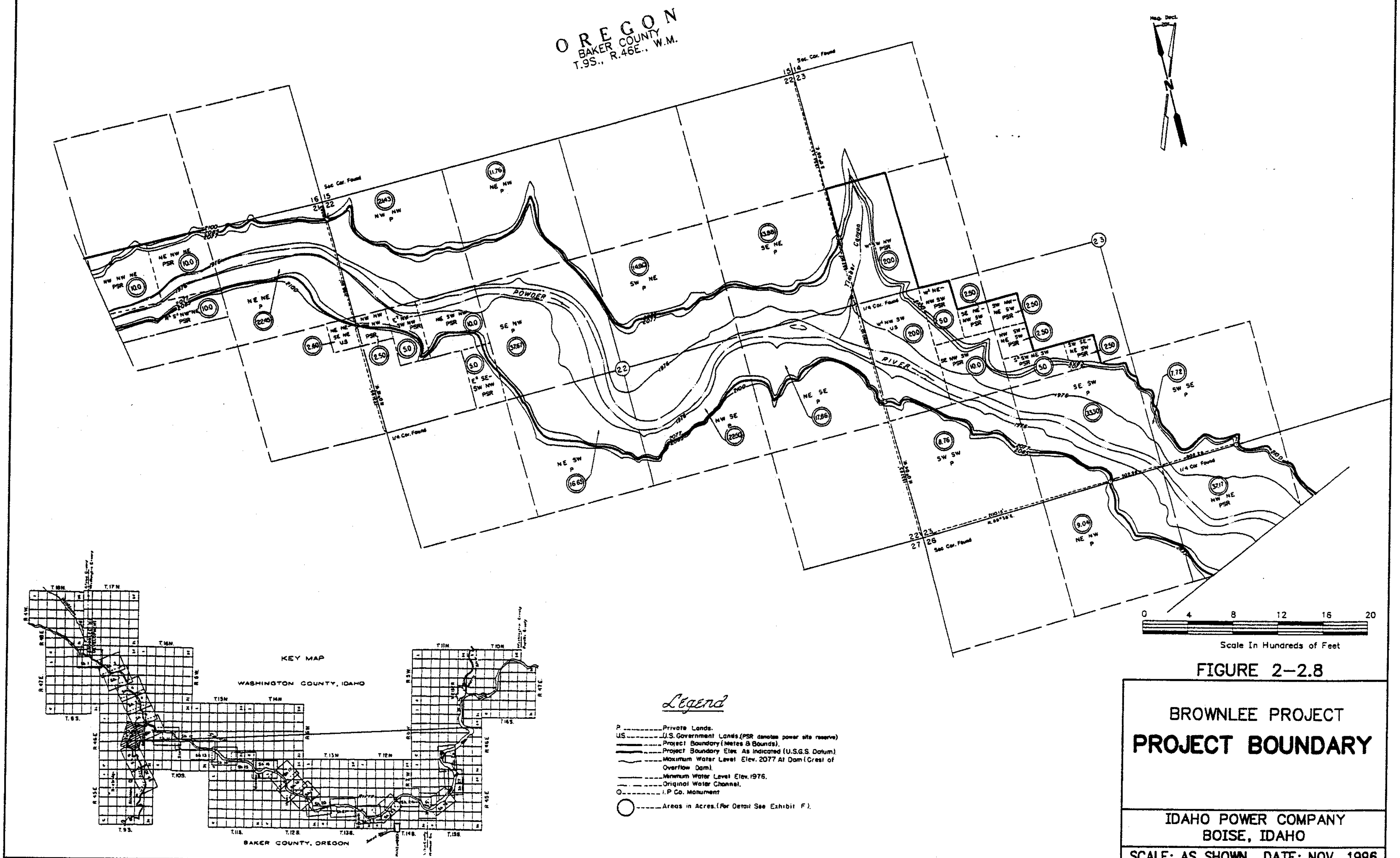

FIGURE 2-2.8

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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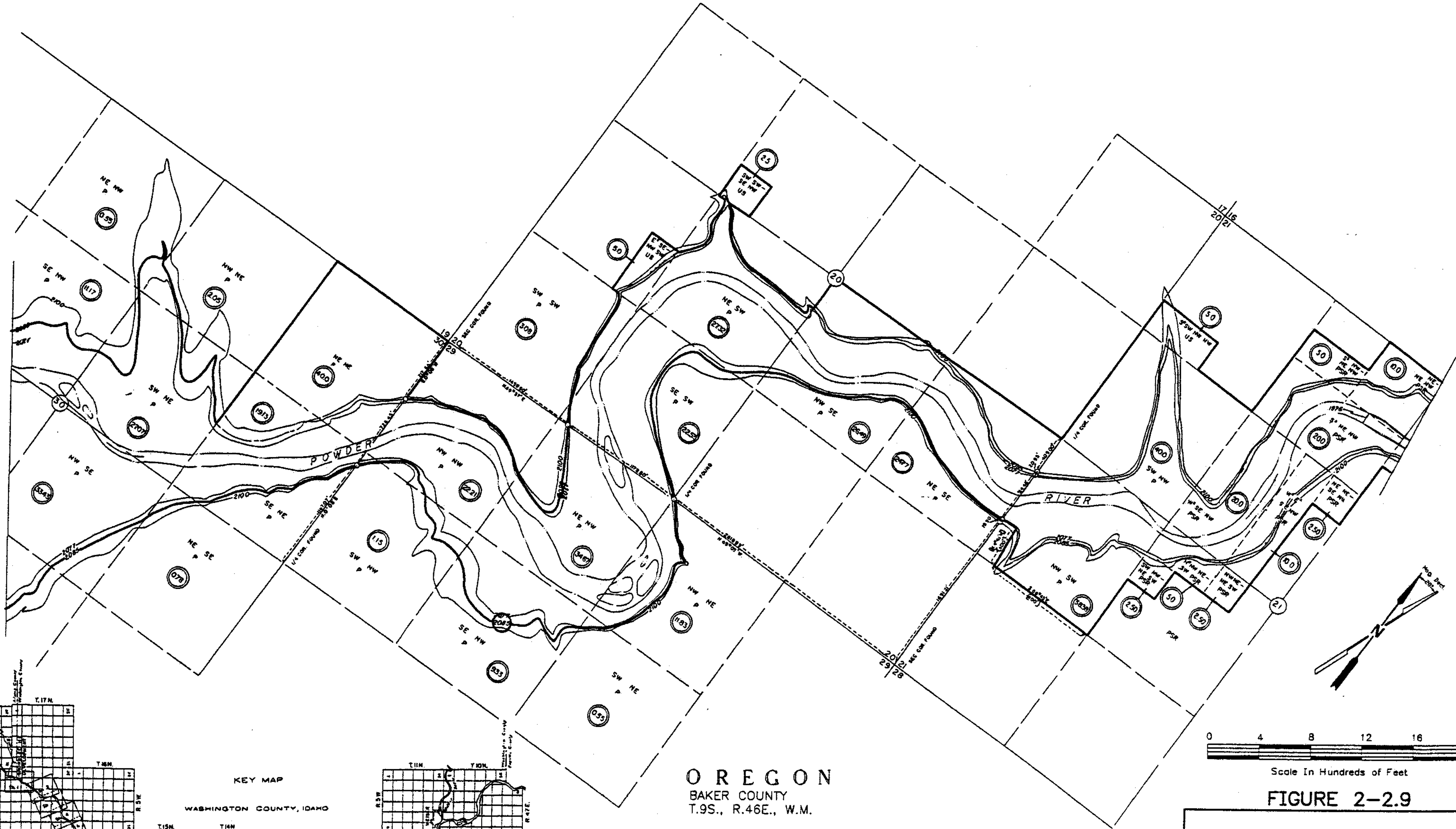

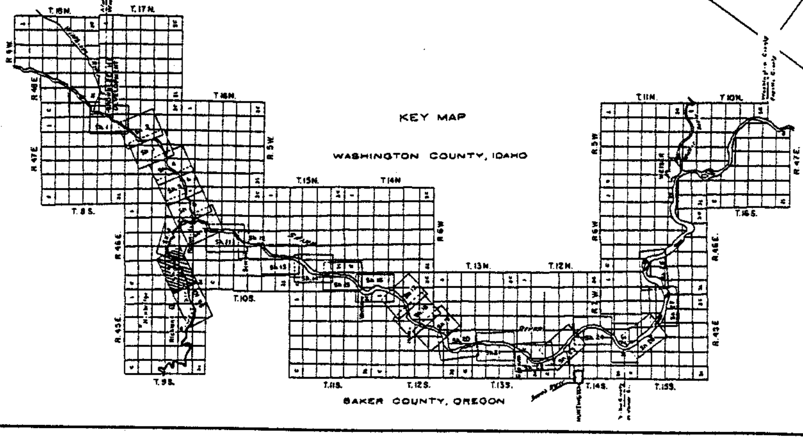

Legend

P. .... Private Lands.
U.S. .... U.S. Government Lands. (PSR denotes power site reserve)
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.... Minimum Water Level Elev. 1976.
.... Original Water Channel.
O .... I.P. Co. Monument.
○ .... Areas in Acres. (For Detail See Exhibit F).

FIGURE 2–2.9

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

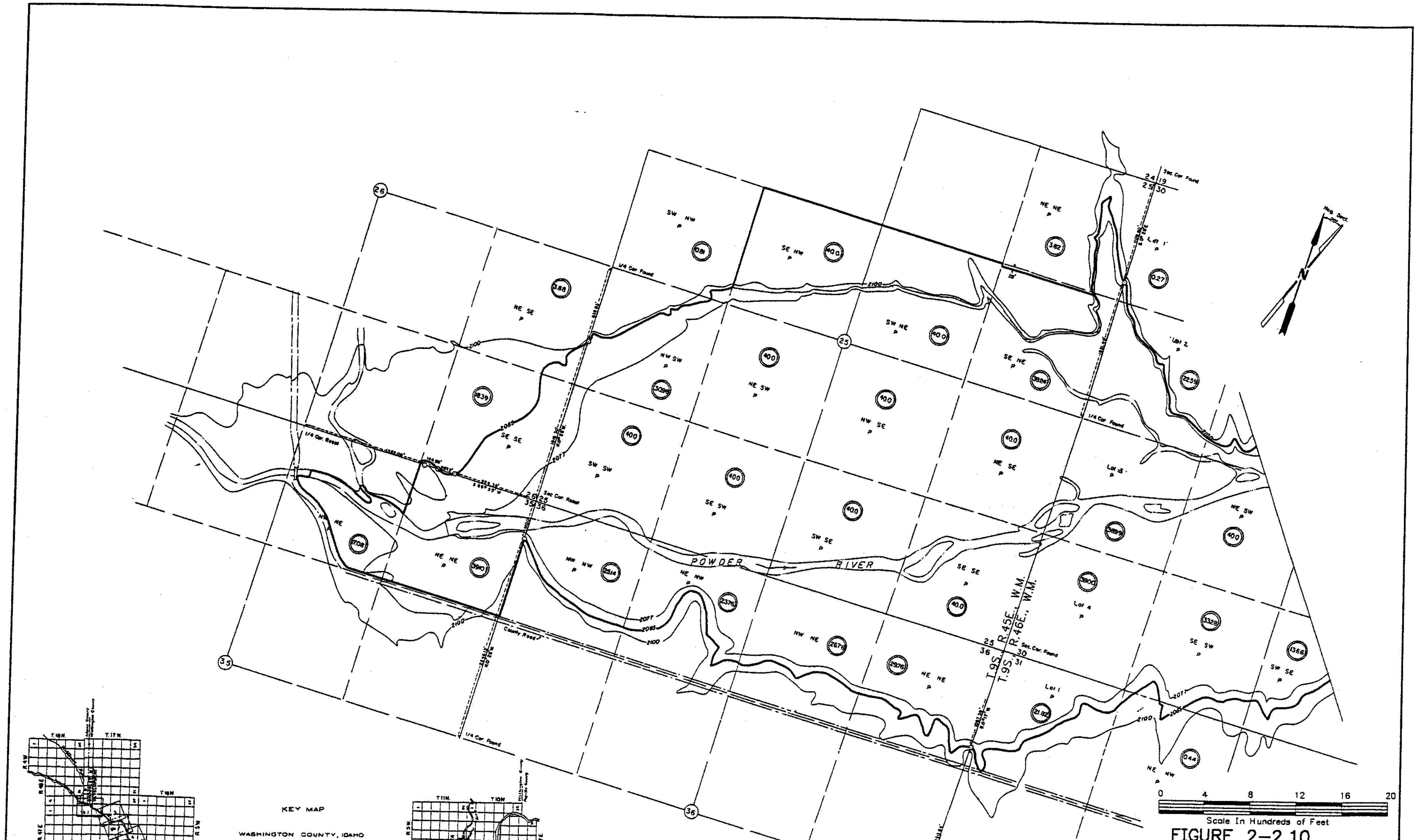

FIGURE 2-2.10

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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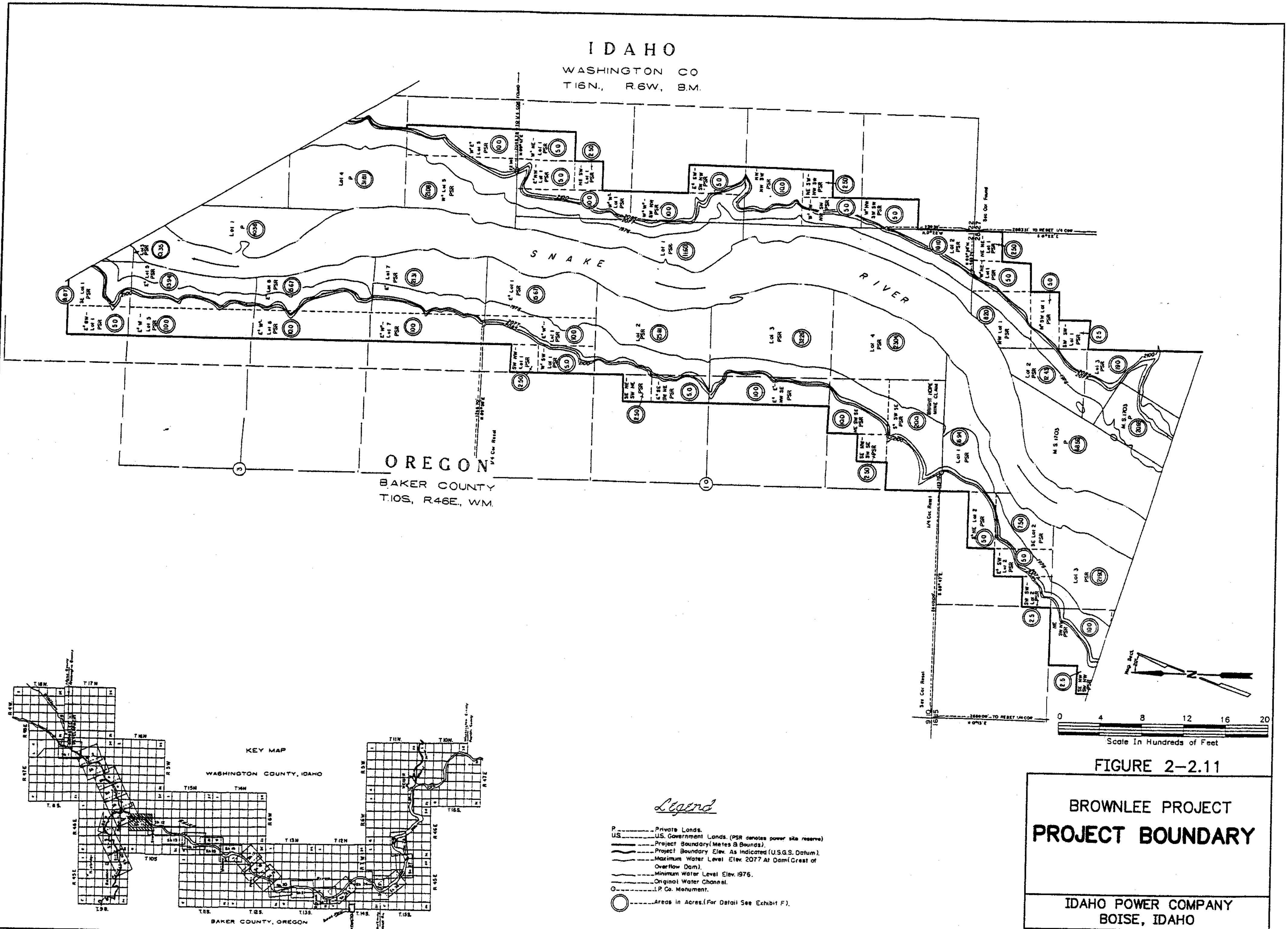

FIGURE 2–2.11

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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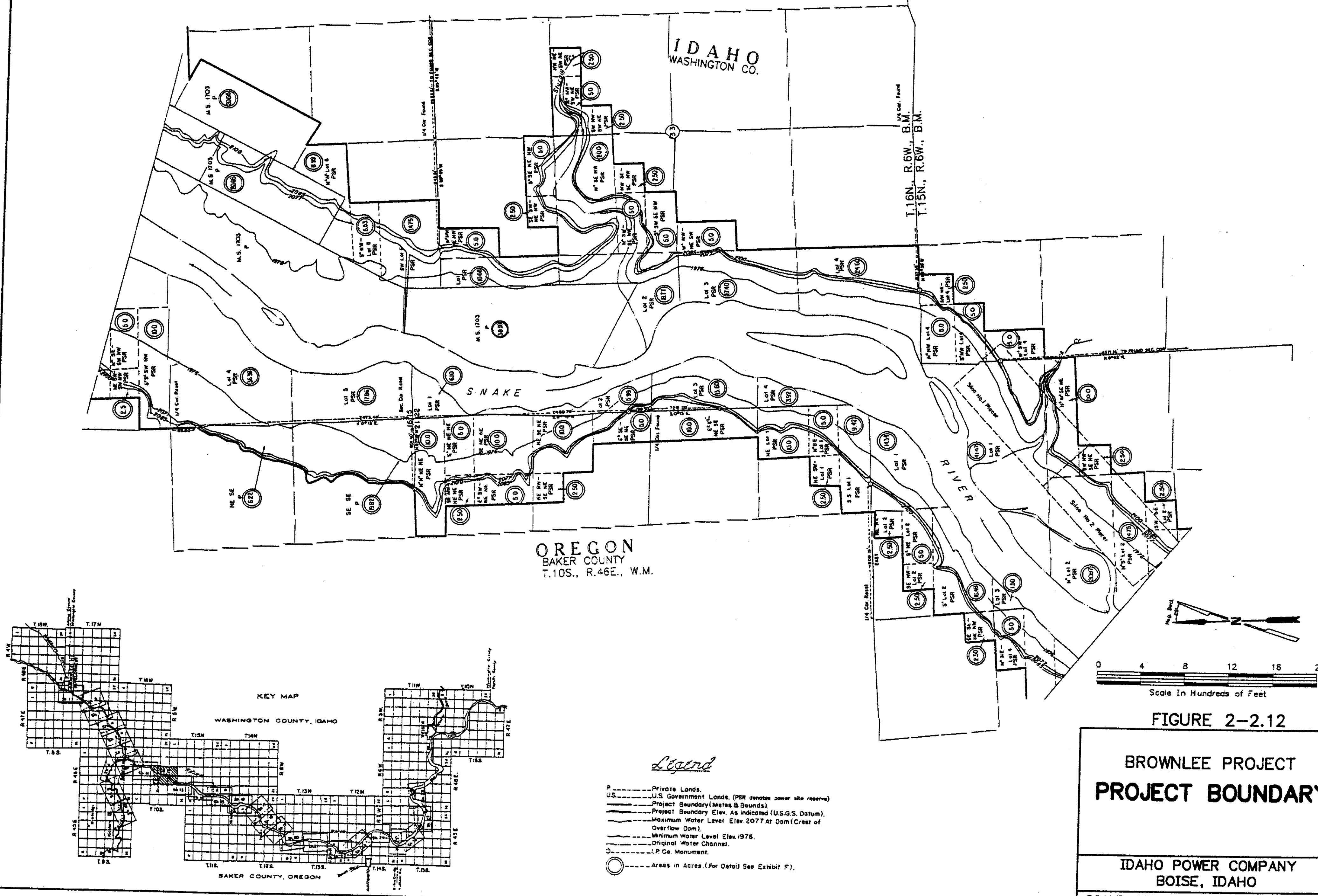

FIGURE 2-2.12

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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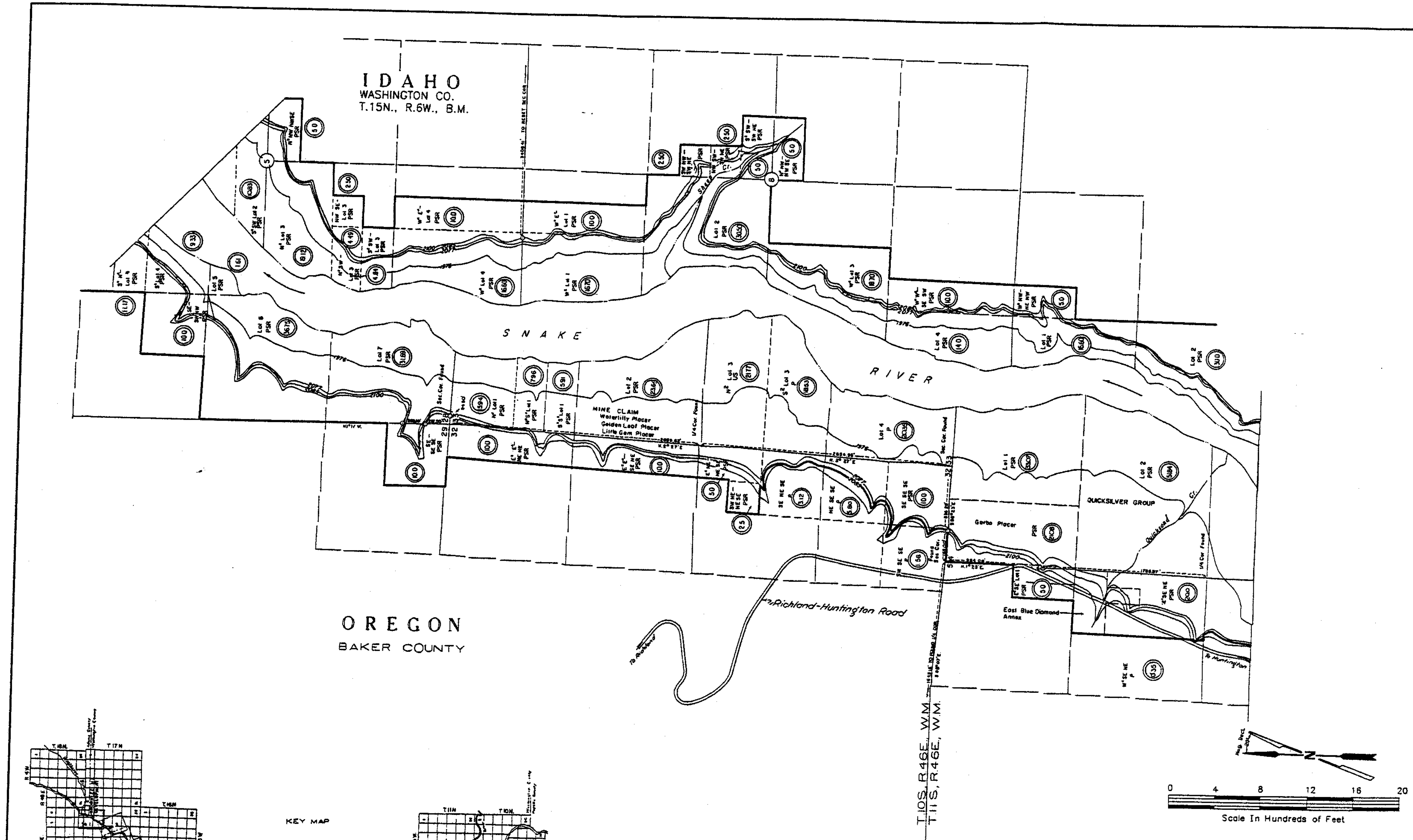

FIGURE 2-2.13

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

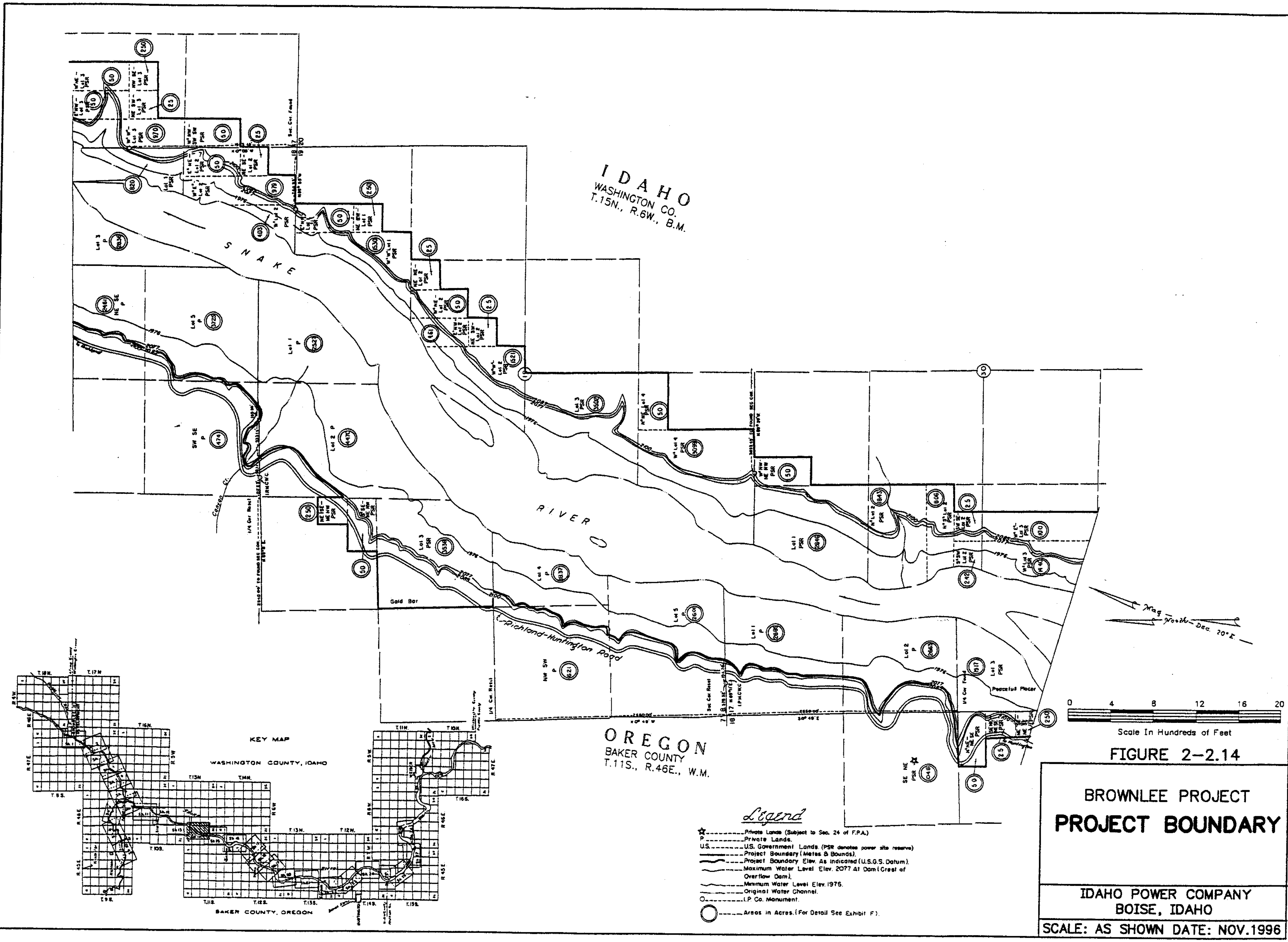

FIGURE 2-2.14

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

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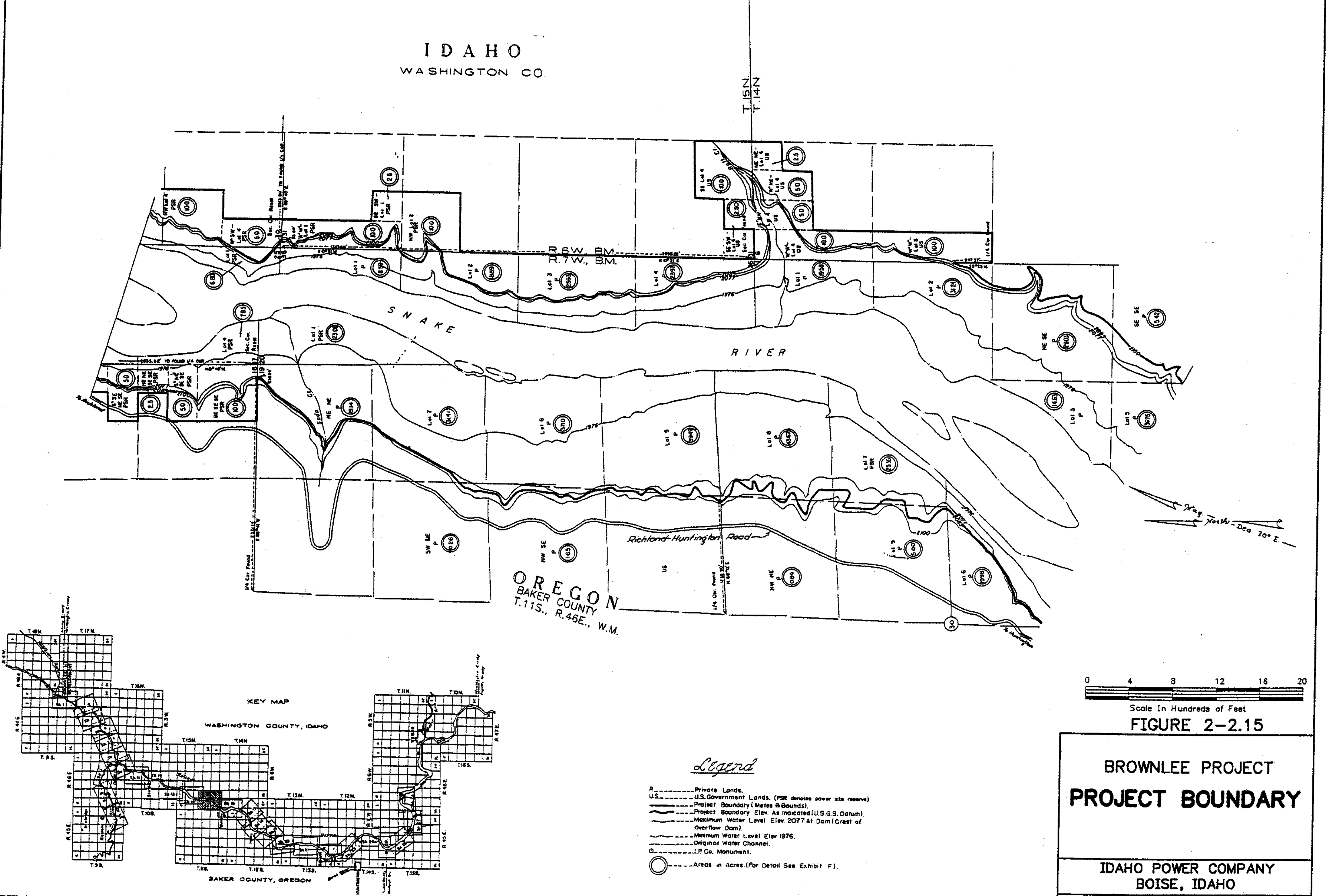

FIGURE 2-2.15

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

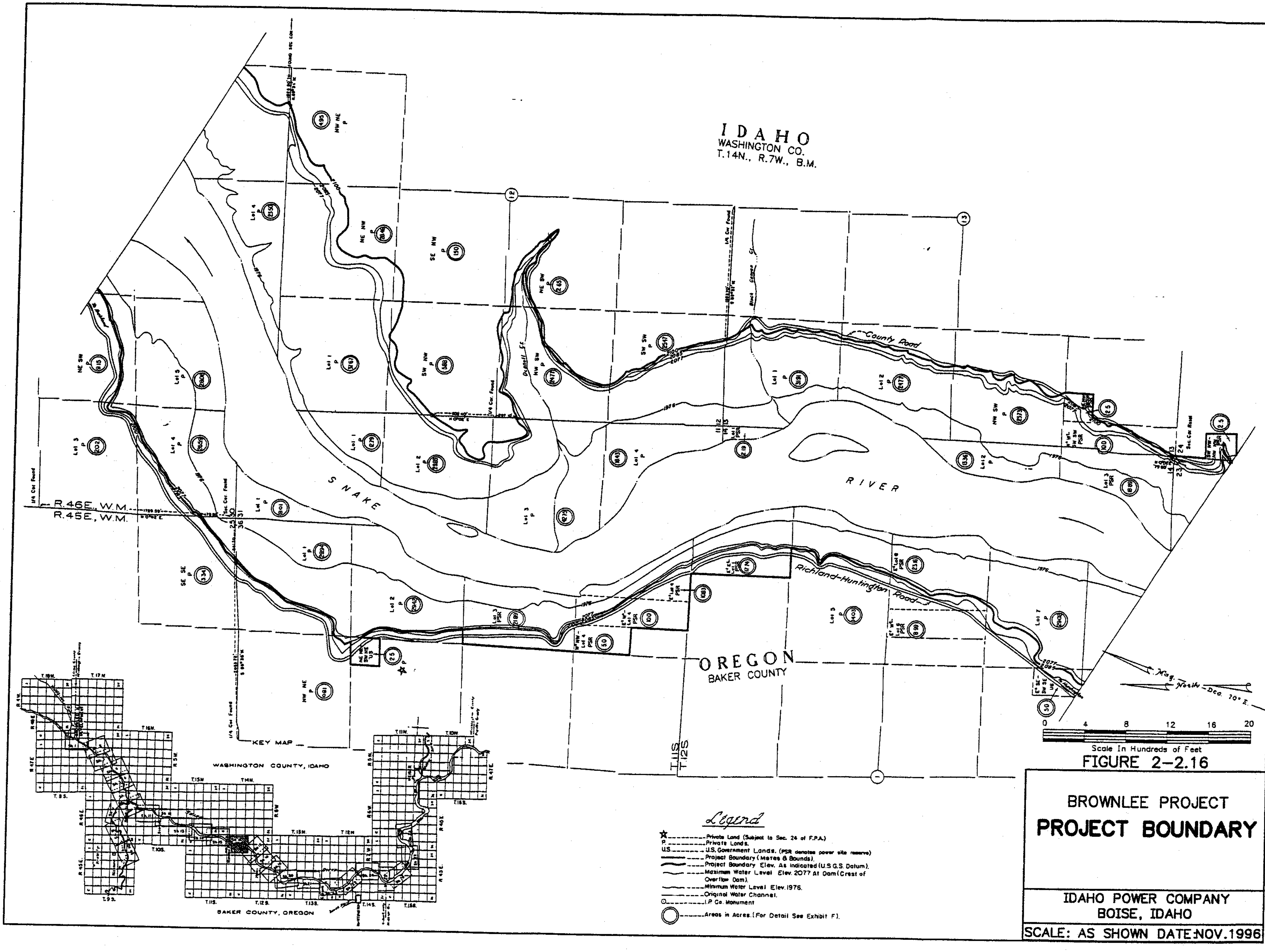

FIGURE 2–2.16

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

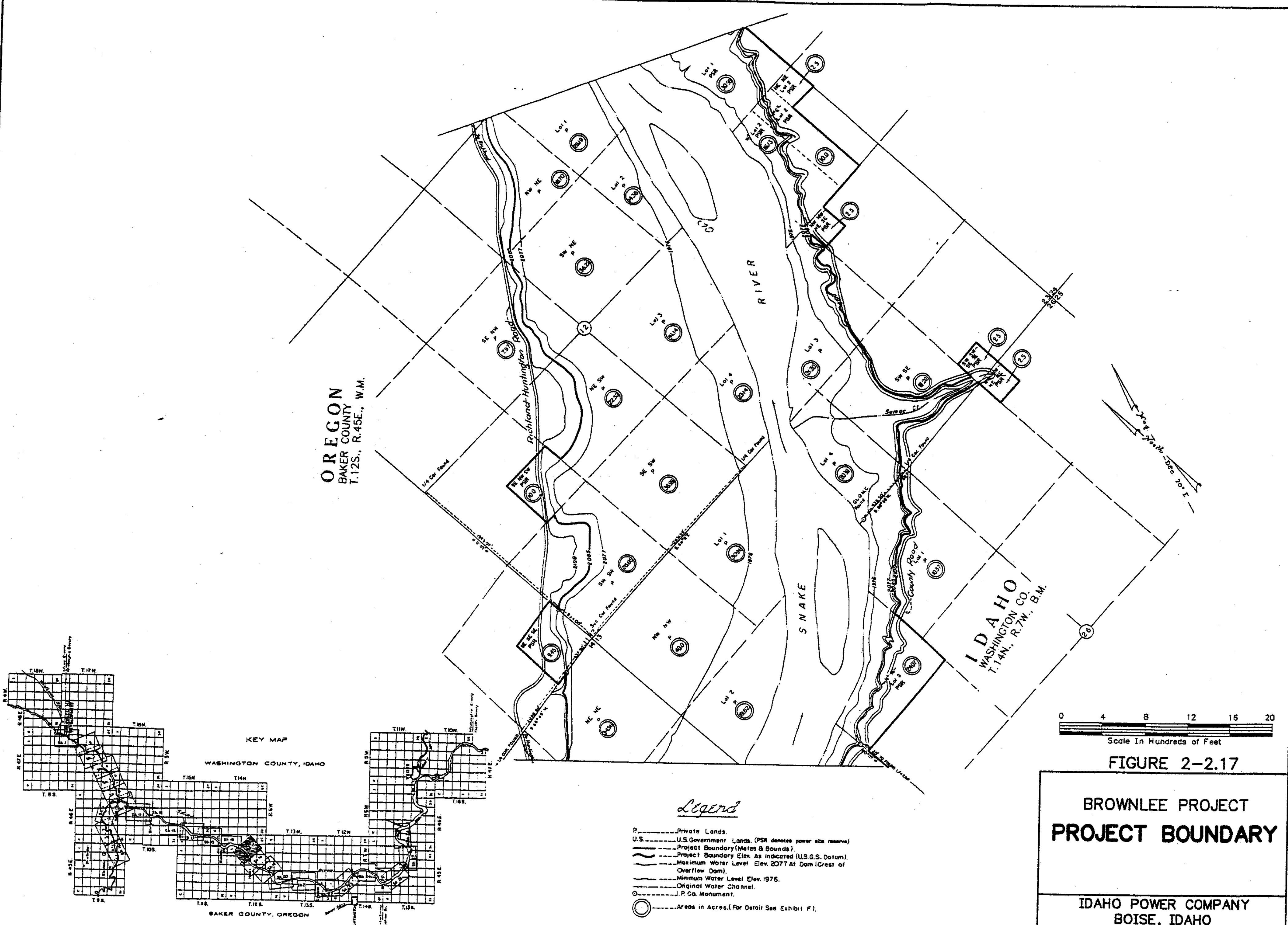

FIGURE 2-2.17

Legend

P .... Private Lands.
U.S. .... U.S. Government Lands. (PSR denotes power site reserve)
.... Project Boundary (Metes & Bounds).
.... Project Boundary Elev. As Indicated (U.S.G.S. Datum).
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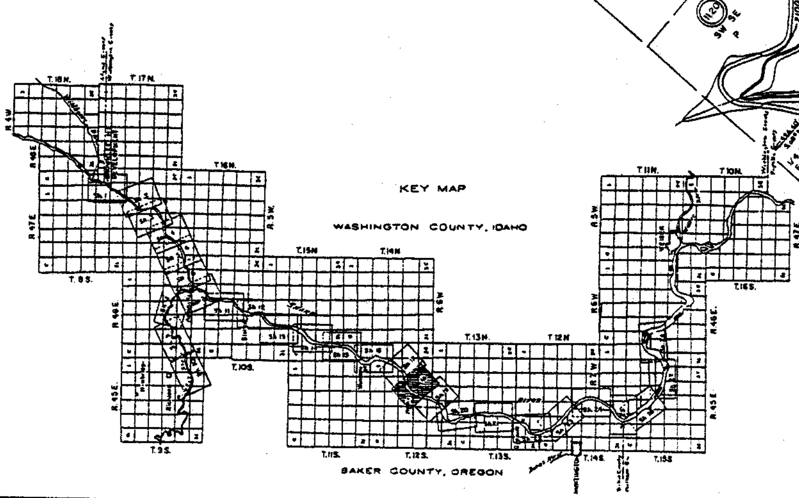
.... Original Water Channel.
.... I.P.Co. Monument.
.... Areas in Acres. (For Detail See Exhibit F).

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996



Legend

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- Minimum Water Level Elev. 1976.
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- I.P. Co. Monument.
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FIGURE 2-2.18

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

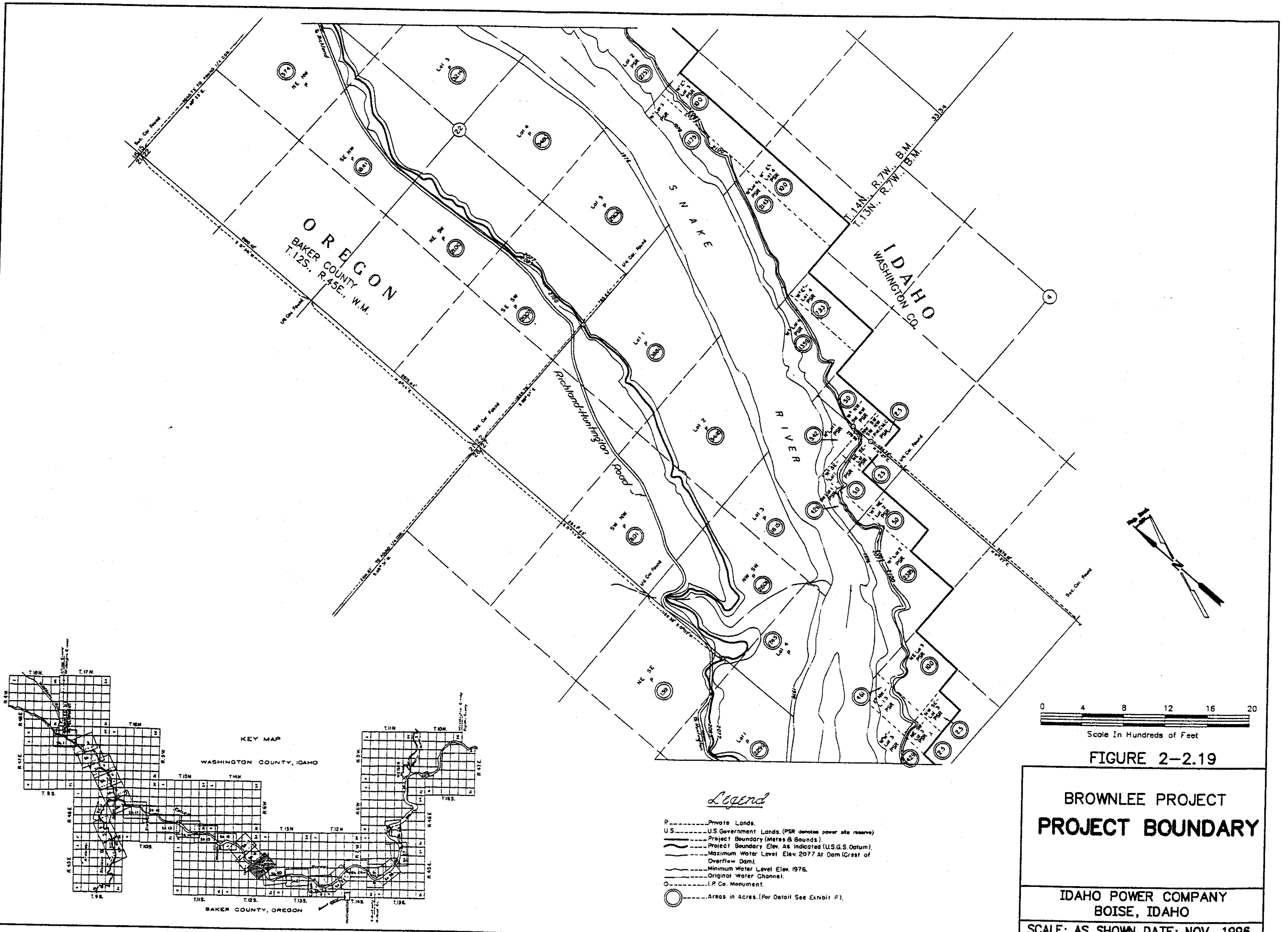


FIGURE 2-2.19

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

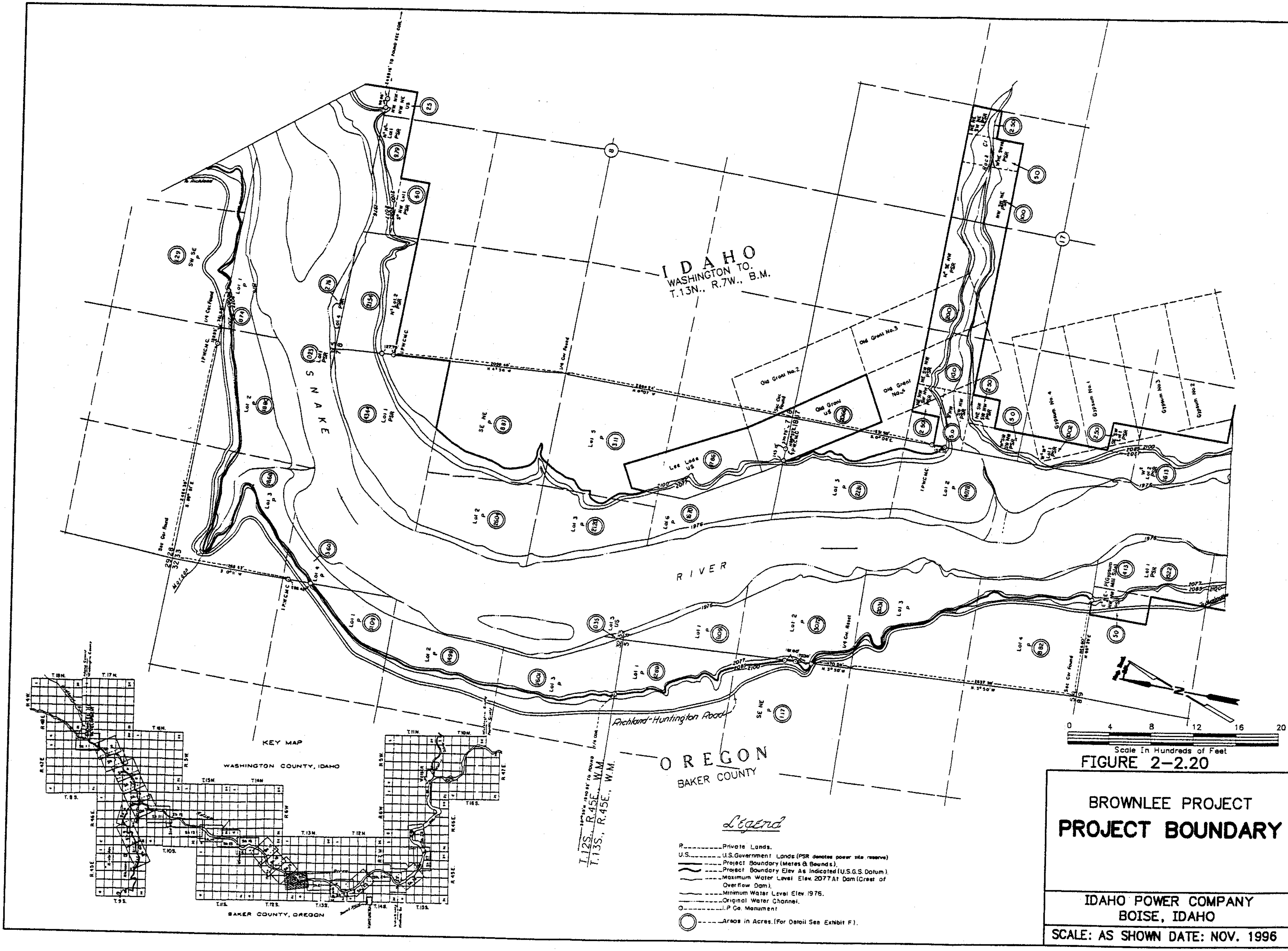


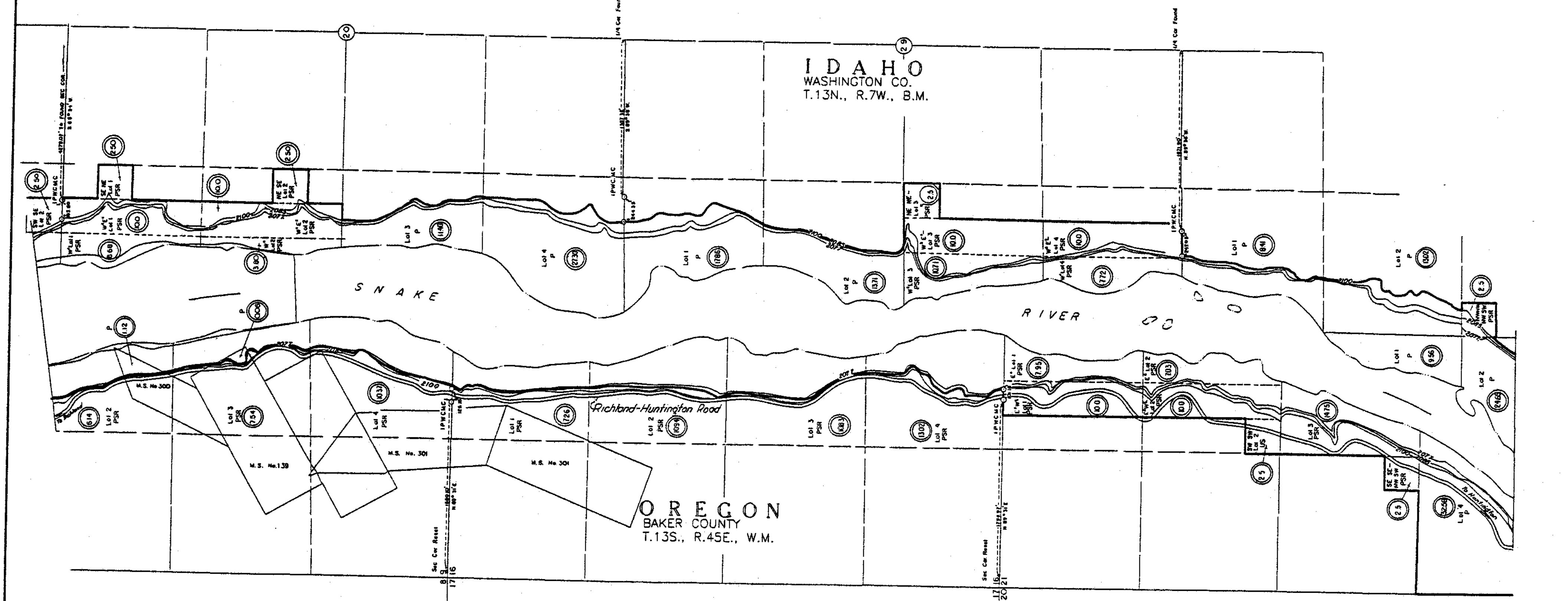
FIGURE 2–2.20

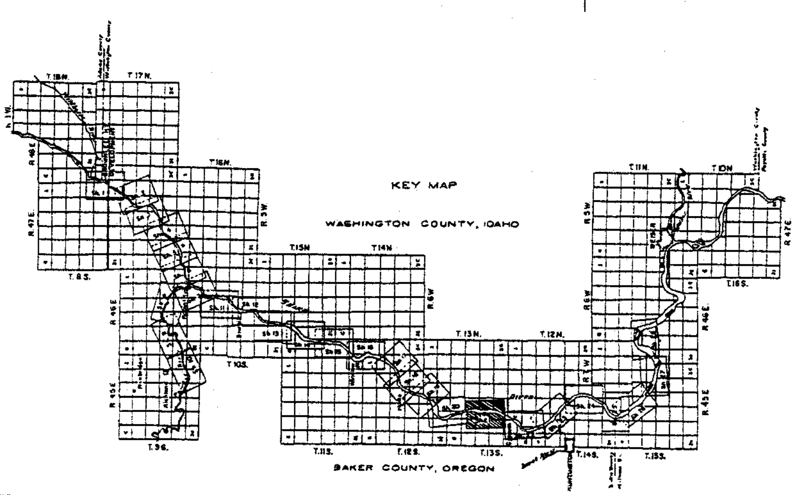
BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996





Legend

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- Minimum Water Level Elev. 1976.
- Original Water Channel.
- I.P.Co. Monument.
- Areas in Acres. (For Detail See Exhibit F).

0 4 8 12 16 20

Scale In Hundreds of Feet

FIGURE 2-2.21

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

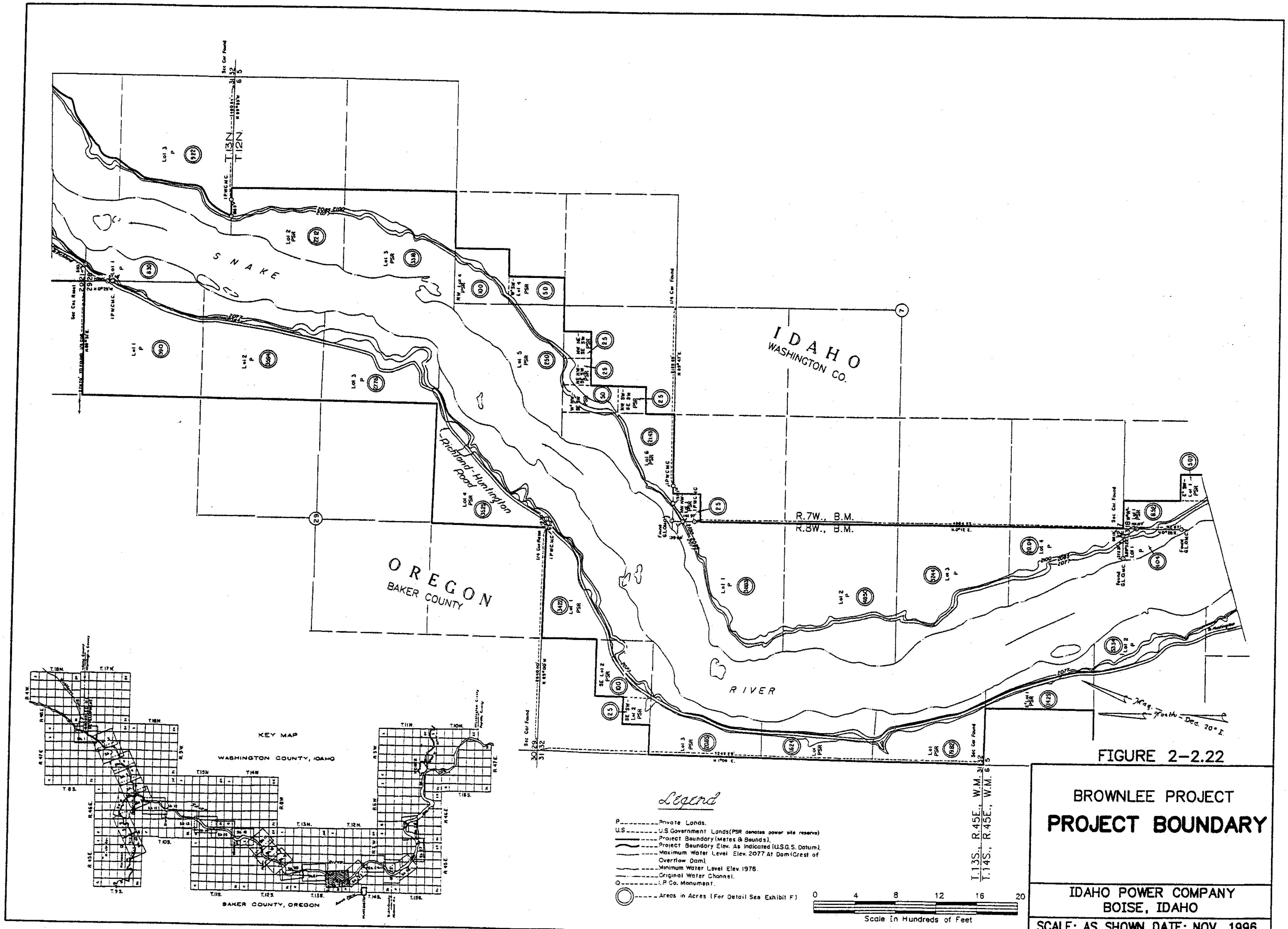


FIGURE 2-2.22

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

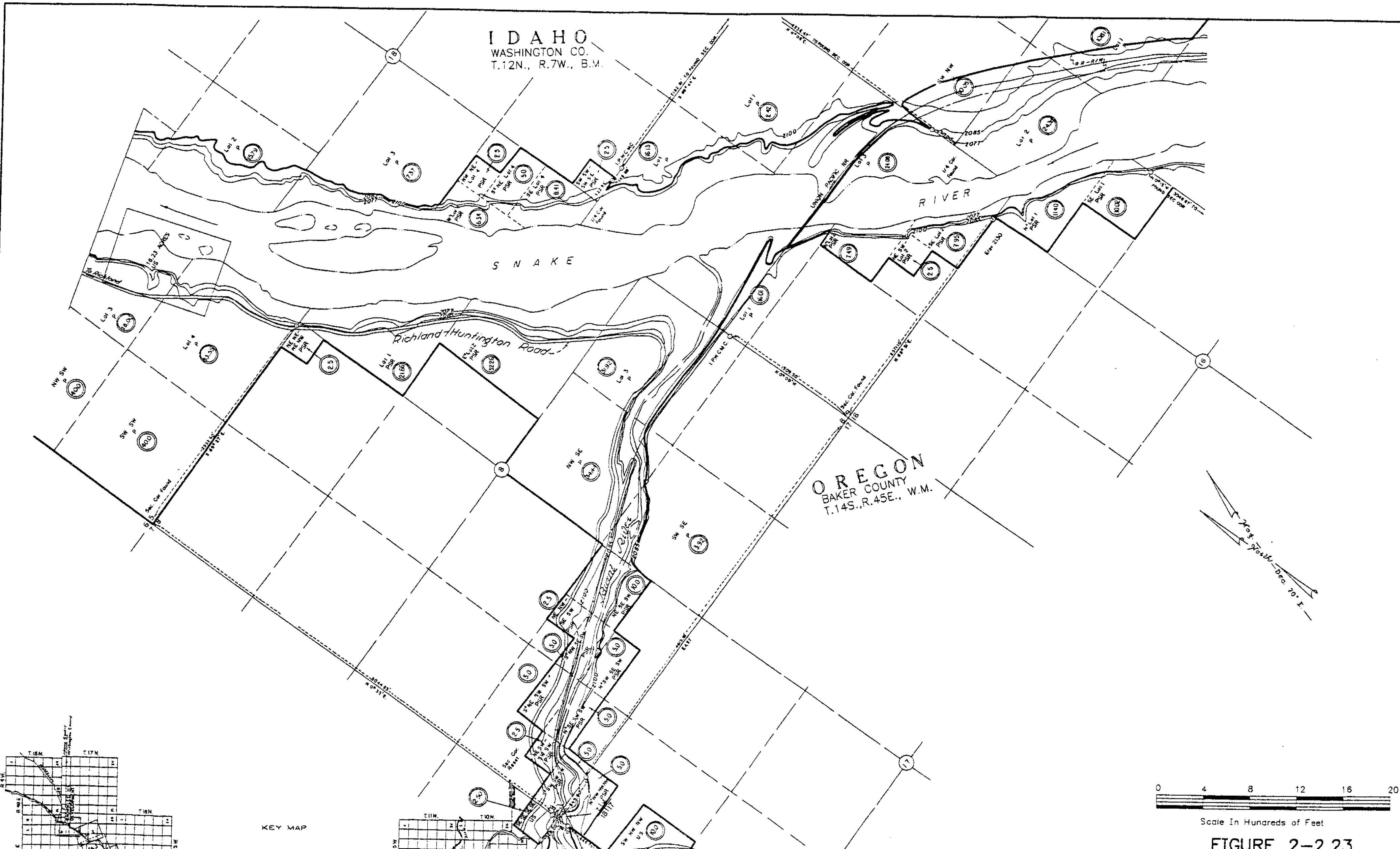


FIGURE 2-2.23

BROWNLEE PROJECT
PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

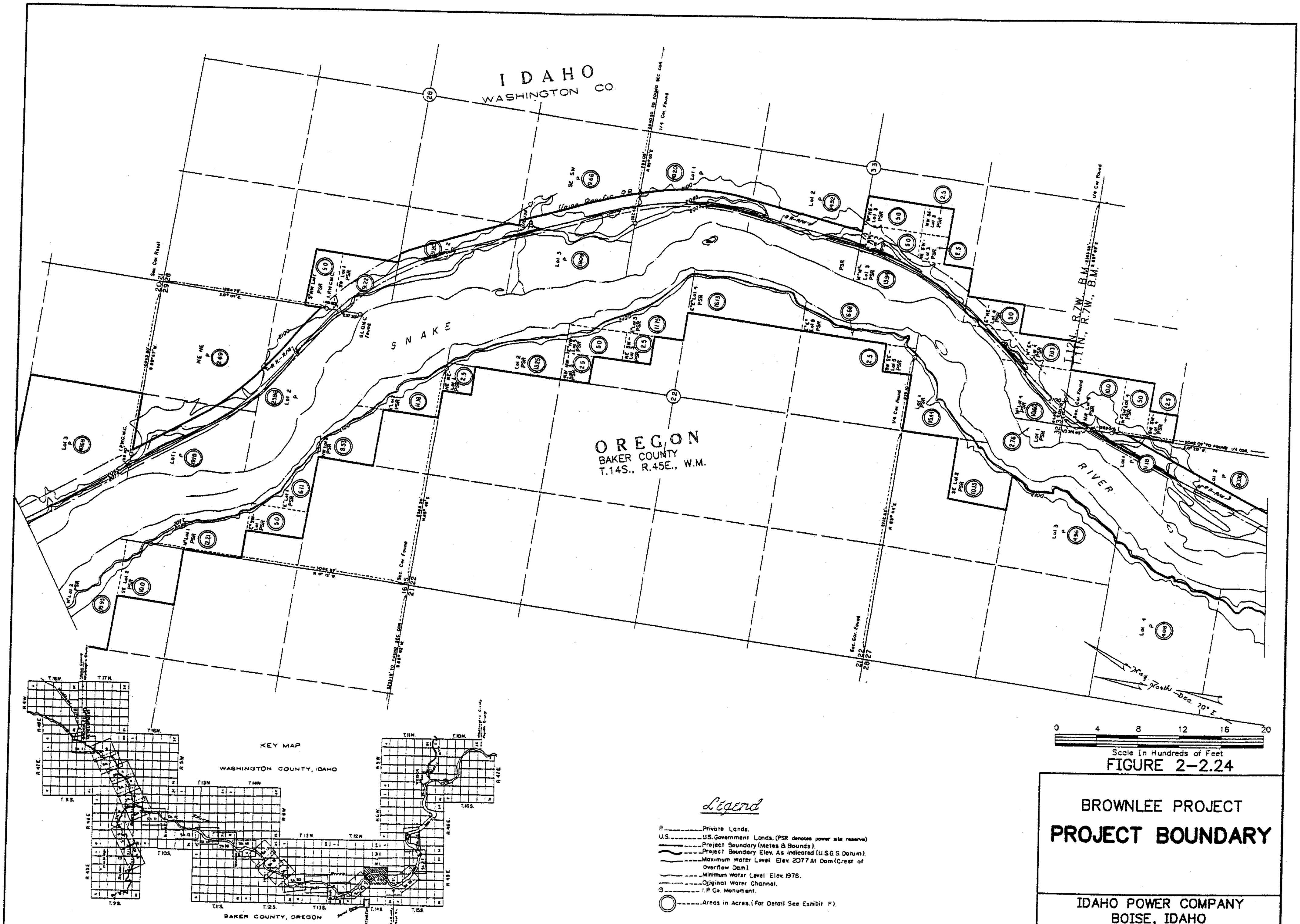


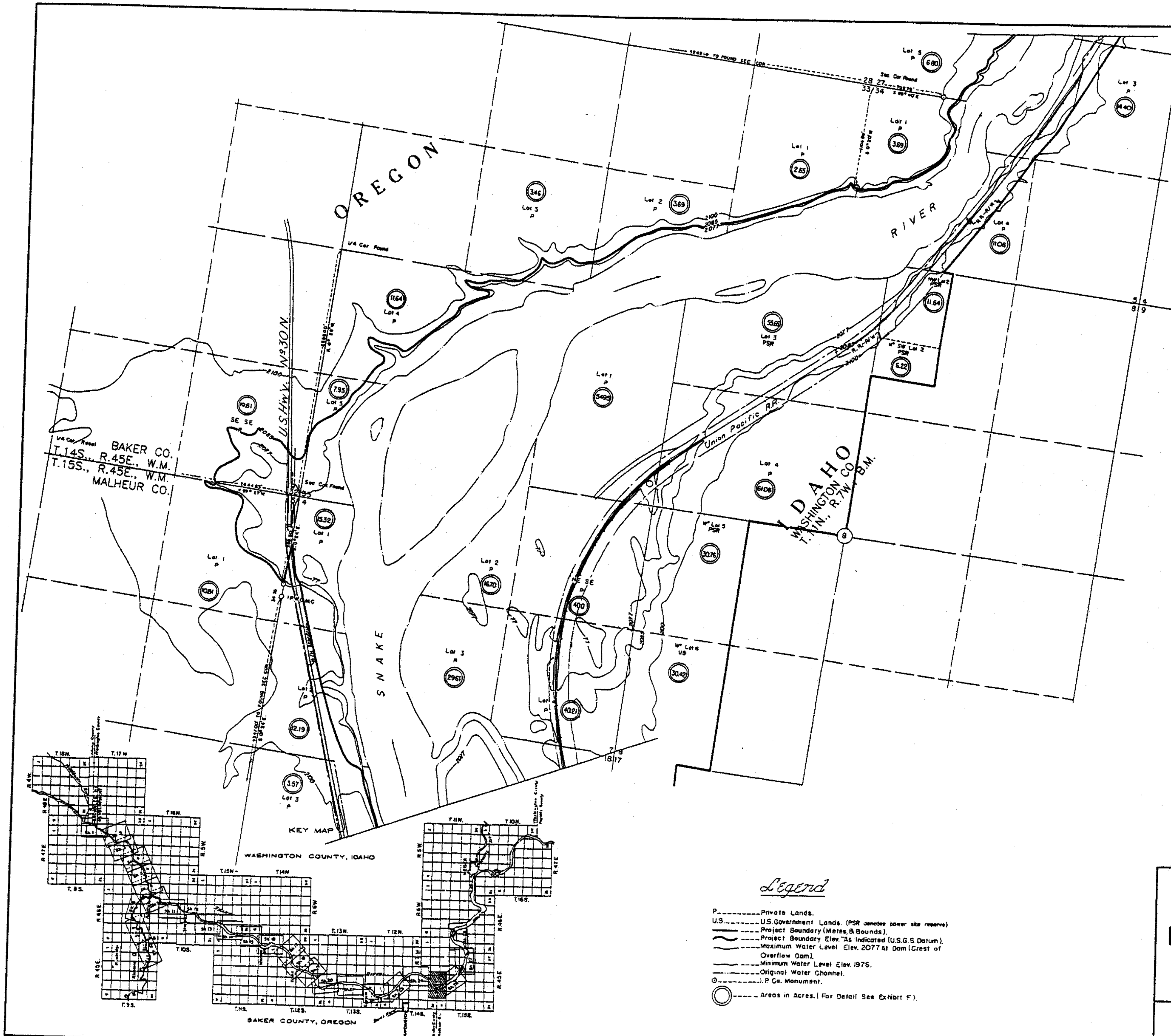
FIGURE 2-2.24

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



Legend

P .... Private Lands.
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.... Project Boundary Elev. As Indicated (U.S.G.S. Datum).
.... Maximum Water Level Elev. 2077 At Dam (Crest of Overflow Dam).
.... Minimum Water Level Elev. 1976.
.... Original Water Channel.
.... I.P. Co. Monument.
.... Areas in Acres. (For Detail See Exhibit F).

0 4 8 12 16 20

Scale In Hundreds of Feet

FIGURE 2-2.25

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

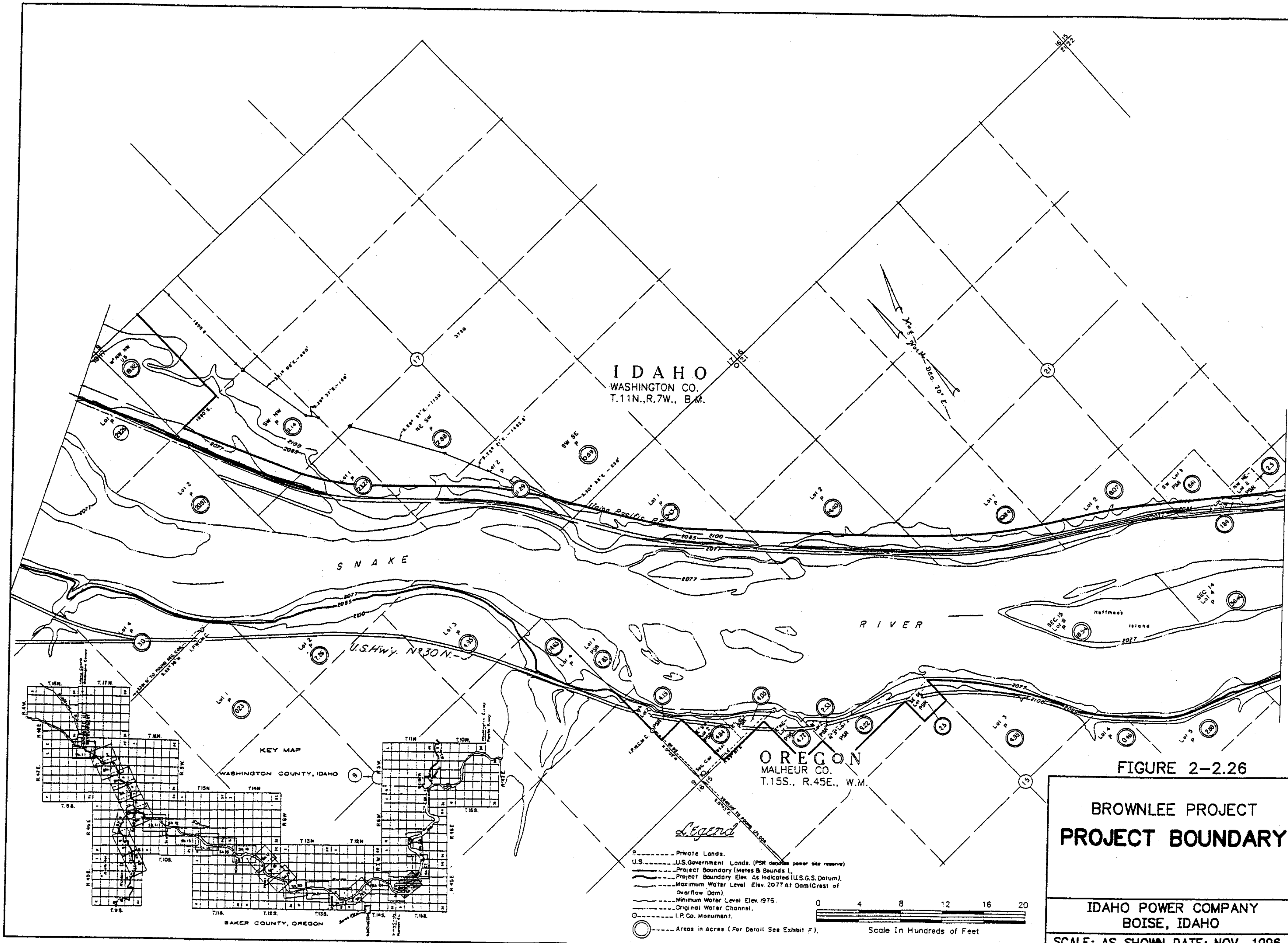


FIGURE 2–2.26

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

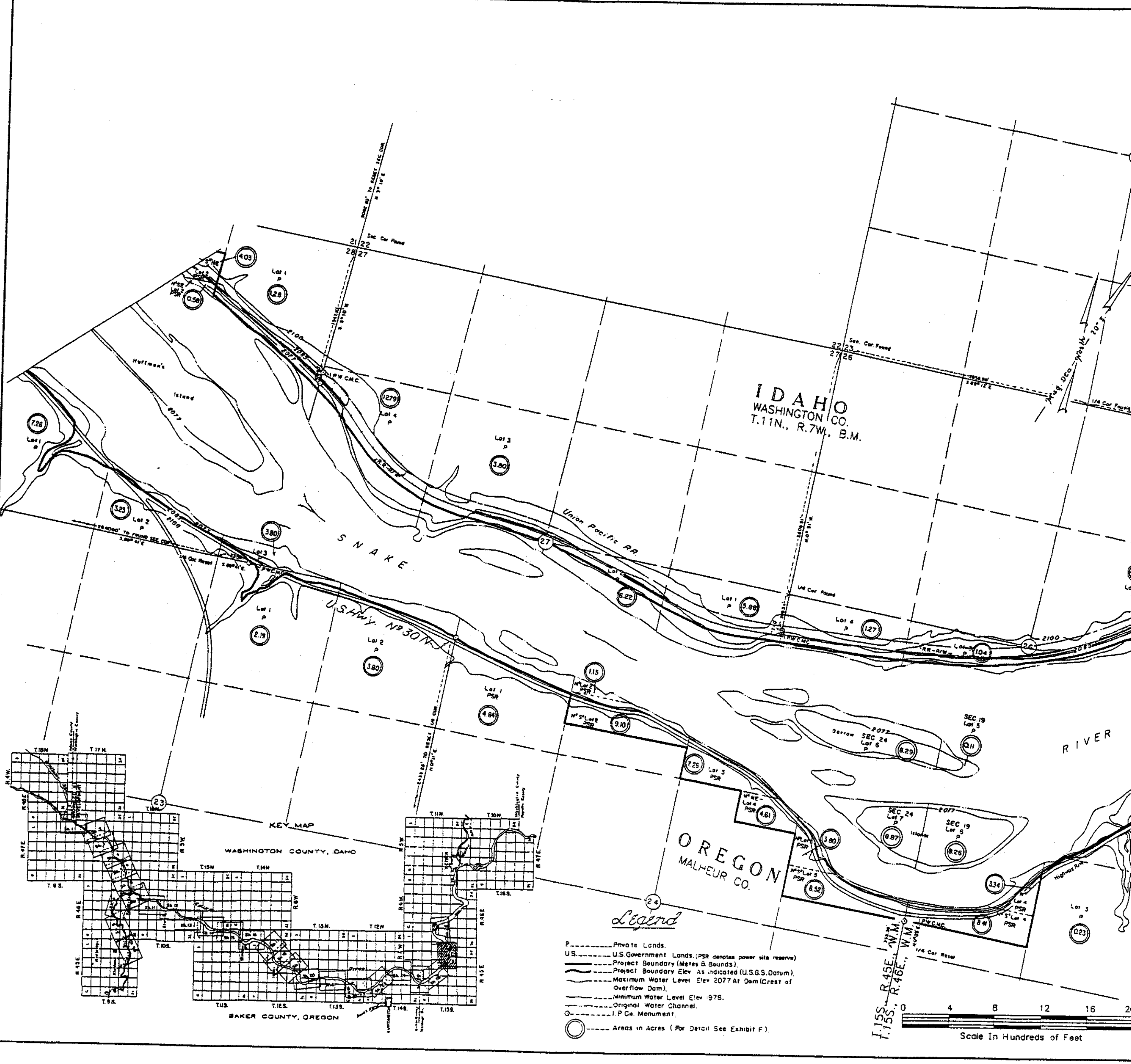


FIGURE 2-2.27

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

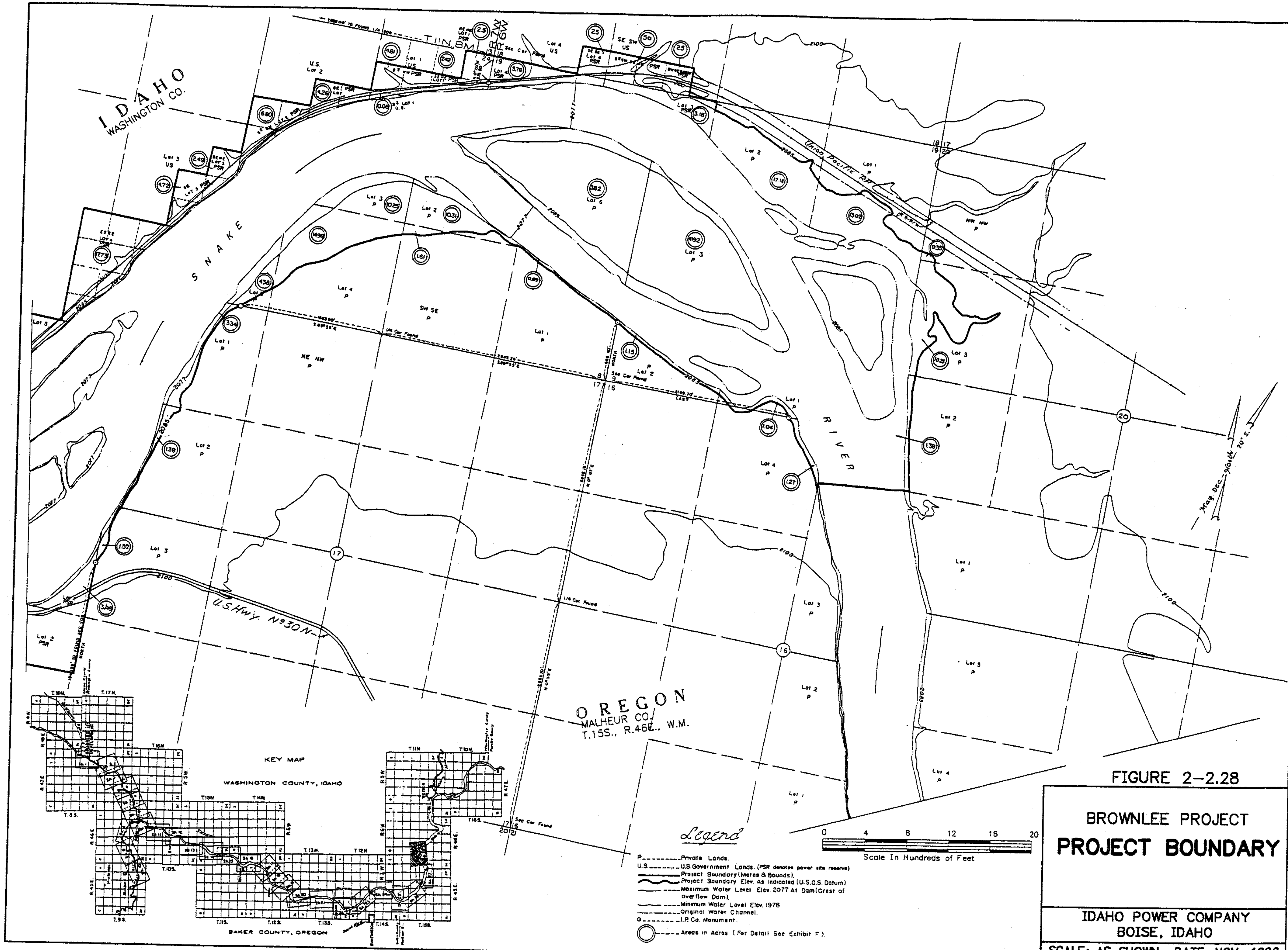


FIGURE 2-2.28

BROWNLEE PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

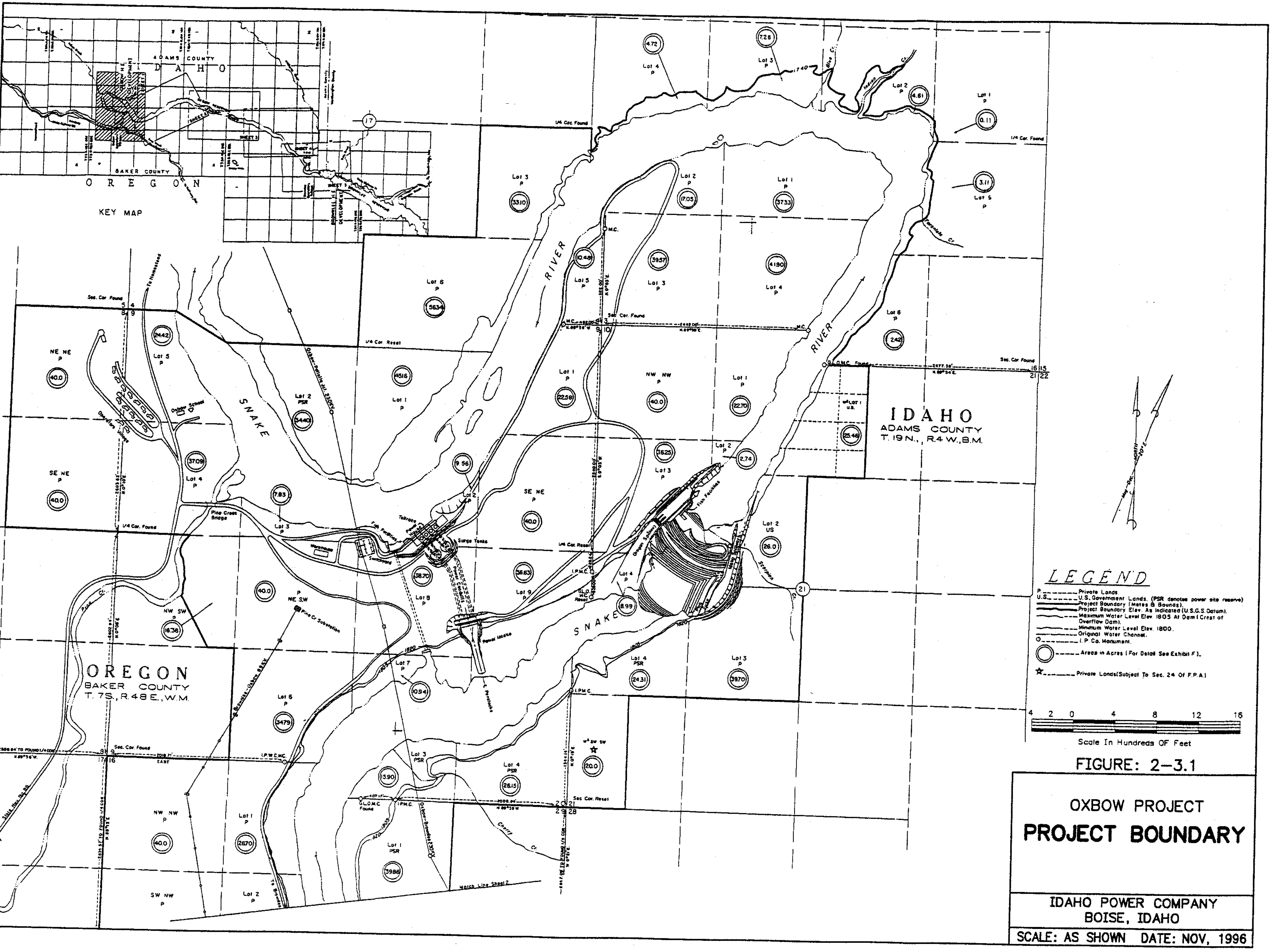


FIGURE: 2-3.1

OXBOW PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV, 1996

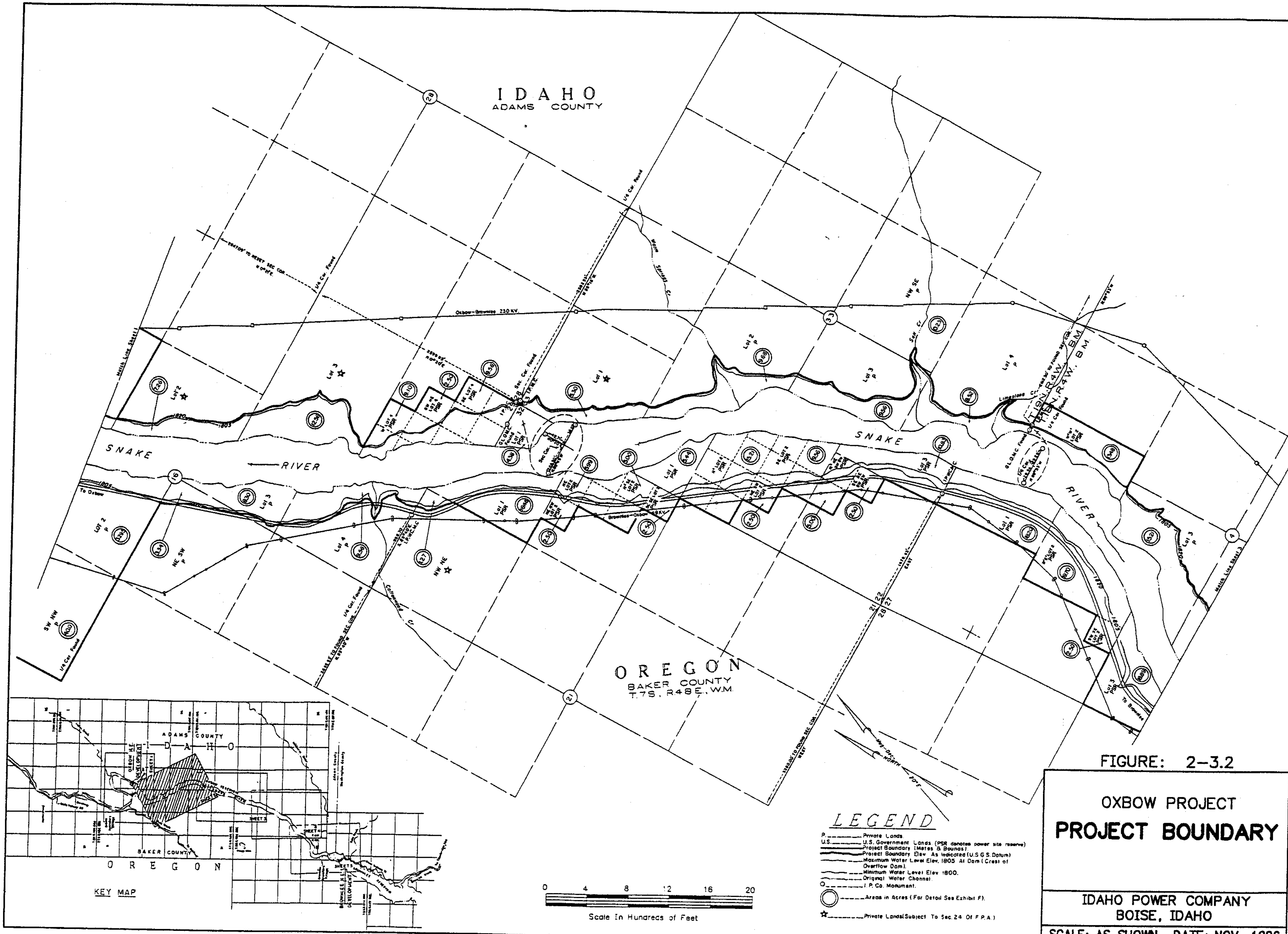


FIGURE: 2-3.2

OXBOW PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

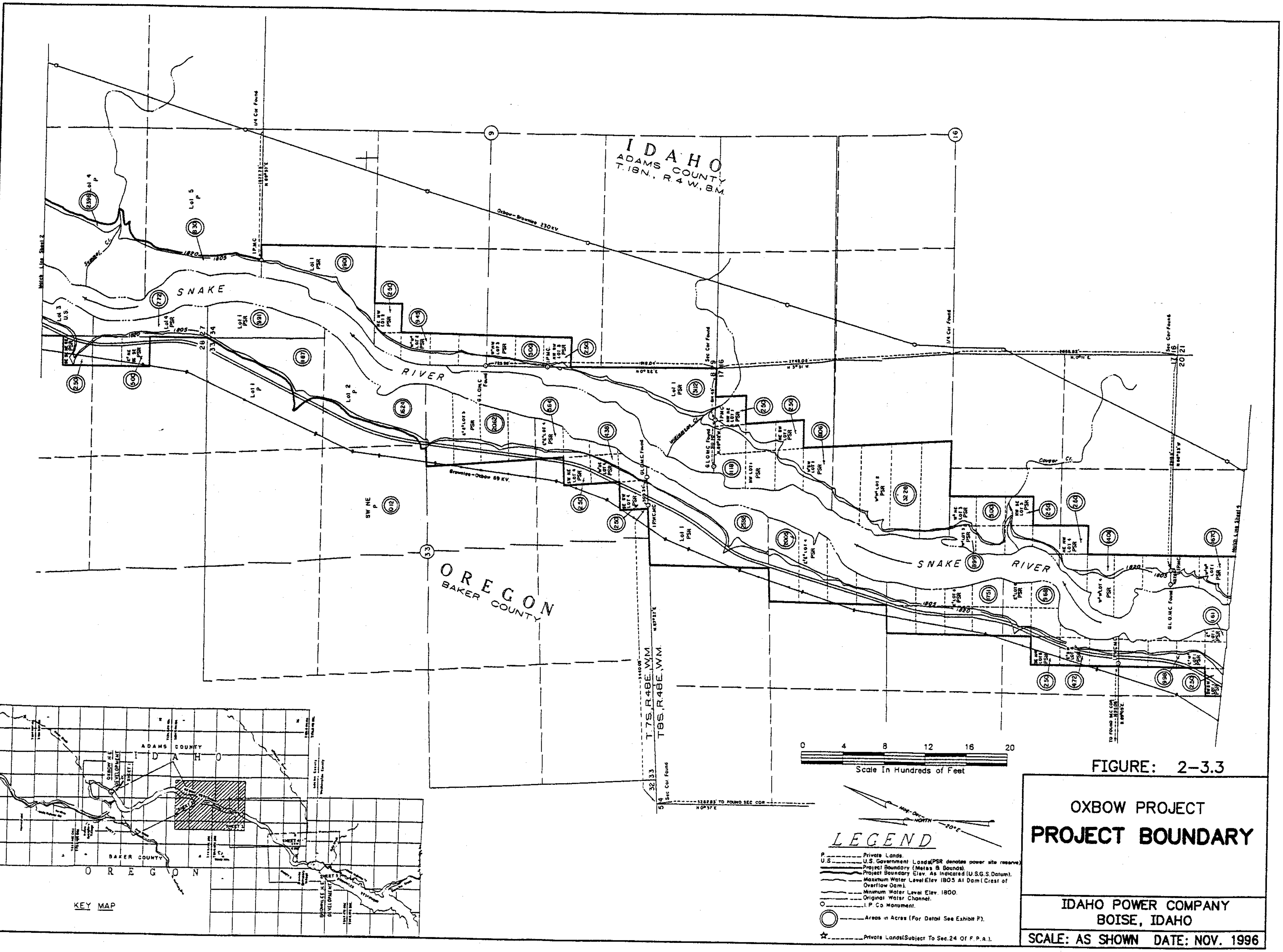


FIGURE: 2-3.3

OXBOW PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

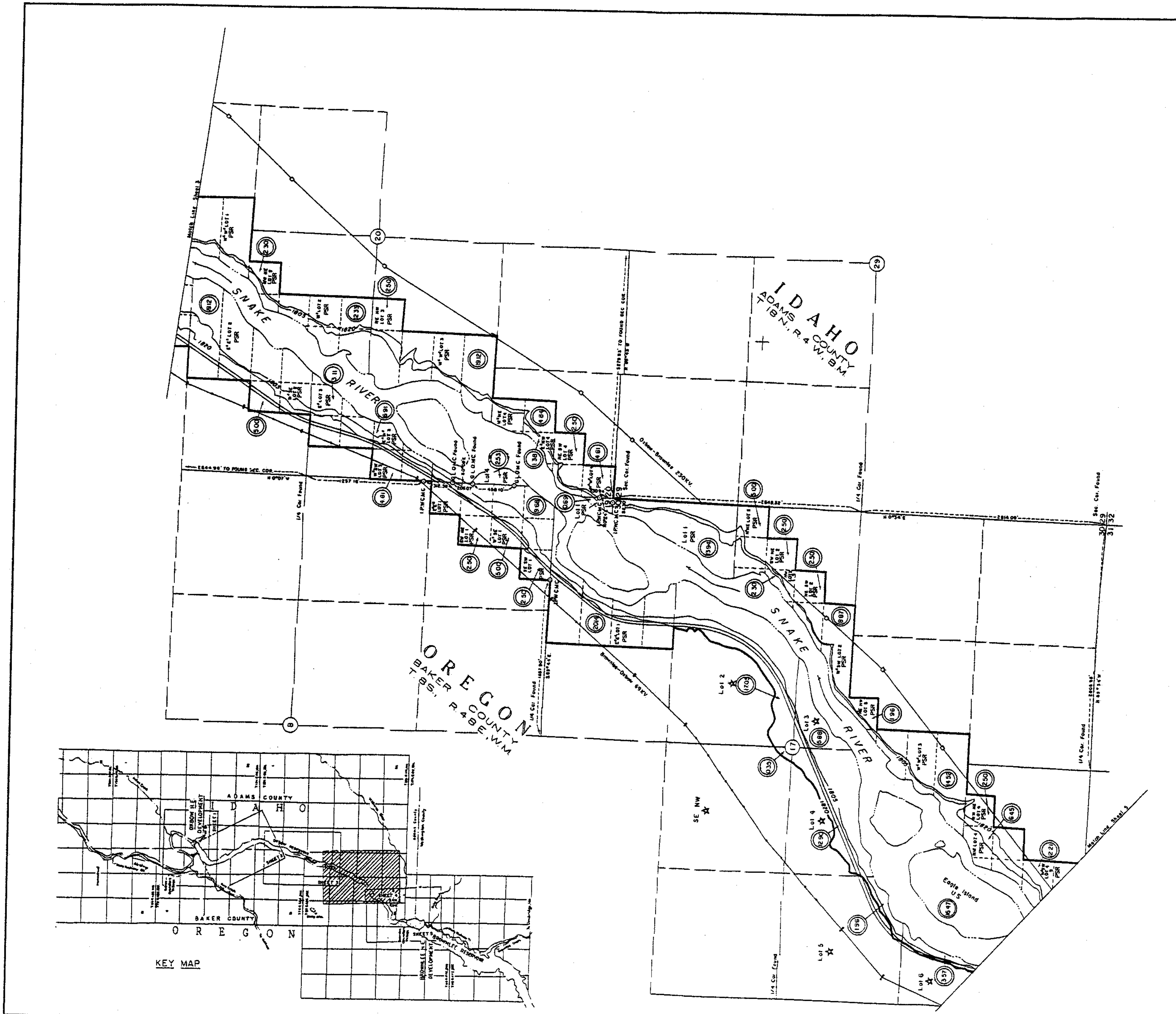


FIGURE: 2–3.4

OXBOW PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

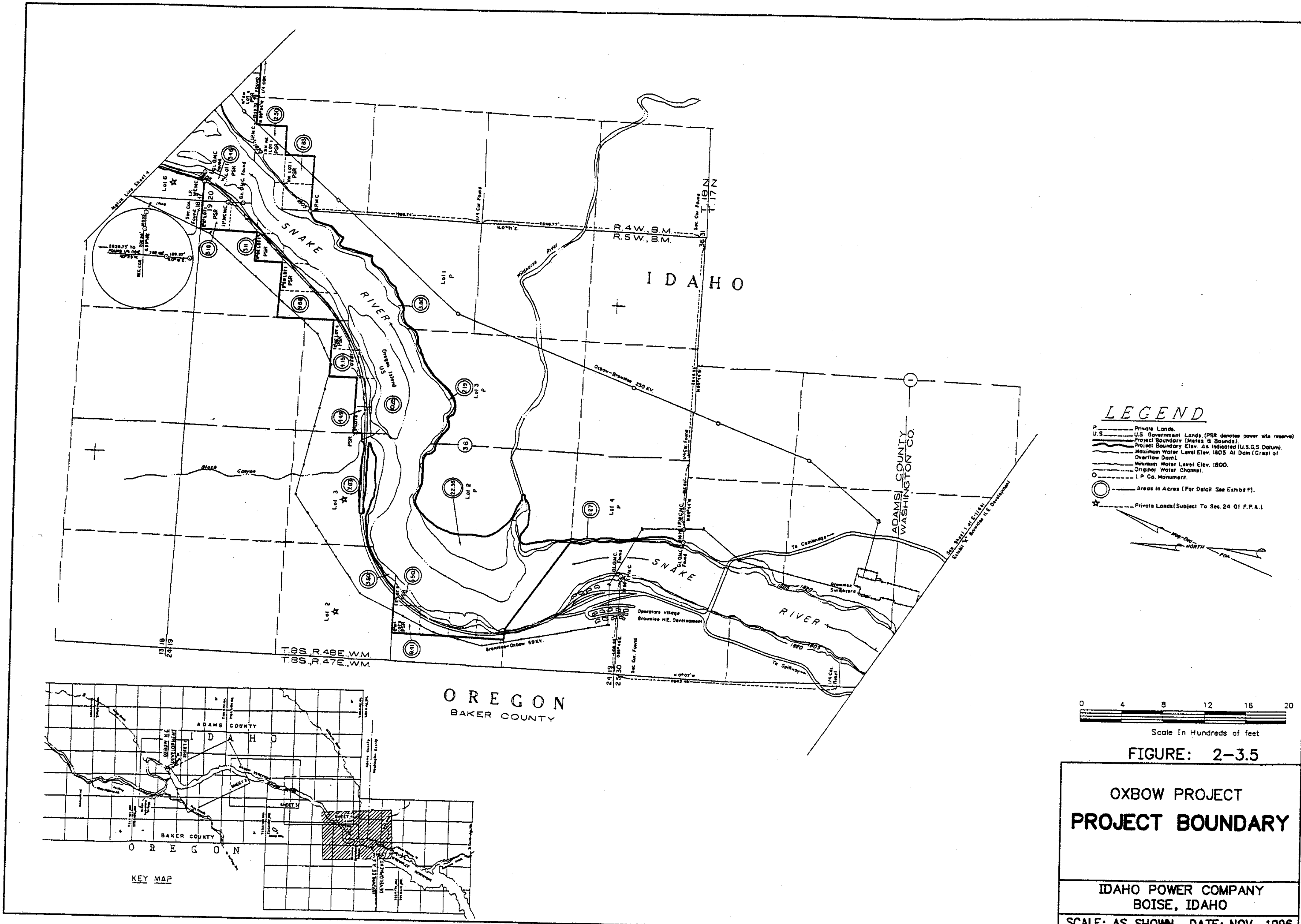


FIGURE: 2–3.5

OXBOW PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

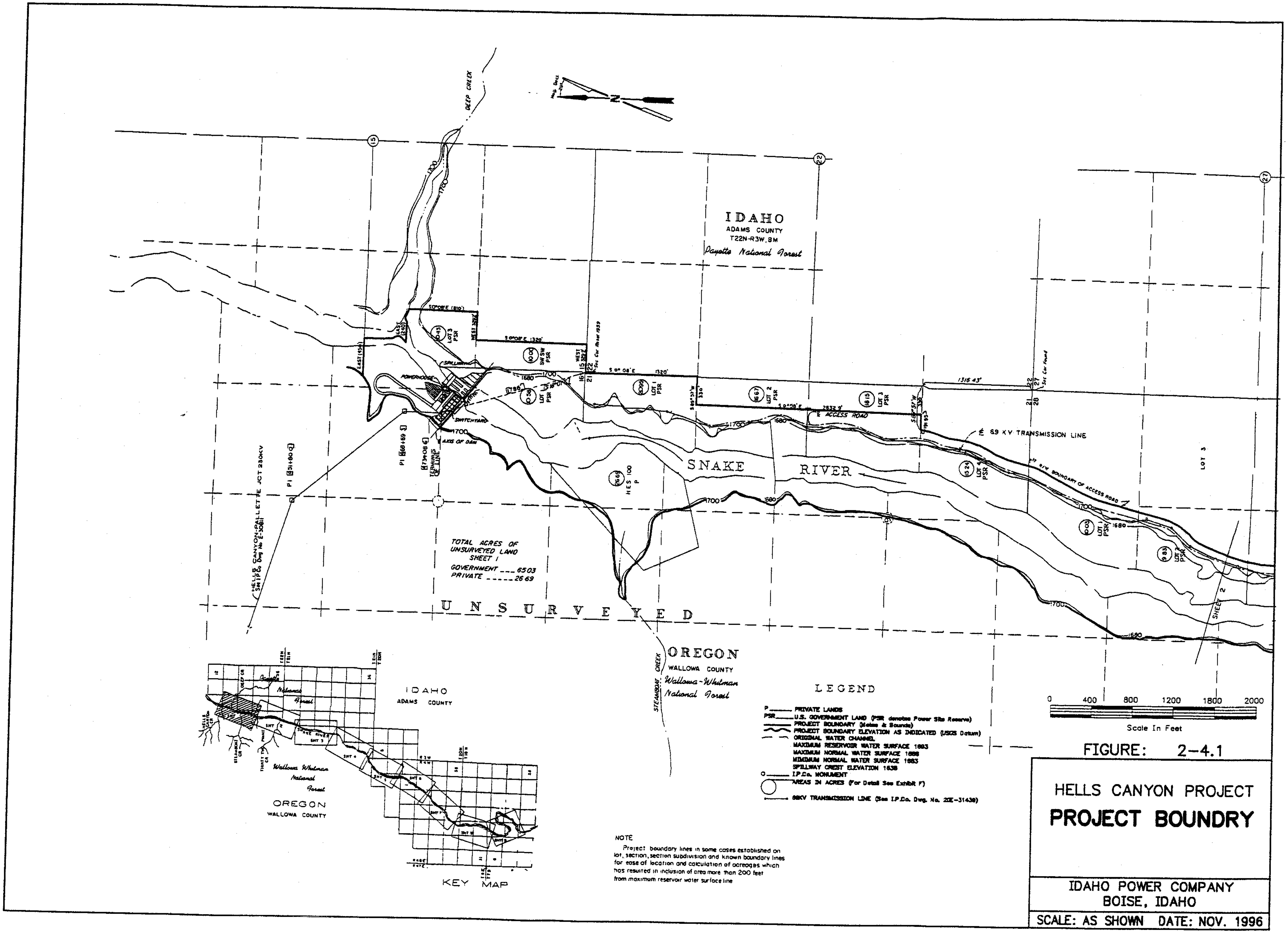


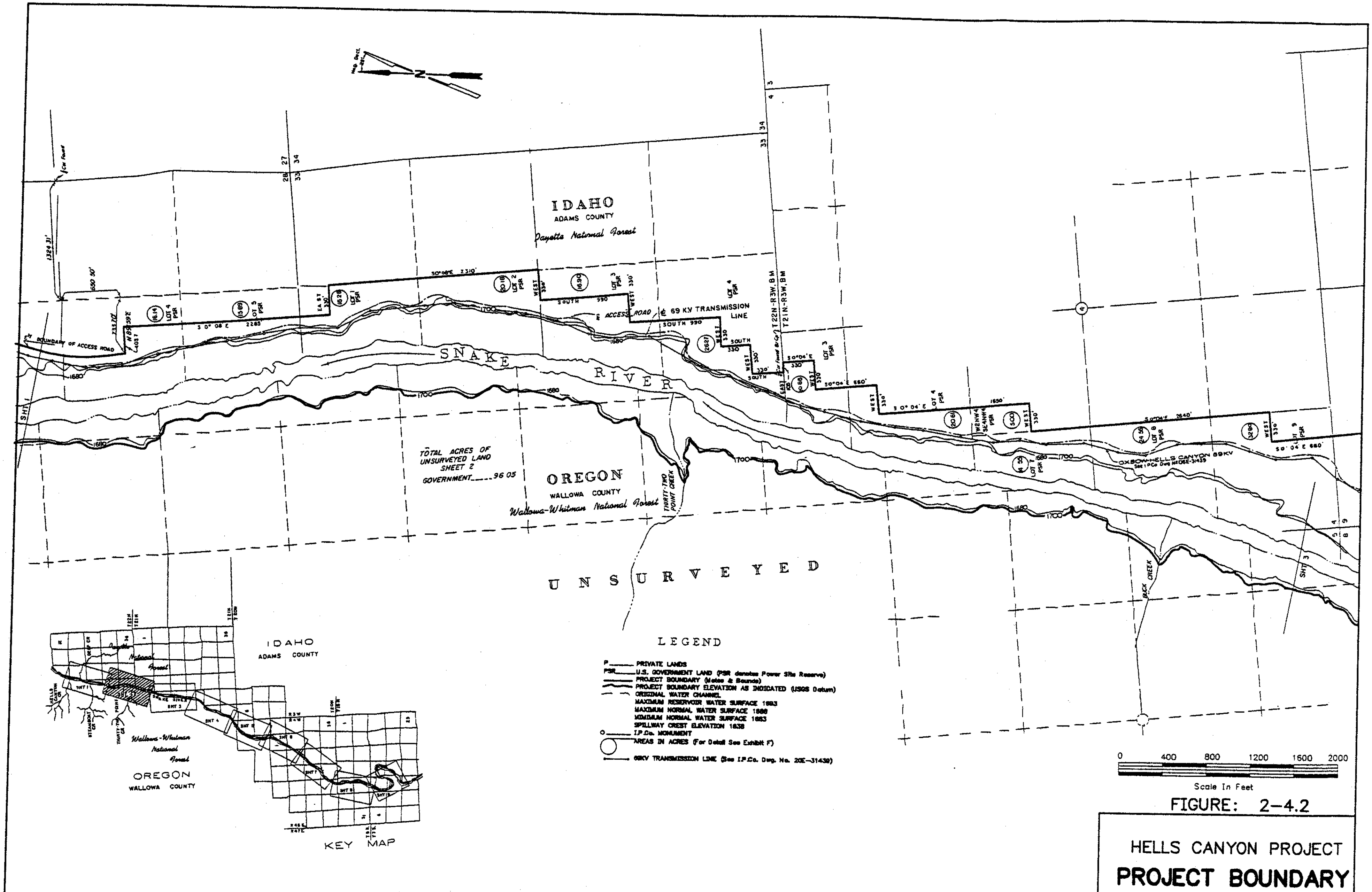
FIGURE: 2-4.1

HELLS CANYON PROJECT

PROJECT BOUNDRY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



NOTE:
Project boundary lines in some cases established on lot, section, section subdivision and known boundary lines for ease of location and calculation of acreages which has resulted in inclusion of area more than 200 feet from maximum reservoir water surface line.

FIGURE: 2-4.2

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

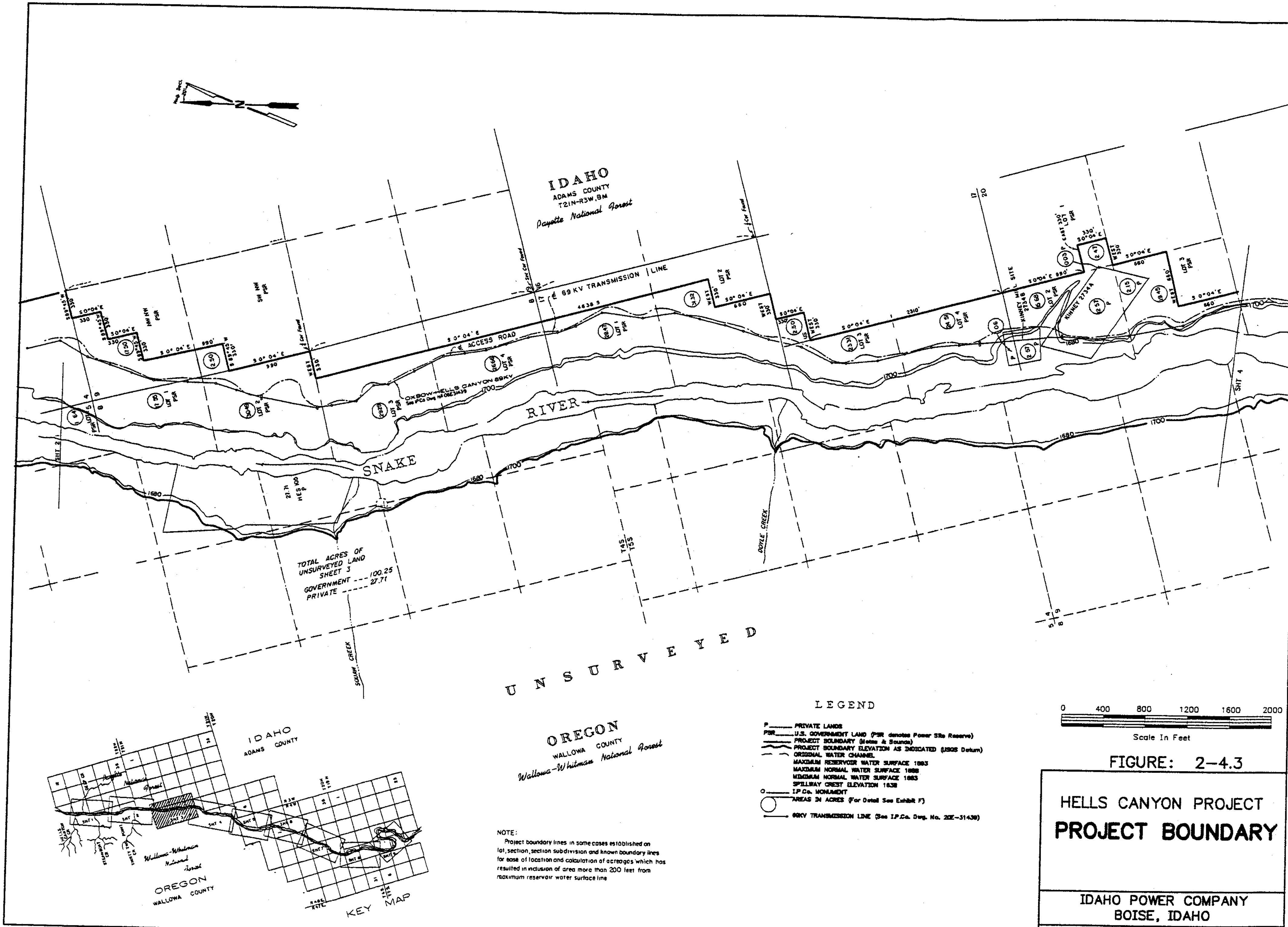


FIGURE: 2-4.3

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

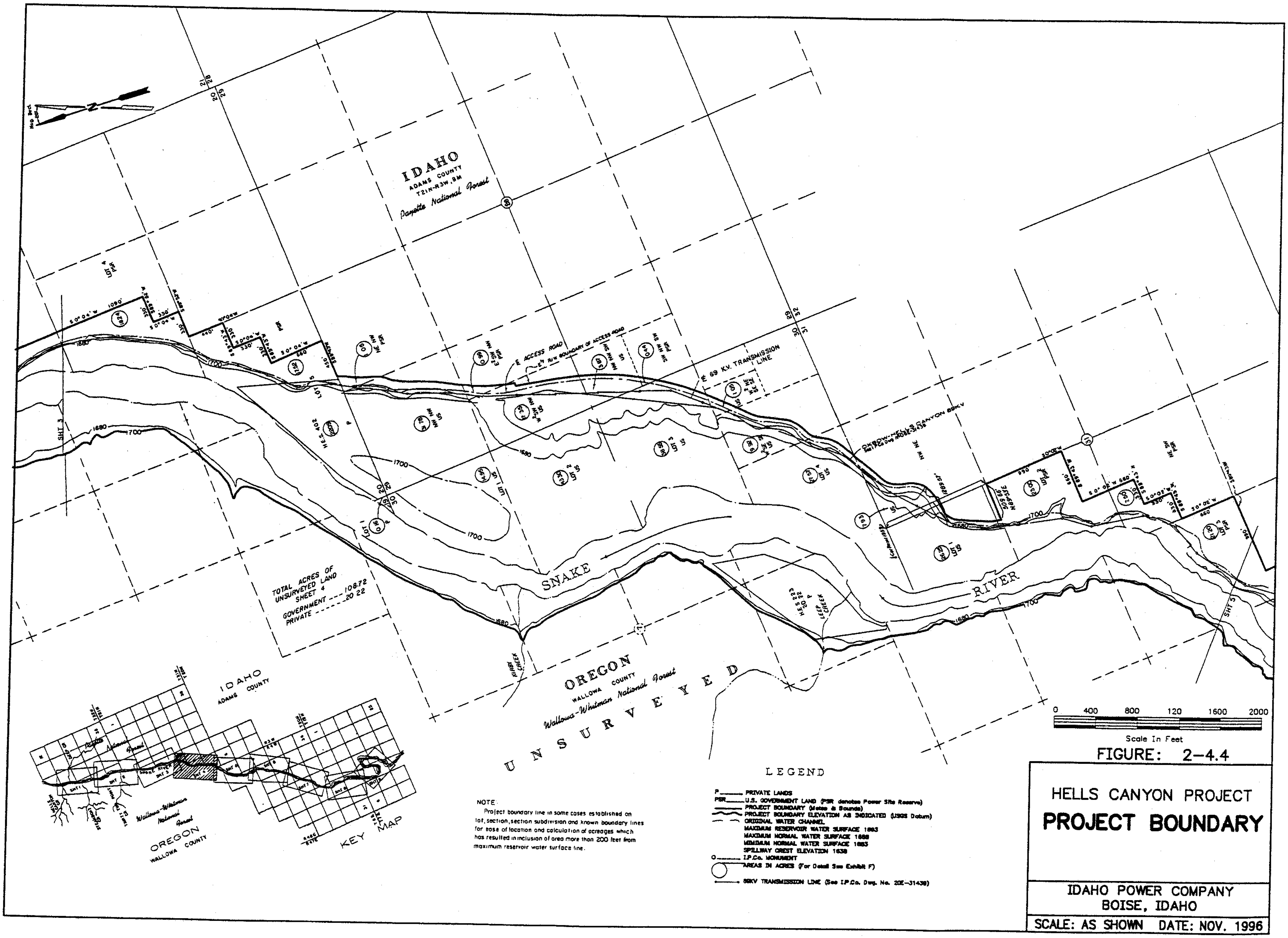


FIGURE: 2-4.4

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

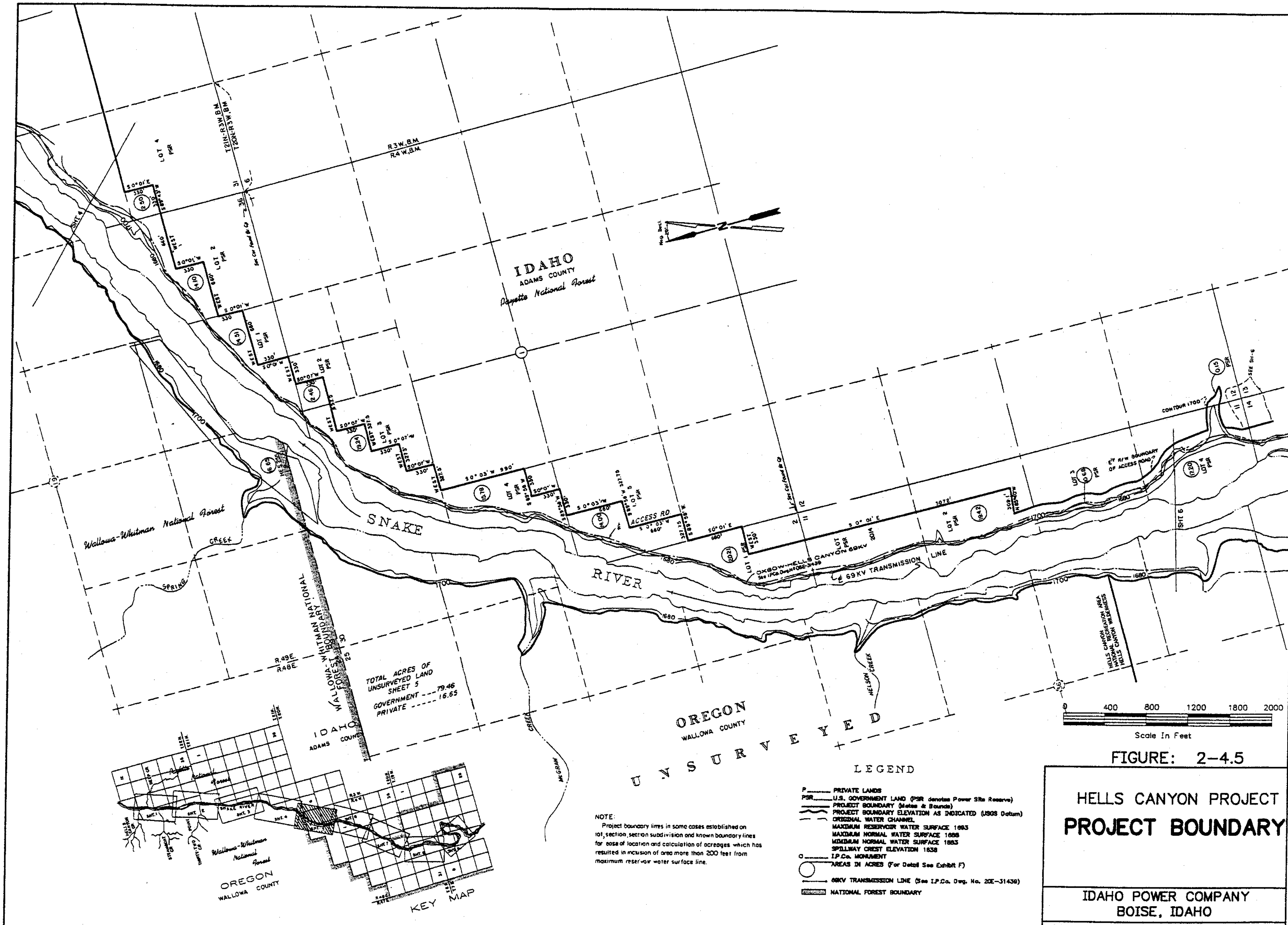


FIGURE: 2-4.5

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

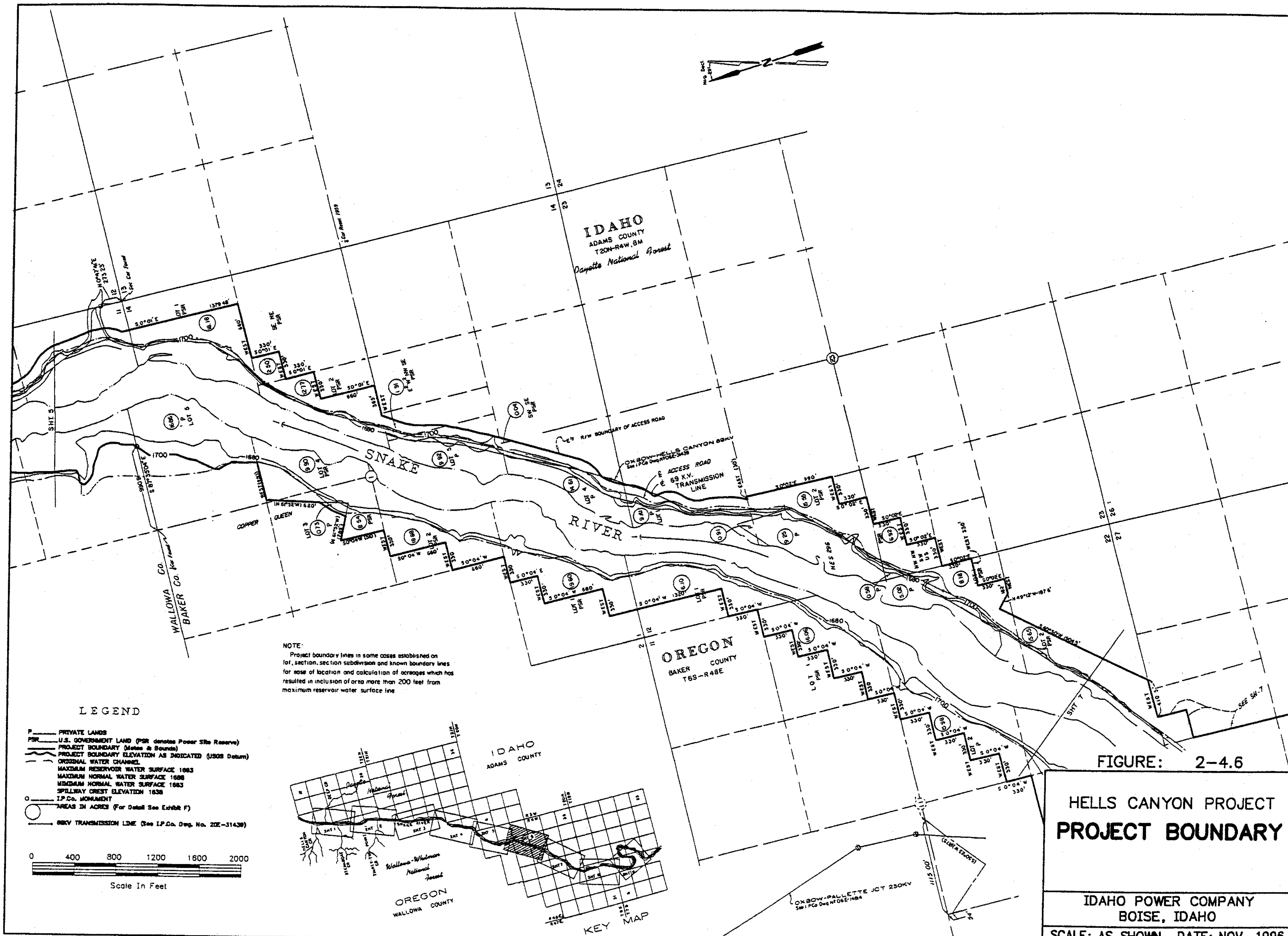


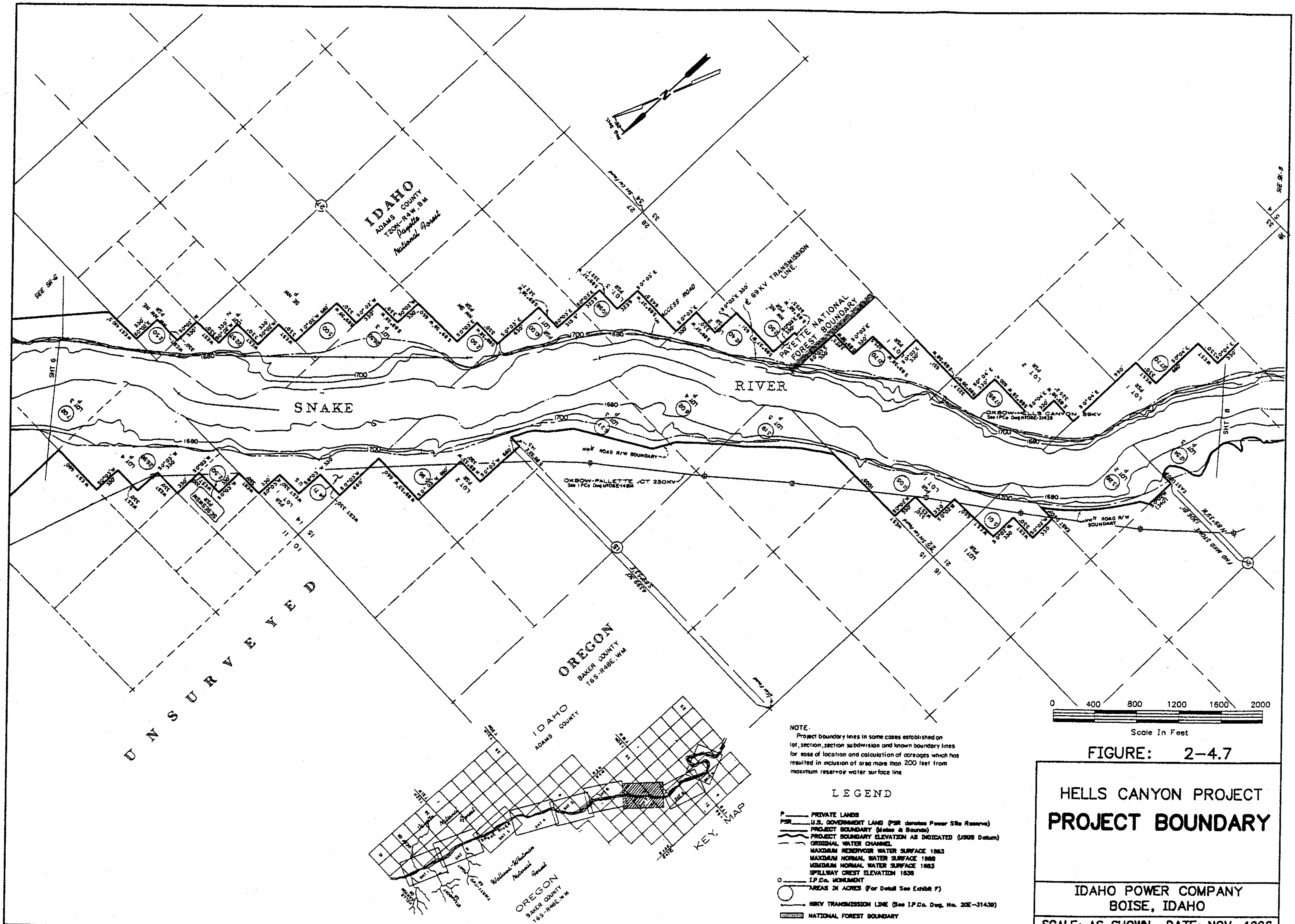
FIGURE: 2-4.6

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



NOTE-

Project boundary lines in some cases established on lot, section, section subdivision and known boundary lines for ease of location and calculation of acreages which has resulted in inclusion of area more than 200 feet from maximum reservoir water surface line

LEGEND

- P —— PRIVATE LANDS
- PSR —— U.S. GOVERNMENT LAND (PSR denotes Power Site Reserve)
- PROJECT BOUNDARY (Metes & Bounds)
- PROJECT BOUNDARY ELEVATION AS INDICATED (USGS Datum)
- ORIGINAL WATER CHANNEL
- MAXIMUM RESERVOIR WATER SURFACE 1883
- MAXIMUM NORMAL WATER SURFACE 1888
- MINIMUM NORMAL WATER SURFACE 1683
- SPILLWAY CREST ELEVATION 1838
- O —— I.P.Co. MONUMENT
- AREAS IN ACRES (For Detail See Exhibit F)
- 69KV TRANSMISSION LINE (See I.P.Co. Dwg. No. 20E-31439)
- NATIONAL FOREST BOUNDARY

FIGURE: 2-4.7

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

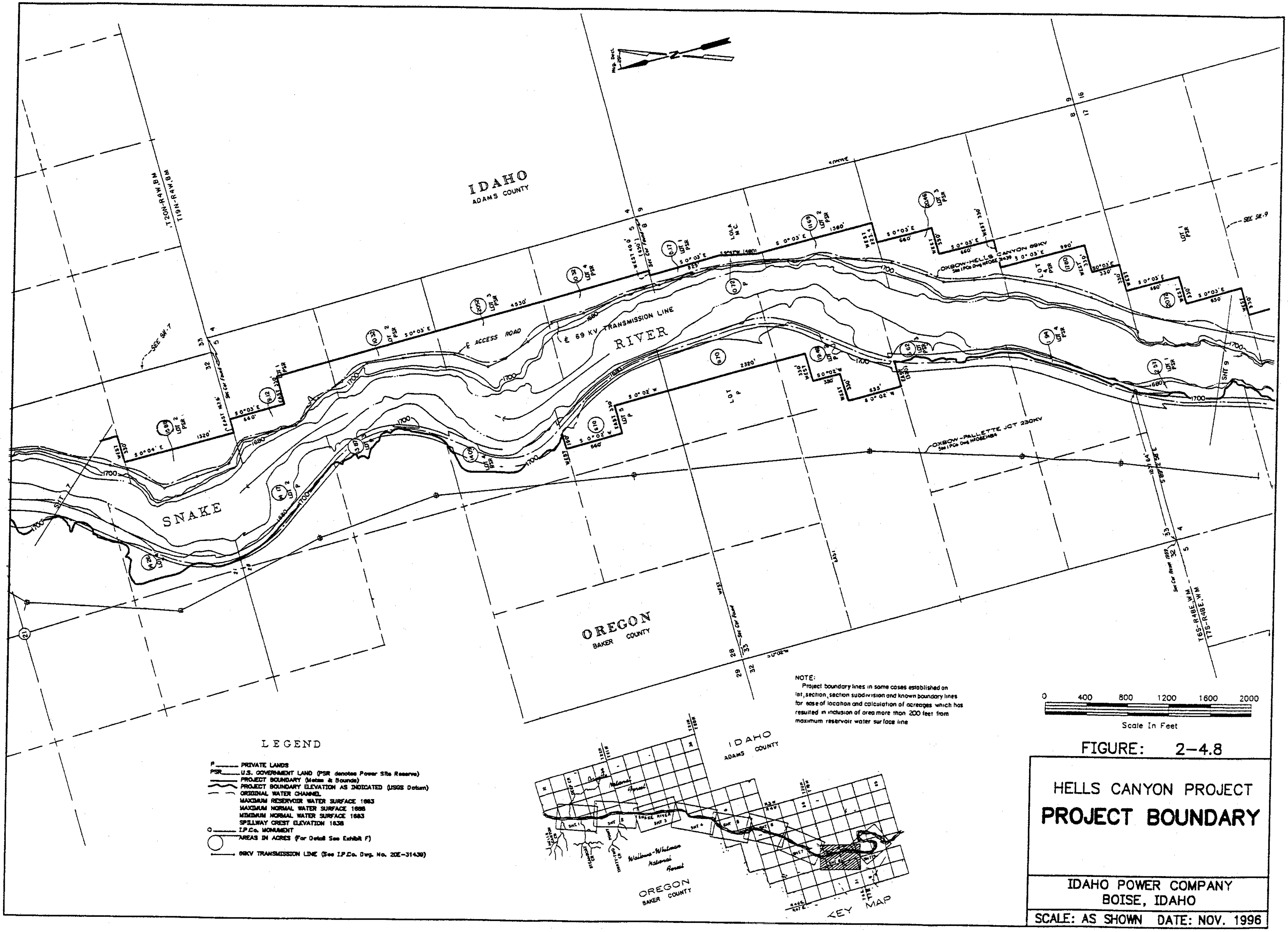


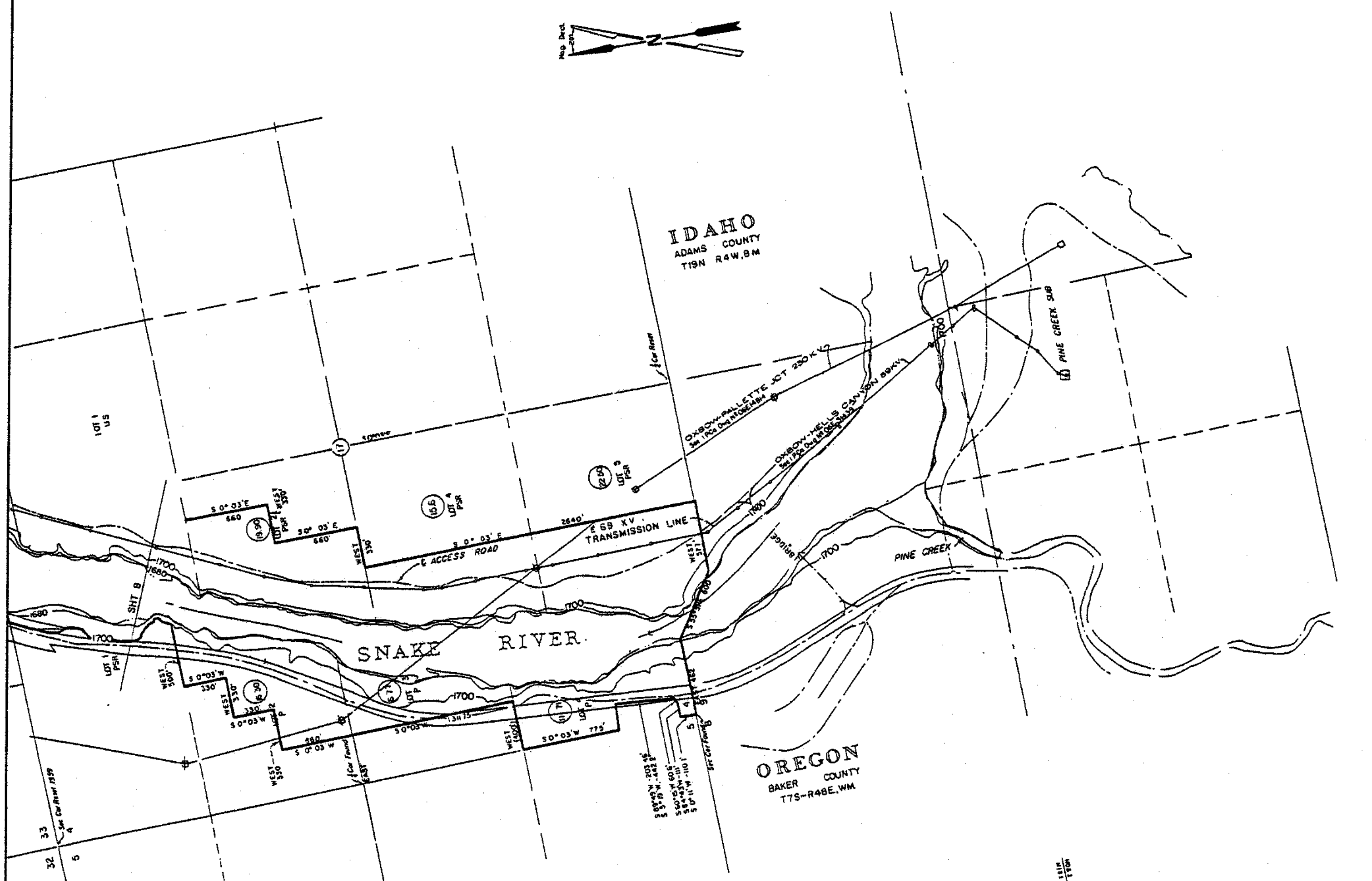
FIGURE: 2-4.8

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



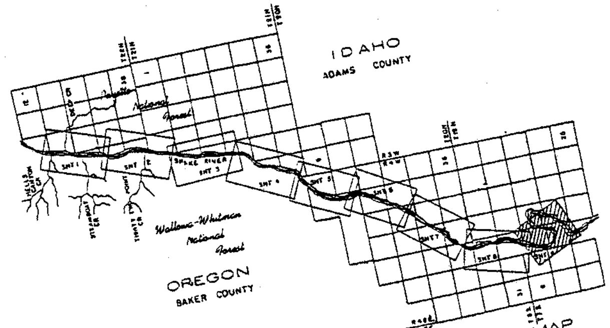
LEGEND

- P — PRIVATE LANDS
- PSR — U.S. GOVERNMENT LAND (PSR denotes Power Site Reserve)
- PROJECT BOUNDARY (Metes & Bounds)
- PROJECT BOUNDARY ELEVATION AS INDICATED (USGS Datum)
- ORIGINAL WATER CHANNEL
- MAXIMUM RESERVOIR WATER SURFACE 1693
- MAXIMUM NORMAL WATER SURFACE 1688
- MINIMUM NORMAL WATER SURFACE 1683
- SPILLWAY CREST ELEVATION 1638
- O — I.P.Co. MONUMENT
- AREAS IN ACRES (For Detail See Exhibit F)
- 69KV TRANSMISSION LINE (See I.P.Co. Dwg. No. 20E-31439)

0 400 800 1200 1600 2000

Scale In Feet

NOTE:
Project boundary lines in some cases established on lot, section, section subdivision and known boundary lines for ease of location and calculation of acreages which has resulted in inclusion of area more than 200 feet from maximum reservoir water surface line



KEY MAP

FIGURE: 2-4.9

HELLS CANYON PROJECT

PROJECT BOUNDARY

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

PARCEL of LAND W.M., OREGON	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
T.8S., R.48E.			
SEC 19			25.28
30			51.89
T.8S., R.47E.			
SEC 25		21.02	89.74
36	219.53		
35		2.50	
T.9S., R.47E.			
SEC 1			12.88
2		2.50	173.63
10		5.00	
11			186.22
14	105.04		
15	88.90	16.44	60.46
16	0.35		72.32
20	78.78		55.00
21	47.48		53.95
29	76.57		
30	116.94		56.03
T.9S., R.46E.			
SEC 25	148.04	15.00	32.50
26	166.81		57.50
23	49.78	20.00	50.00
22	156.65		22.50
21	100.83	7.50	107.50
20	104.19	7.50	
35	176.39		13.39
29	79.74		
30	321.97		
31	22.26		
T.10S., R.46E.			
SEC 2			43.36
3			94.79
10			184.28
15			143.08
16	26.04		
21			86.92
22			29.81
28			150.37
29			10.00
32	10.50		37.50
33	38.88	21.77	53.45
T.9S., R.45E.			
SEC 25	434.83		
26	22.27		
35	56.18		
36	105.42		
T.9S., R.45E.			
SEC 4	26.36		105.99
5	86.95		25.00
8	120.56		42.88
17	53.52		27.00
18	0.48		32.50
20	129.05		23.06
30	135.33		25.35
31	8.01		
25	3.34		
T.11S., R.45E.			
SEC 36	82.67		47.42
T.12S., R.45E.			
SEC 1	43.05	5.00	49.89
11			9.45
12	246.11		10.00
13	90.58		
14	151.73	5.00	22.50
15	51.90		
22	211.95		
27	138.96		
28	25.87		
32	42.09		
33	47.82	0.35	
T.13S., R.45E.			
SEC 4	70.94		
5	14.06		
9	1.18		48.40
16			42.05
21	32.58		54.73
28	8.30		
29	102.70		35.25
32			103.63
T.15S., R.45E.			
SEC 5	182.90	16.23	14.29
8	70.28		98.42
7			2.50
9	16.01		17.94
18			51.35
17	3.68	10.00	5.00
16	8.63		
15			43.03
22			82.81
27	15.84		25.57
32	10.61		
33	29.39		
34	3.69		
T.14S., R.45E.			
SEC 4	34.08		
5	10.81		
9	27.01		
10			20.85
14	50.69		
15	26.63		18.97
23	5.99		
24	22.00		34.44
T.15S., R.46E.			
SEC 19	16.89		55.78
8	80.42		
9	44.11		
16	1.27		
17	6.24		
TOTALS	5309.43	155.81	3088.34

TOTAL AREA OF ALL PARCELS........................8553.58

PARCEL of LAND B.M., IDAHO	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
T.17N., R.5W			
SEC 1	103.29	20.00	
2	47.90		
11	189.94		99.44
12	40.00		
14	80.00	40.11	46.80
15	164.68		
22	359.00		
23	53.48	5.00	
26	43.69		
27			109.93
28	34.72		90.49
29			11.52
31			49.07
32	106.17		137.43
33			45.00
T.18N., R.5W.			
SEC 6	85.40		36.38
T.16N., R.6W.			
SEC 1	96.50		76.10
2	95.50		24.20
10	88.80		54.10
11	39.80		
15	116.39		
16	10.36		41.08
21			29.70
22			60.00
28	130.54		83.90
33	38.99		131.45
T.15N., R.6W.			
SEC 4			17.50
5			165.57
8			114.90
17			76.30
18			29.52
19			123.63
30			104.27
25			6.80
31		12.50	22.50
T.15N., R.7W.			
SEC 36	77.29		
T.14N., R.6W.			
SEC 6			32.50
T.14N., R.7W.			
SEC 1	160.15		
11	103.80		
12	131.35		
13	80.41		12.50
14	13.36		21.08
23	59.79		64.82
24			2.50
26	10.37		26.57
27	89.76		34.90
28	27.08		32.02
33			103.98
T.13N., R.7W.			
SEC 4			28.92
5			82.69
6			0.23
8			38.83
7	93.78		43.44
17	20.66		
18	63.59		93.85
20	38.70		35.48
29	31.57		40.93
31	43.43		
32	21.43		2.50
T.12N., R.7W.			
SEC 6			129.23
7			2.50
18	23.16		38.34
19	42.63		
20	92.93		
28	49.95		14.22
29	45.73		
33	32.72		52.37
32	2.76		
T.12N., R.8W.			
SEC 12	144.81		
13	4.04		
T.11N., R.7W.			
SEC 4			17.50
5	57.03		
7	181.47		
8	61.06	30.42	104.27
17	49.27	19.82	
18	50.23		
20	48.74		
21	19.01		8.41
24			84.71
25			3.57
26	15.21		
27	28.69		
28	1.28		8.95
T.11N., R.6W.			
SEC 18			
19	30.18		10.00
20	11.98		6.94
TOTALS	3988.25	127.85	2949.87

TOTAL AREA OF ALL PARCELS........................7063.97

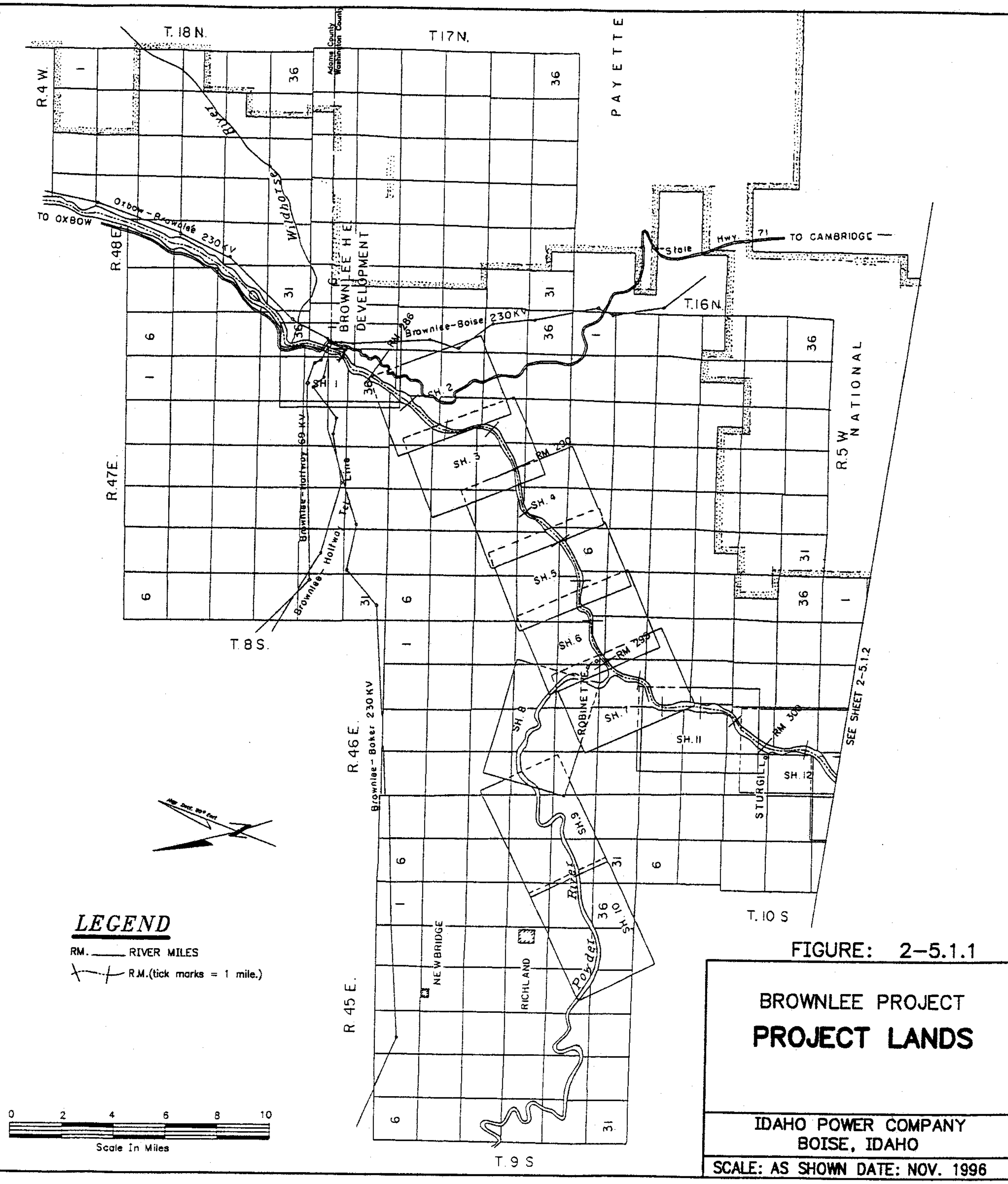


FIGURE: 2–5.1.1

BROWNLEE PROJECT

PROJECT LANDS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

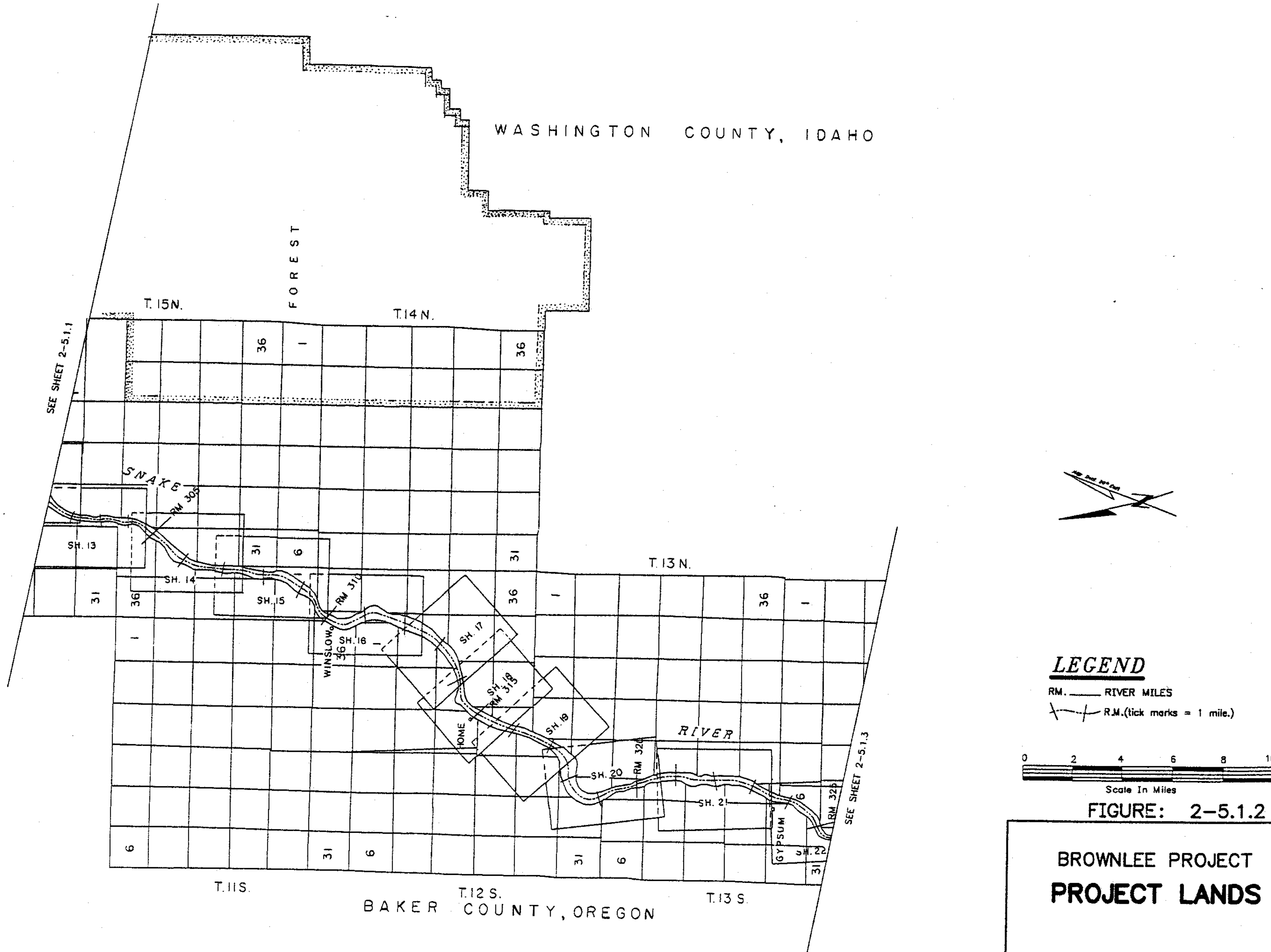


FIGURE: 2–5.1.2

BROWNLEE PROJECT

PROJECT LANDS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

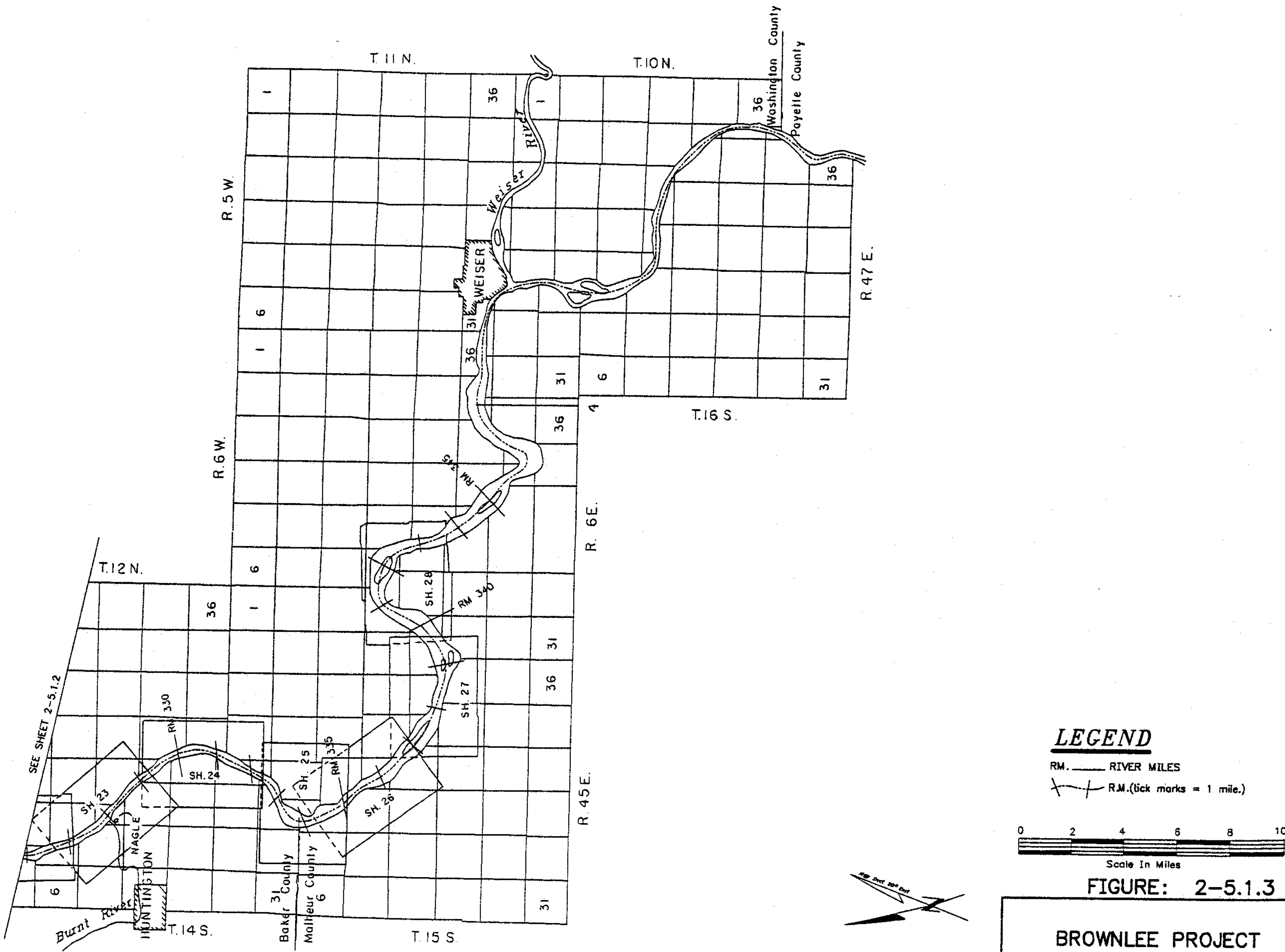


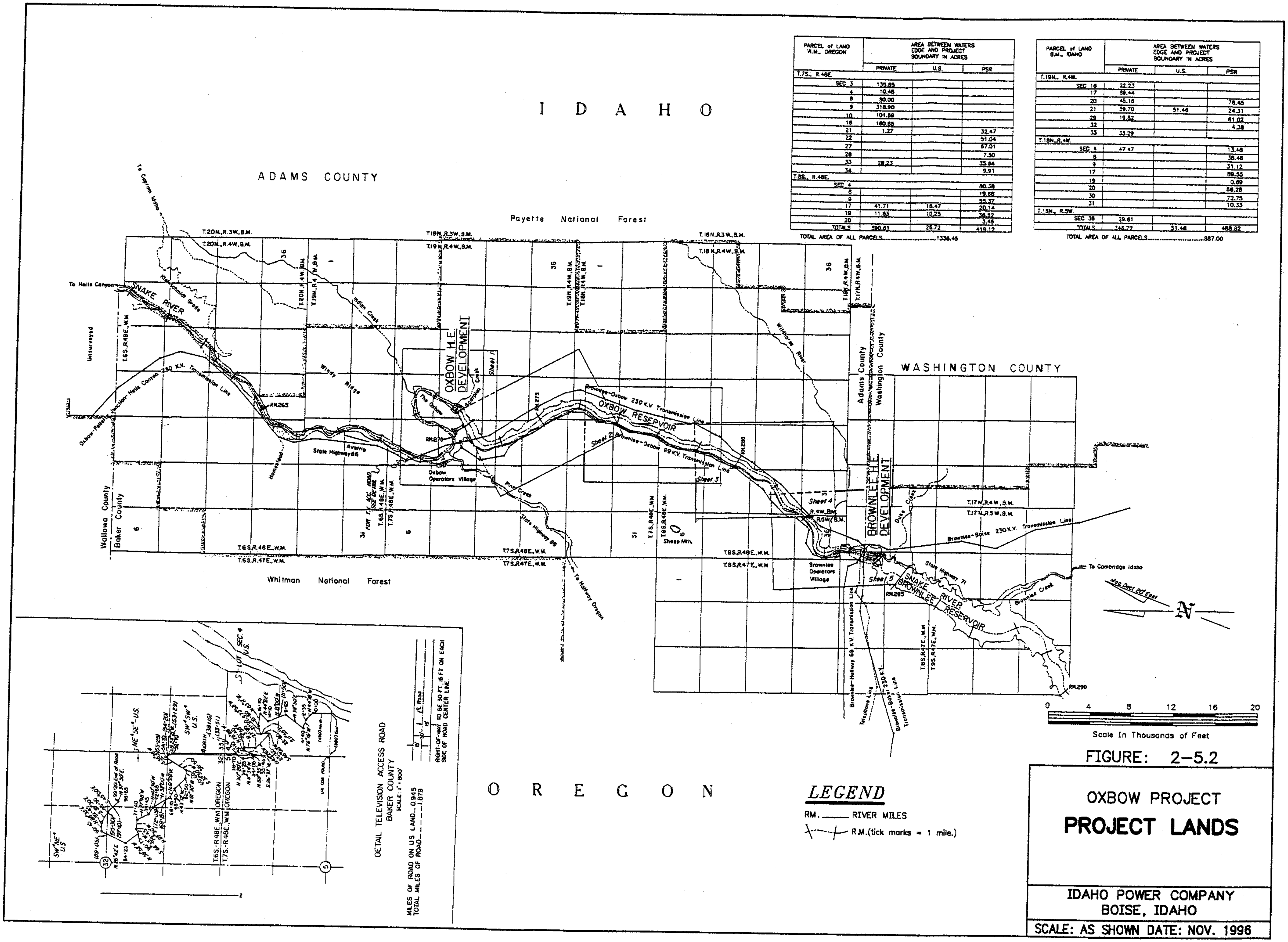
FIGURE: 2-5.1.3

BROWNLEE PROJECT

PROJECT LANDS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



PARCEL of LAND W.M., OREGON	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
T.7S., R.48E.			
SEC 3	135.85		
4	10.48		
8	90.00		
9	318.90		
10	101.89		
16	180.85		
21	1.27		32.47
22			51.04
27			87.01
28			7.50
33	28.23		35.84
34			9.91
T.8S., R.48E.			
SEC 4			80.38
8			19.88
9			55.37
17	41.71	18.47	20.14
19	11.83	10.25	36.32
20			3.46
TOTALS	890.61	28.72	419.12

TOTAL AREA OF ALL PARCELS..........1336.45

PARCEL of LAND B.M., IDAHO	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
T.19N., R.4W.			
SEC 16	22.23		
17	89.44		
20	45.16		78.45
21	59.70	51.46	24.31
29	19.82		61.02
32			4.38
33	33.29		
T.18N., R.4W.			
SEC 4	47.47		13.48
8			38.48
9			31.12
17			59.55
19			0.69
20			86.28
30			72.75
31			10.33
T.18N., R.5W.			
SEC 36	29.61		
TOTALS	346.72	51.46	488.82

TOTAL AREA OF ALL PARCELS..........887.00

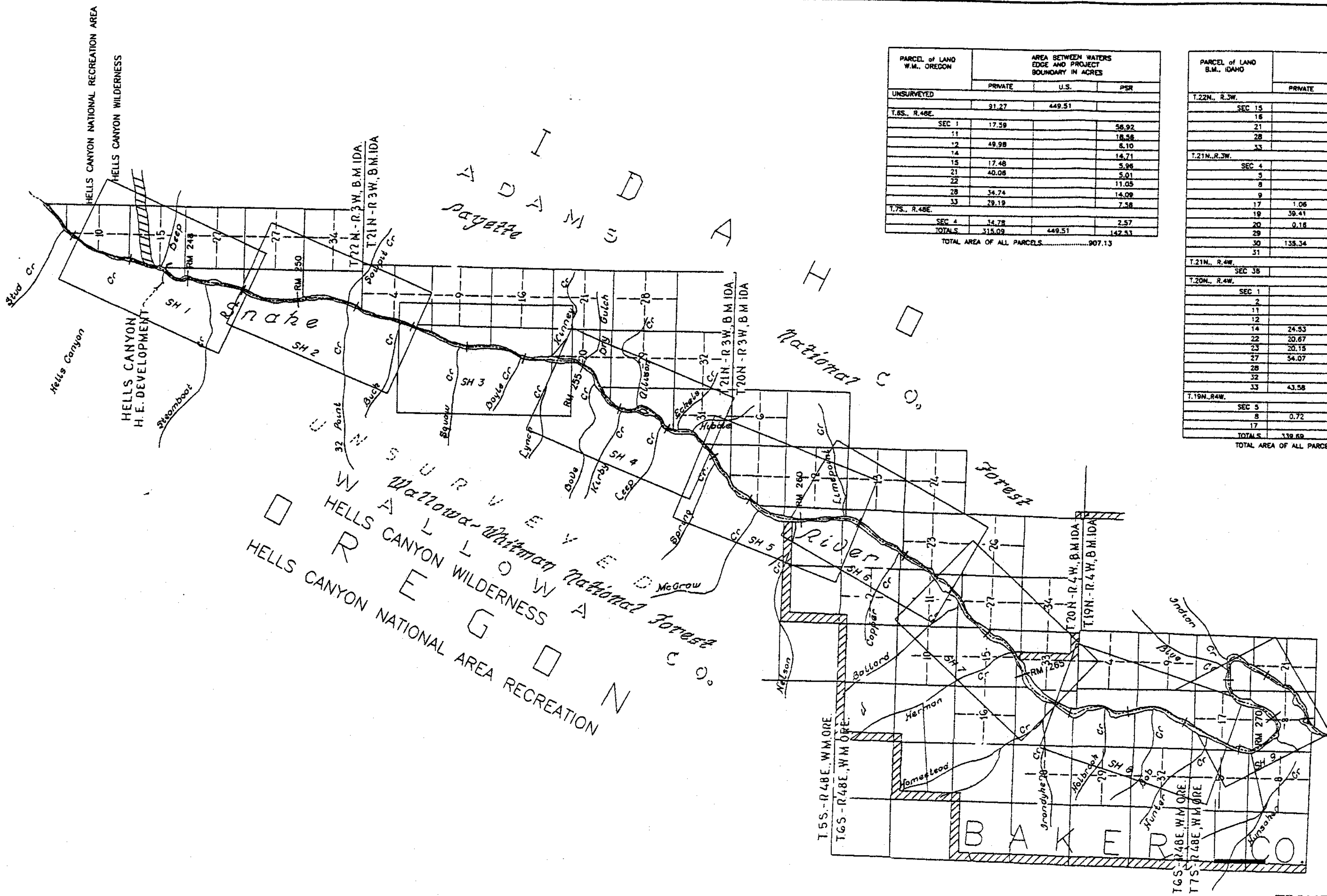
FIGURE: 2-5.2

OXBOW PROJECT

PROJECT LANDS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



PARCEL of LAND W.M., OREGON	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
UNSURVEYED			
	91.27	449.51	
T.6S., R.48E.			
SEC 1	17.59		56.92
11			18.56
12	49.98		6.10
14			14.71
15	17.48		5.96
21	40.06		5.01
22			11.05
28	34.74		14.09
33	29.19		7.58
T.7S., R.48E.			
SEC 4	34.78		2.57
TOTALS	315.09	449.51	142.53

TOTAL AREA OF ALL PARCELS..................907.13

PARCEL of LAND B.M., IDAHO	AREA BETWEEN WATERS EDGE AND PROJECT BOUNDARY IN ACRES		
	PRIVATE	U.S.	PSR
T.22N., R.3W.			
SEC 15			20.43
16			10.58
21			71.01
28			51.89
33			79.83
T.21N., R.3W.			
SEC 4			108.37
5			1.64
8			103.99
9			20.00
17	1.06	2.50	107.81
19	39.41		73.36
20	0.16		
29		53.00	2.48
30	135.34		
31		34.18	54.20
T.21N., R.4W.			
SEC 36			28.81
T.20N., R.4W.			
SEC 1			51.48
2			20.21
11			67.44
12			0.15
14	24.53		35.40
22	20.67		8.18
23	20.15		22.47
27	54.07		5.00
28			33.38
32			
33	43.58		42.16
T.19N., R4W.			
SEC 5			50.28
8	0.72		55.12
17			76.72
TOTALS	339.69	89.68	1203.79

TOTAL AREA OF ALL PARCELS..................1633.16

LEGEND

RM. ——— RIVER MILES

R.M. (tick marks = 1 mile.)

- - NATIONAL FOREST BOUNDARY

0 1 2 3 4

Scale In Miles

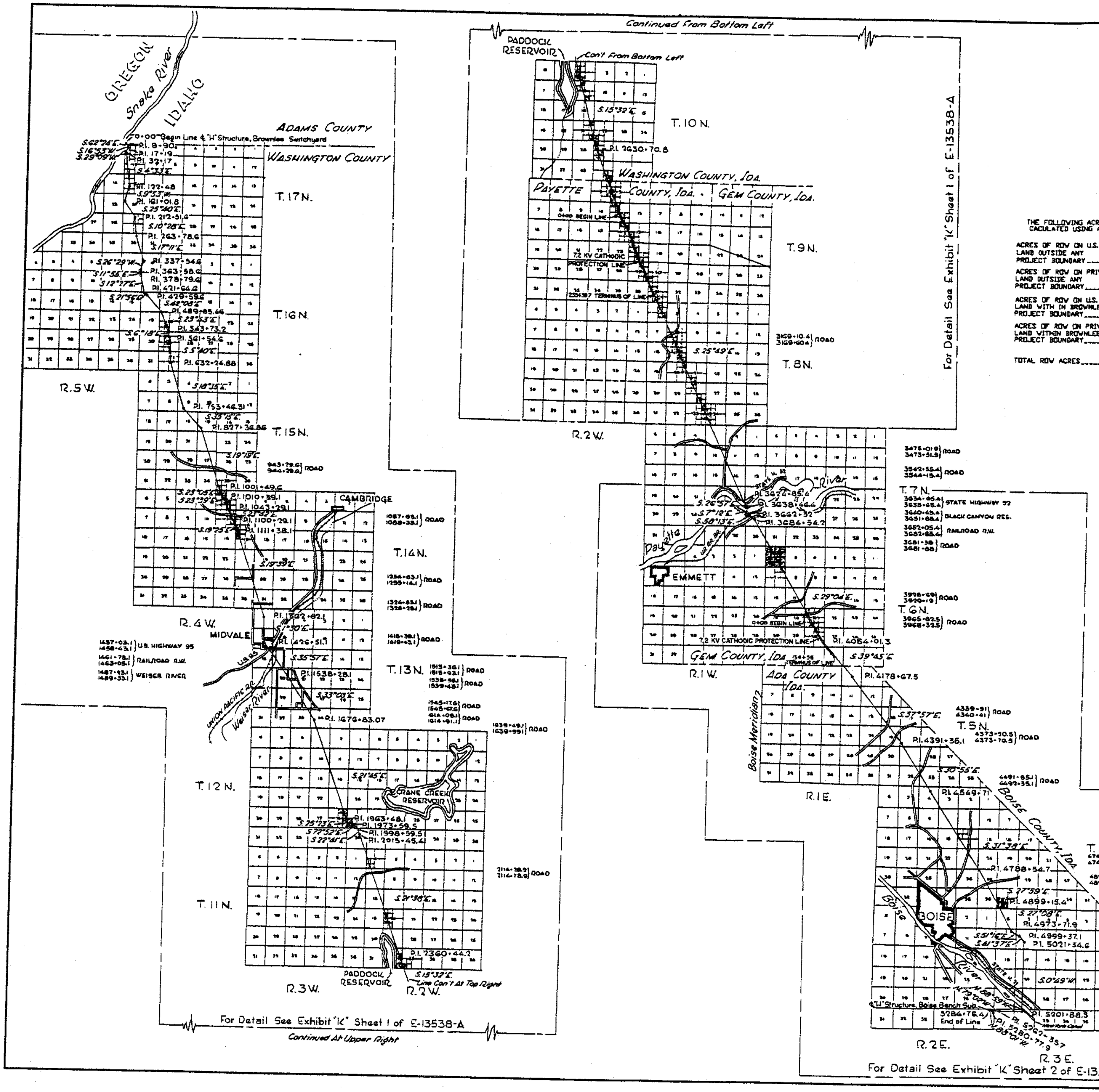
FIGURE: 2-5.3

HELLS CANYON PROJECT

PROJECT LANDS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



THE FOLLOWING ACREAGES WERE CACULATED USING A 150' ROW

ACRES OF ROW ON U.S. LAND OUTSIDE ANY PROJECT BOUNDARY 420.960

ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY 1154.033

ACRES OF ROW ON U.S. LAND WITH IN BROWNLEE PROJECT BOUNDARY 3.931

ACRES OF ROW ON PRIVATE LAND WITHIN BROWNLEE PROJECT BOUNDARY 12.336

TOTAL ROW ACRES 1591.260

Legend

■ .... U.S. Government Lands

Miles of Line on U.S. Government Lands 23.369
Miles of Line on State Lands 12.5363
Miles of Line on Private Lands 63.688
Miles of Line Across Rivers and Roads 0.4969
Total Miles of Line 100.0902

7.2 KV CATHODIC PROTECTION LINE:
MILES OF LINE ON U.S. GOVERNMENT LANDS WITHIN EXIST. R/W 6.0368
MILES OF LINE ON U.S. GOVERNMENT LANDS OUTSIDE EXIST. R/W 0.0876
TOTAL MILES OF LINE 7.1151

NOTE:
OPERATED AS:
1. BROWNLEE–BOISE BENCH No.1 AND 2 (904)
2. BROWNLEE–QUARTZ JUNCTION (903)

0 2 4 6 8 10 12
Scale In Miles

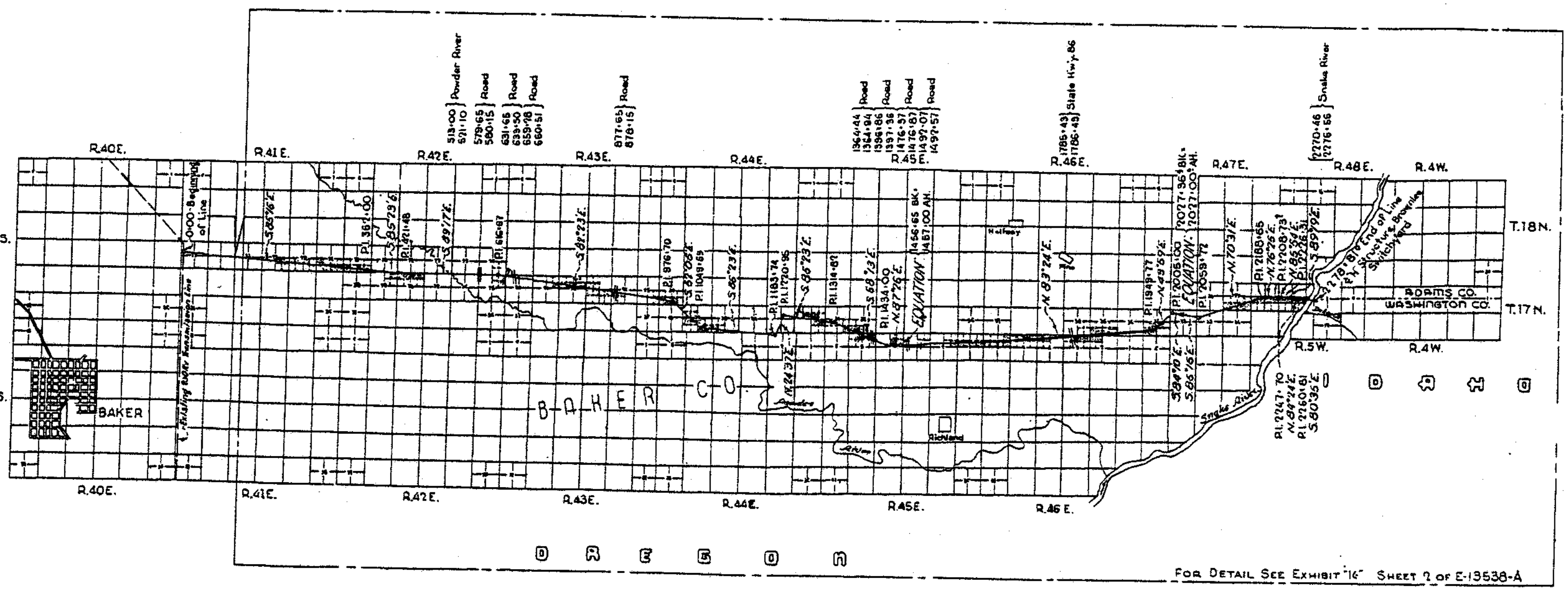
FIGURE 2–6.1.1

BOISE – BROWNLEE – BAKER 230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



NOTE:
OPERATED AS:
1.BROWNLEE–BOISE BENCH No.1 AND 2 (904)
2.BROWNLEE–QUARTZ JUNCTION (903)

Legend

☐ ---- U.S. Government Lands

Miles of line on U.S. Government lands	19.868
" " " " State lands	0.963
" " " " Private lands	21.925
" " " " across rivers and roads	0,403
Total miles of line	43.159

THE FOLLOWING ACREAGES WERE CALCULATED USING A 150' ROW

ACRE OF ROW ON US LAND OUTSIDE ANY PROJECT BOUNDARY	356.32
ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY	398.636
ACRES OF ROW ON U.S. LAND WITH IN BROWNLEE PROJECT BOUNDARY	4.907
ACRES OF ROW ON PRIVATE LAND WITH IN BROWNLEE PROJECT BOUNDARY	0.775
ACRES OF ROW CROSSING THE SNAKE RIVER WITH IN PROJECT BOUNDARIES	2.101
TOTAL ROW ACRES	762.739

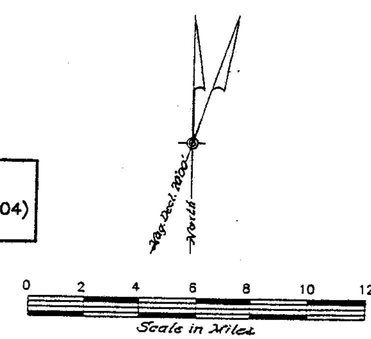


FIGURE 2–6.1.2

BOISE – BROWNLEE – BAKER
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

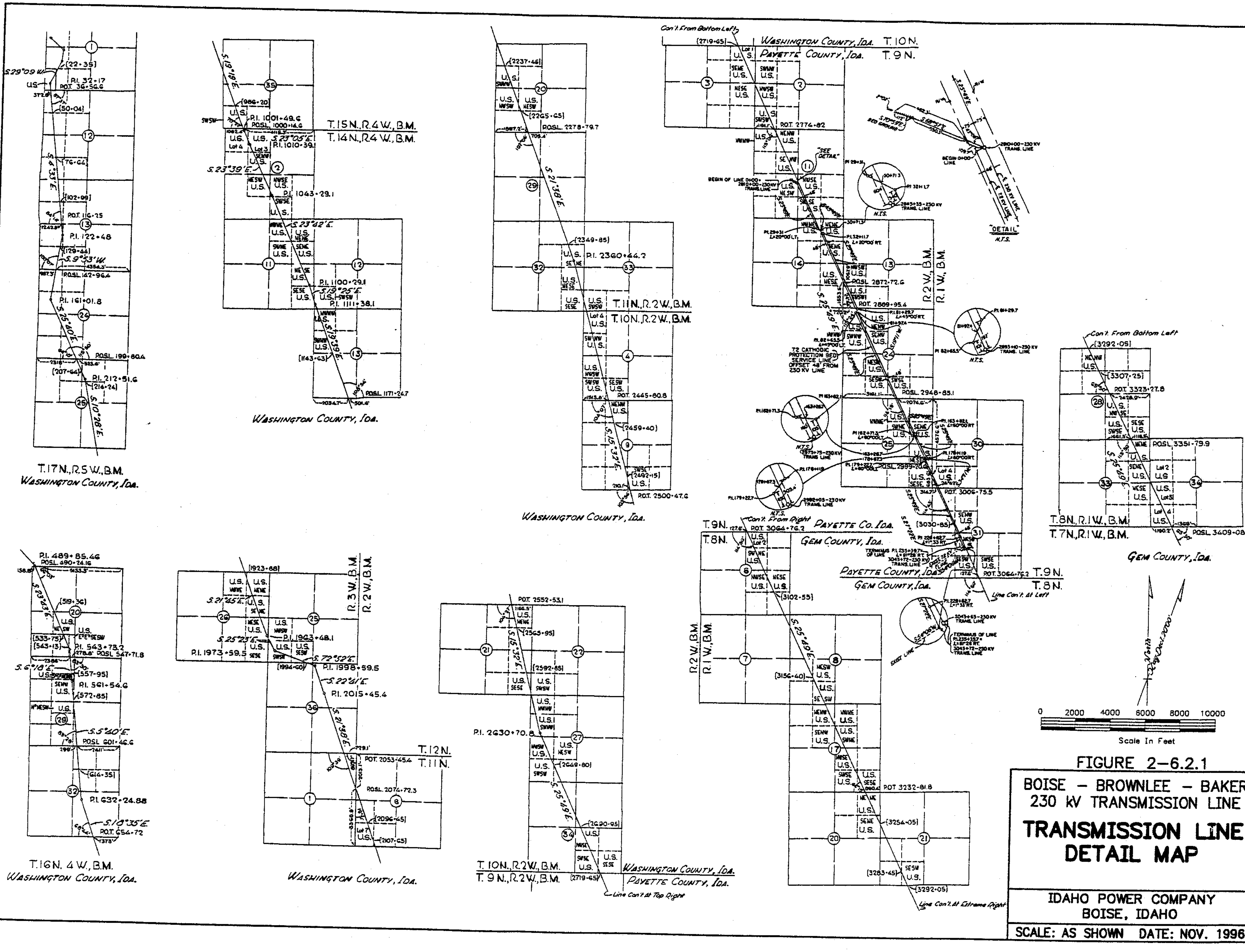


FIGURE 2-6.2.1

BOISE – BROWNLEE – BAKER
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

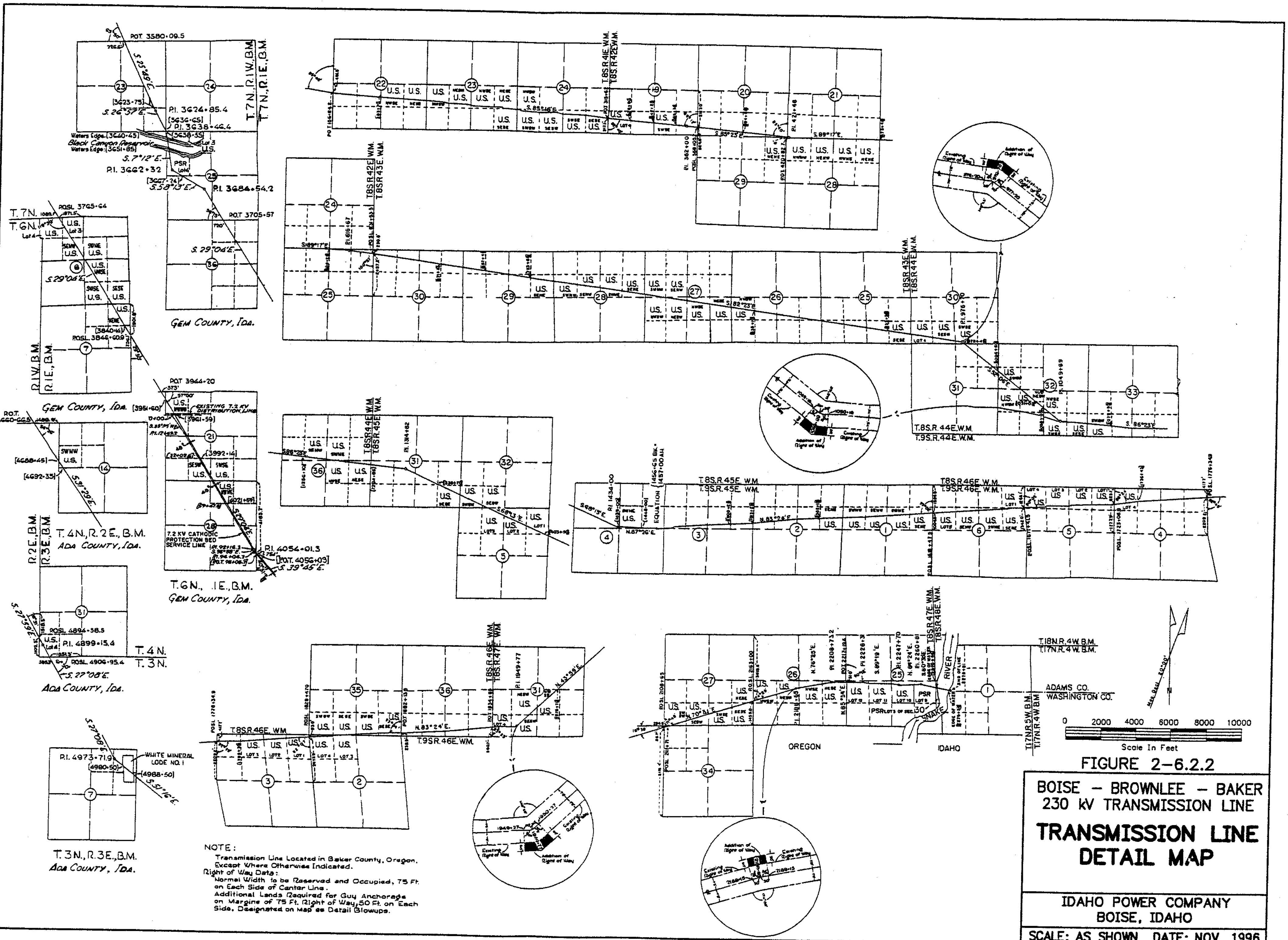


FIGURE 2-6.2.2
BOISE – BROWNLEE – BAKER
230 kV TRANSMISSION LINE
TRANSMISSION LINE
DETAIL MAP
IDAHO POWER COMPANY
BOISE, IDAHO
SCALE: AS SHOWN DATE: NOV. 1996
NOTE:
Transmission Line Located in Baker County, Oregon, Except Where Otherwise Indicated.
Right of Way Data:
Normal Width to be Reserved and Occupied, 75 Ft. on Each Side of Center Line.
Additional Lands Required for Guy Anchorage on Margins of 75 Ft. Right of Way, 50 Ft. on Each Side, Designated on Map as Detail Blowups.
0 2000 4000 6000 8000 10000
Scale In Feet
GEM COUNTY, IDA.
T.6N., 1E., B.M.
GEM COUNTY, IDA.
T. 4N., R. 2E., B.M.
ADA COUNTY, IDA.
ADA COUNTY, IDA.
T. 3N., R. 3E., B.M.
ADA COUNTY, IDA.
Black Canyon Reservoir
WHITE MINERAL LODE NO. 1
7.2 KV CATHODIC PROTECTION BED SERVICE LINE
EXISTING 7.2 KV DISTRIBUTION LINE
ADAMS CO.
WASHINGTON CO.
OREGON
IDAHO
SNAKE RIVER
EQUATION
Existing Right of Way
Addition of Right of Way

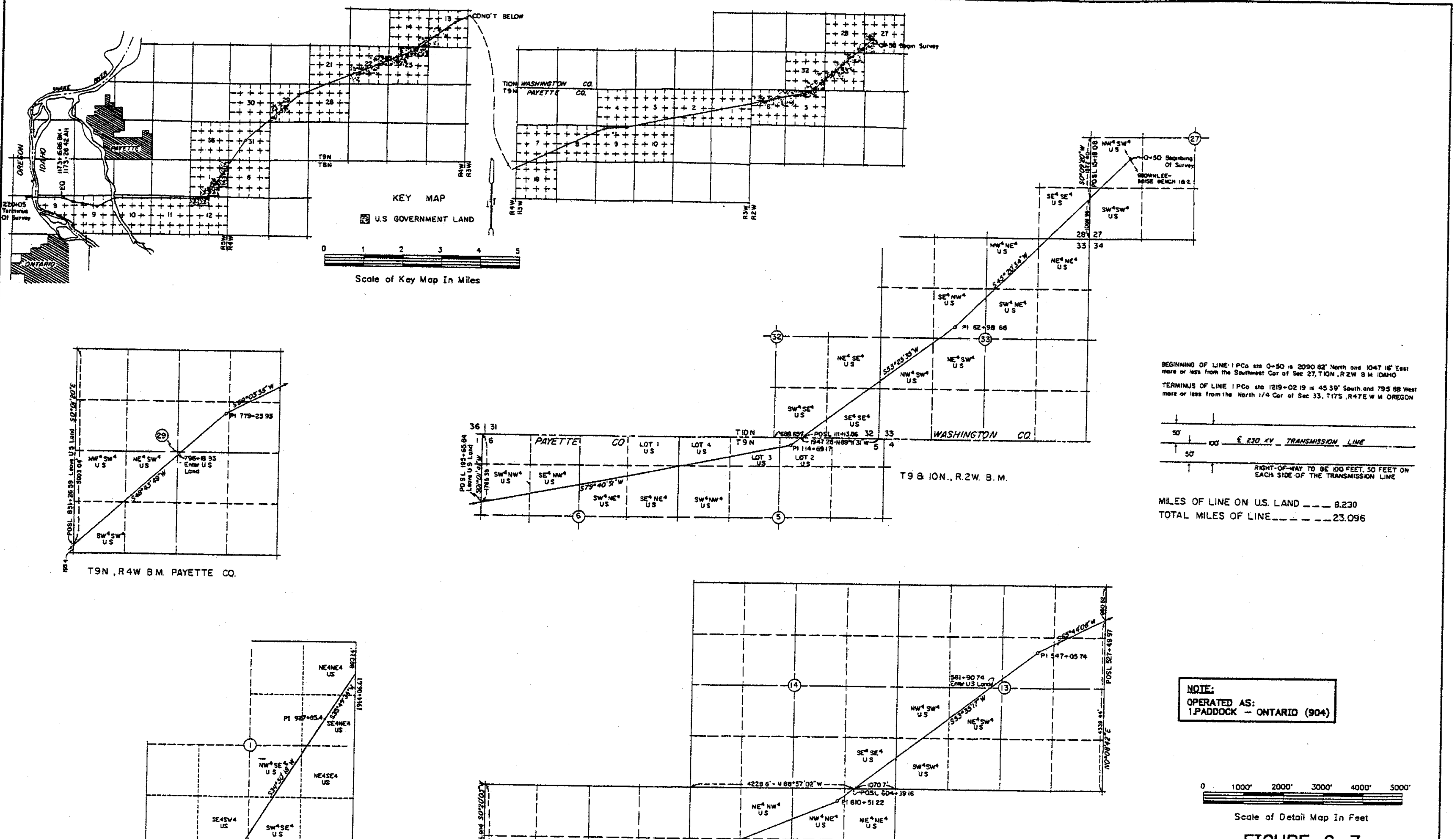


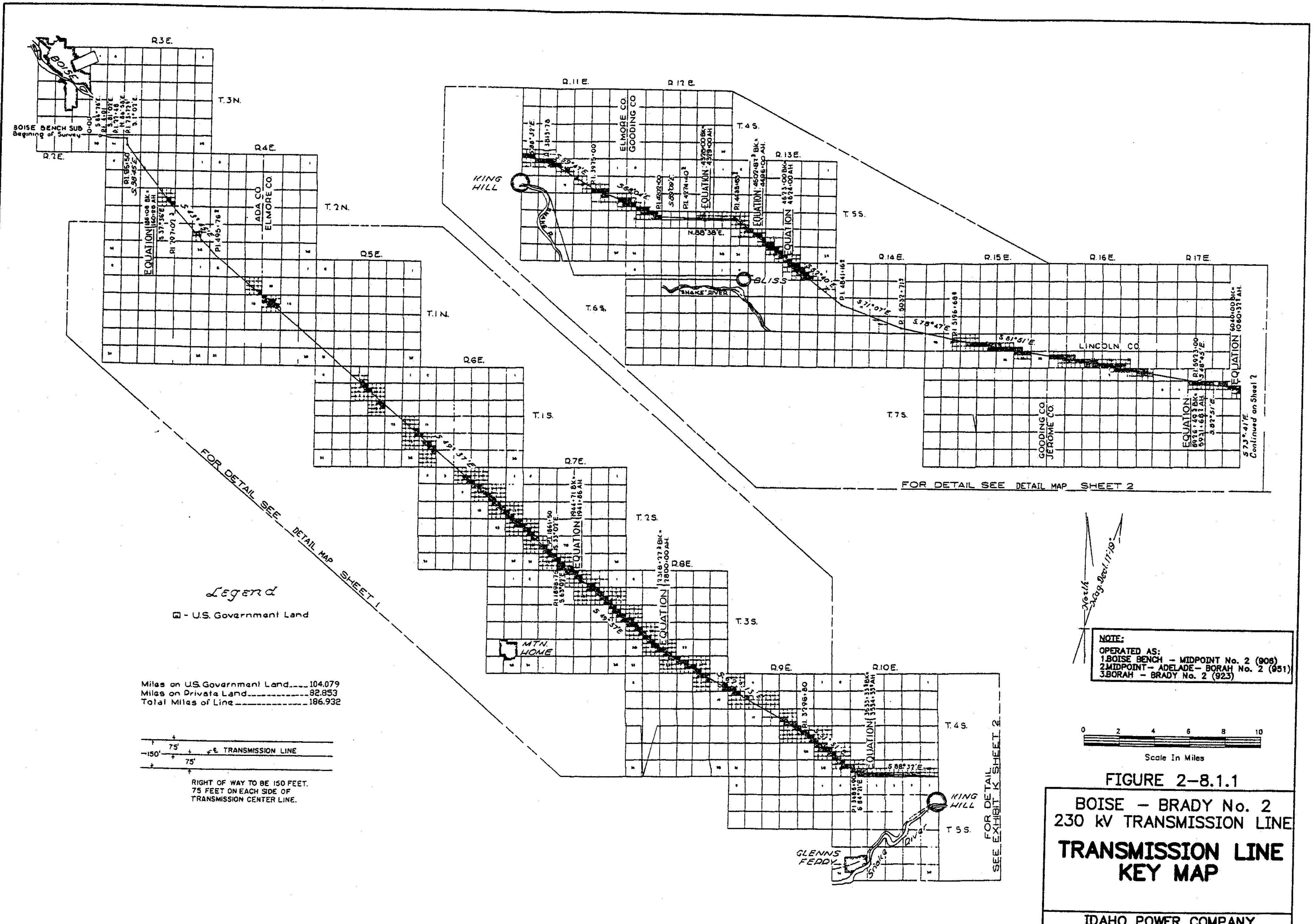
FIGURE 2–7

PADDOCK – ONTARIO
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY & DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



NOTE:
OPERATED AS:
1. BOISE BENCH – MIDPOINT No. 2 (906)
2. MIDPOINT – ADELADE – BORAH No. 2 (951)
3. BORAH – BRADY No. 2 (923)

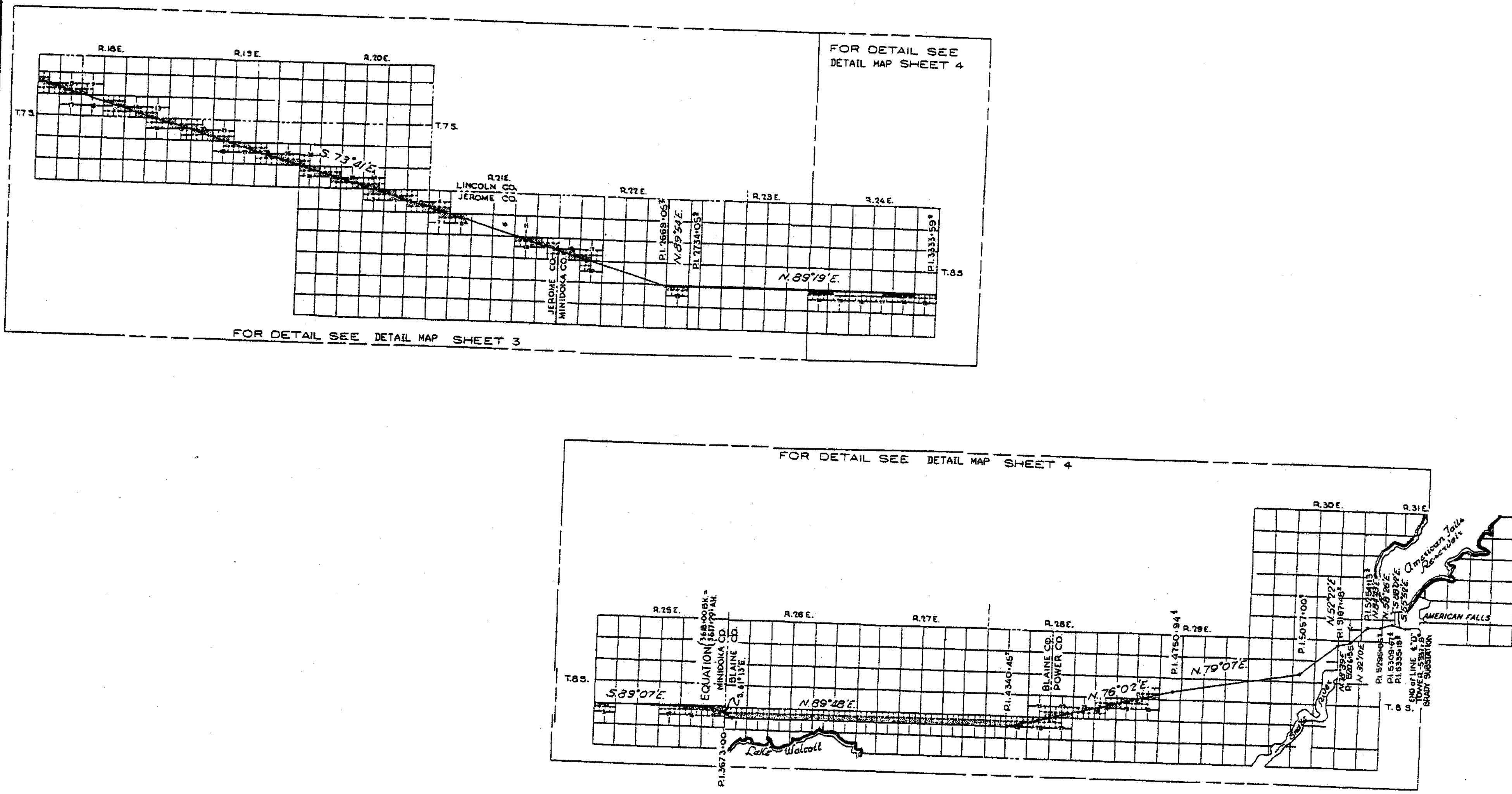
FIGURE 2–8.1.1

BOISE – BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



Legend

▣ - U.S. Government Land

150' — 75' / 75' — ℄ TRANSMISSION LINE

RIGHT OF WAY TO BE 150 FEET. 75 FEET ON EACH SIDE OF TRANSMISSION CENTER LINE.

NOTE:
OPERATED AS:
1. BOISE BENCH – MIDPOINT No. 2 (906)
2. MIDPOINT – ADELADE – BORAH No. 2 (951)
3. BORAH – BRADY No. 2 (923)

0 2 4 6 8 10
Scale In Miles

North / Mag. Decl. 18°19'±

FIGURE 2-8.1.2

BOISE – BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

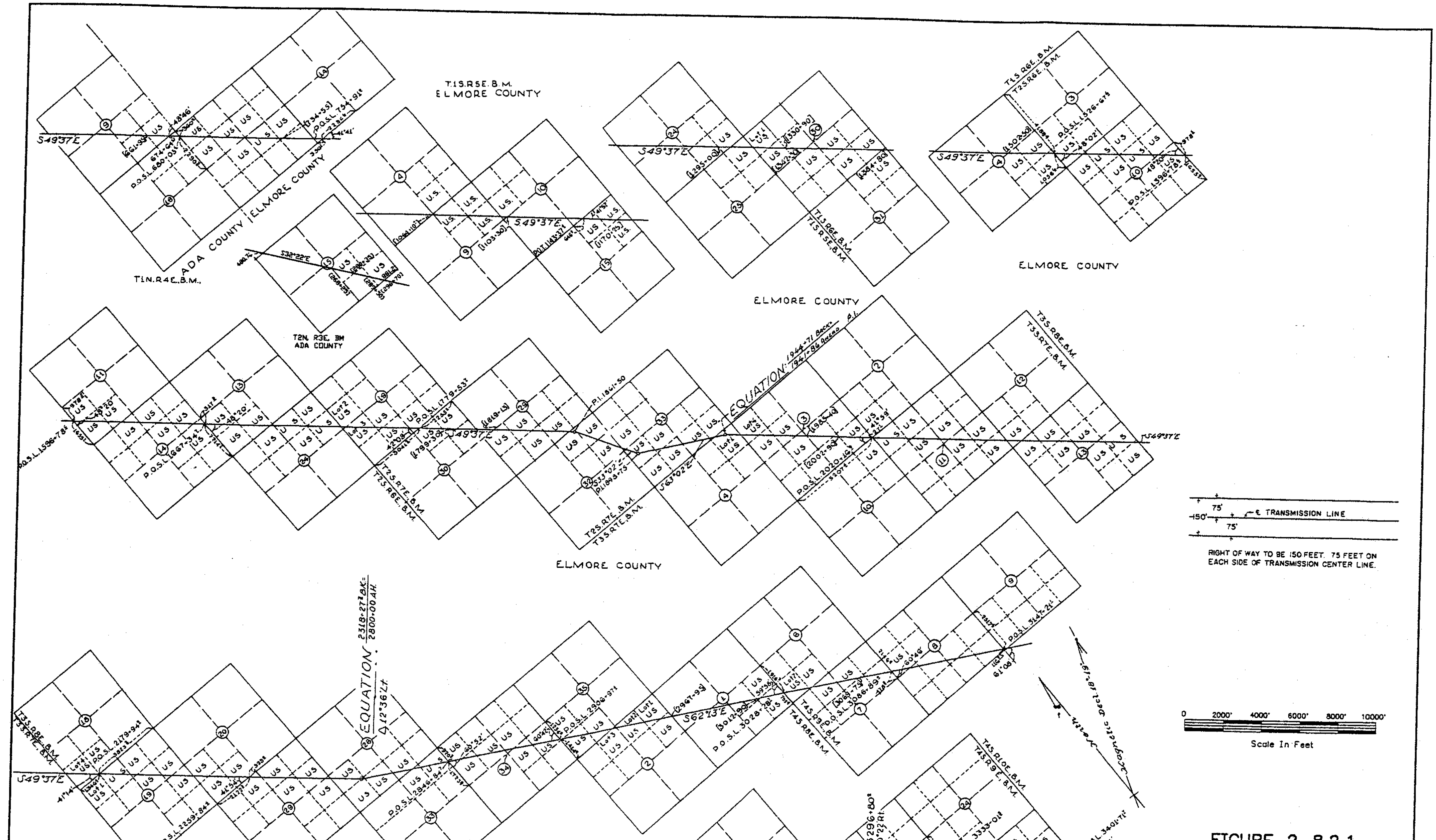


FIGURE 2-8.2.1

BOISE - BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

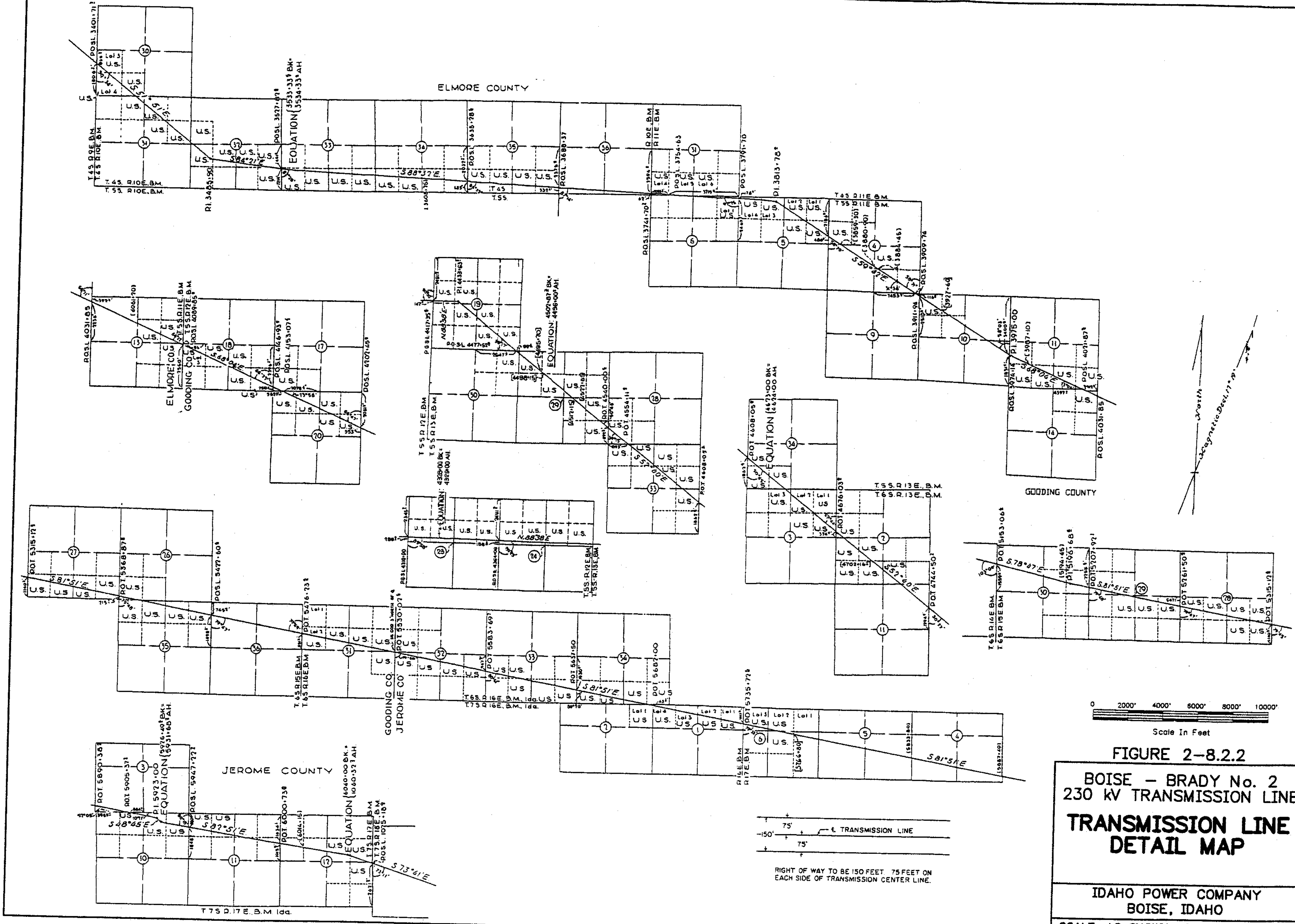


FIGURE 2-8.2.2

BOISE - BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

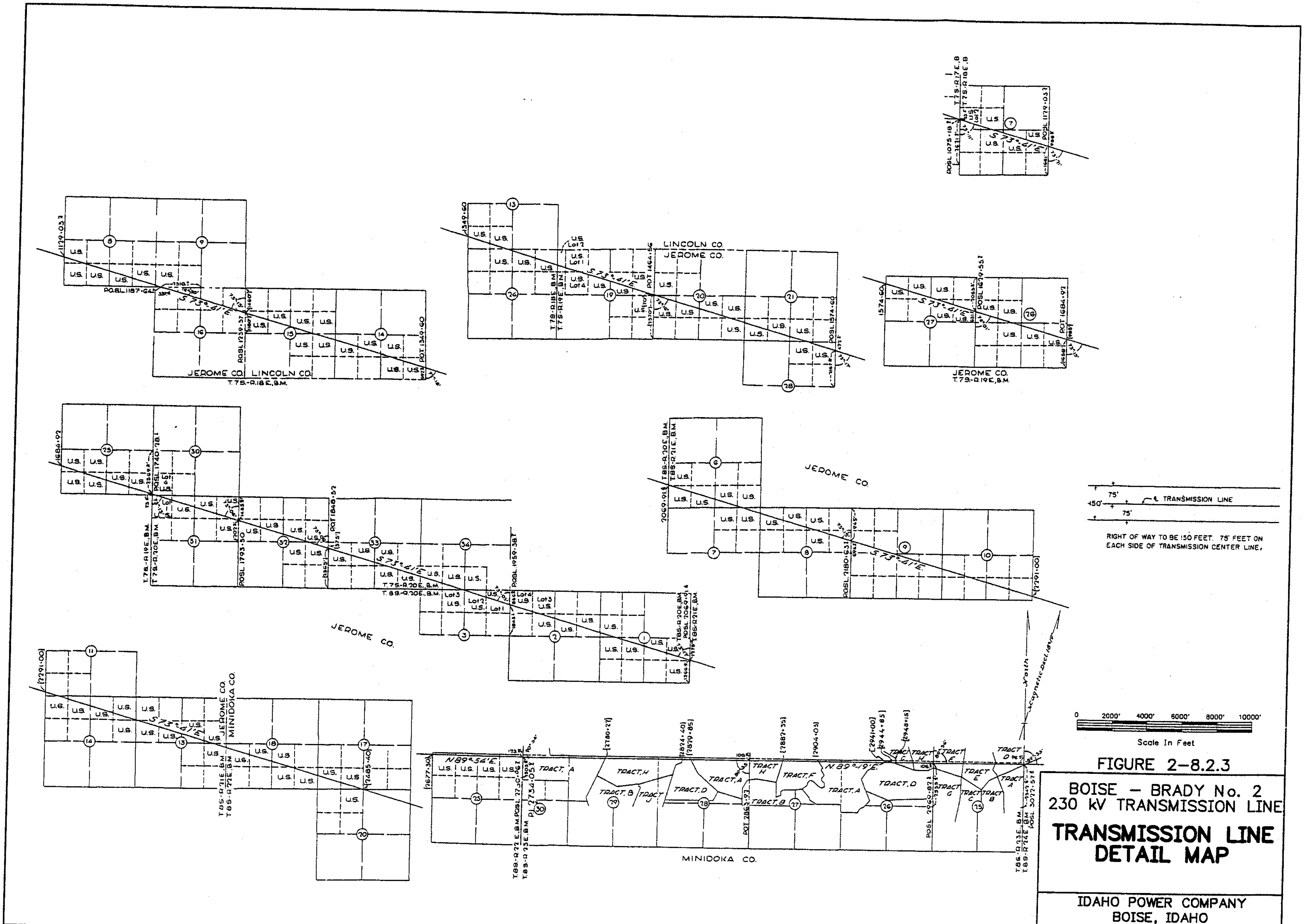


FIGURE 2-8.2.3

BOISE – BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

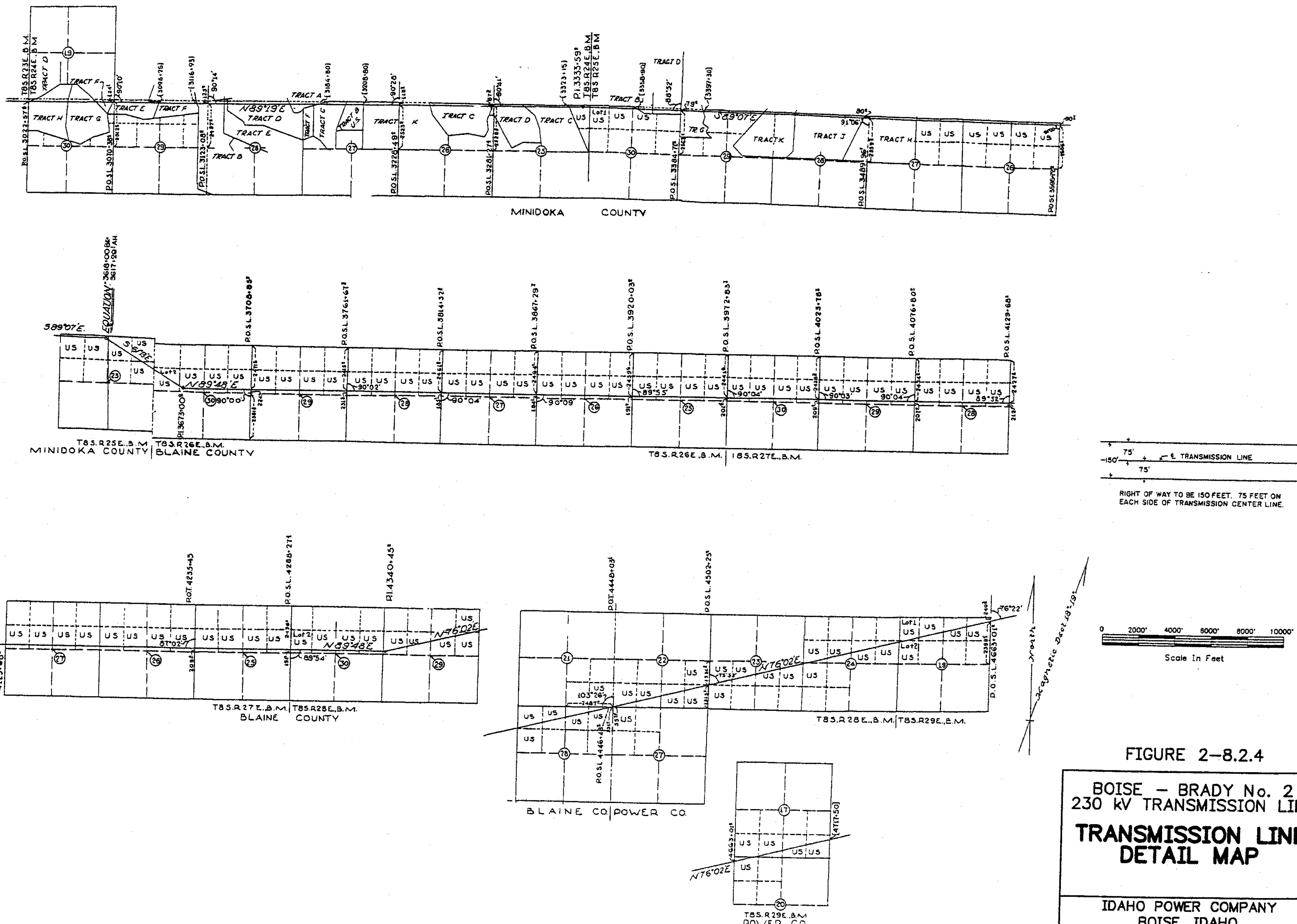


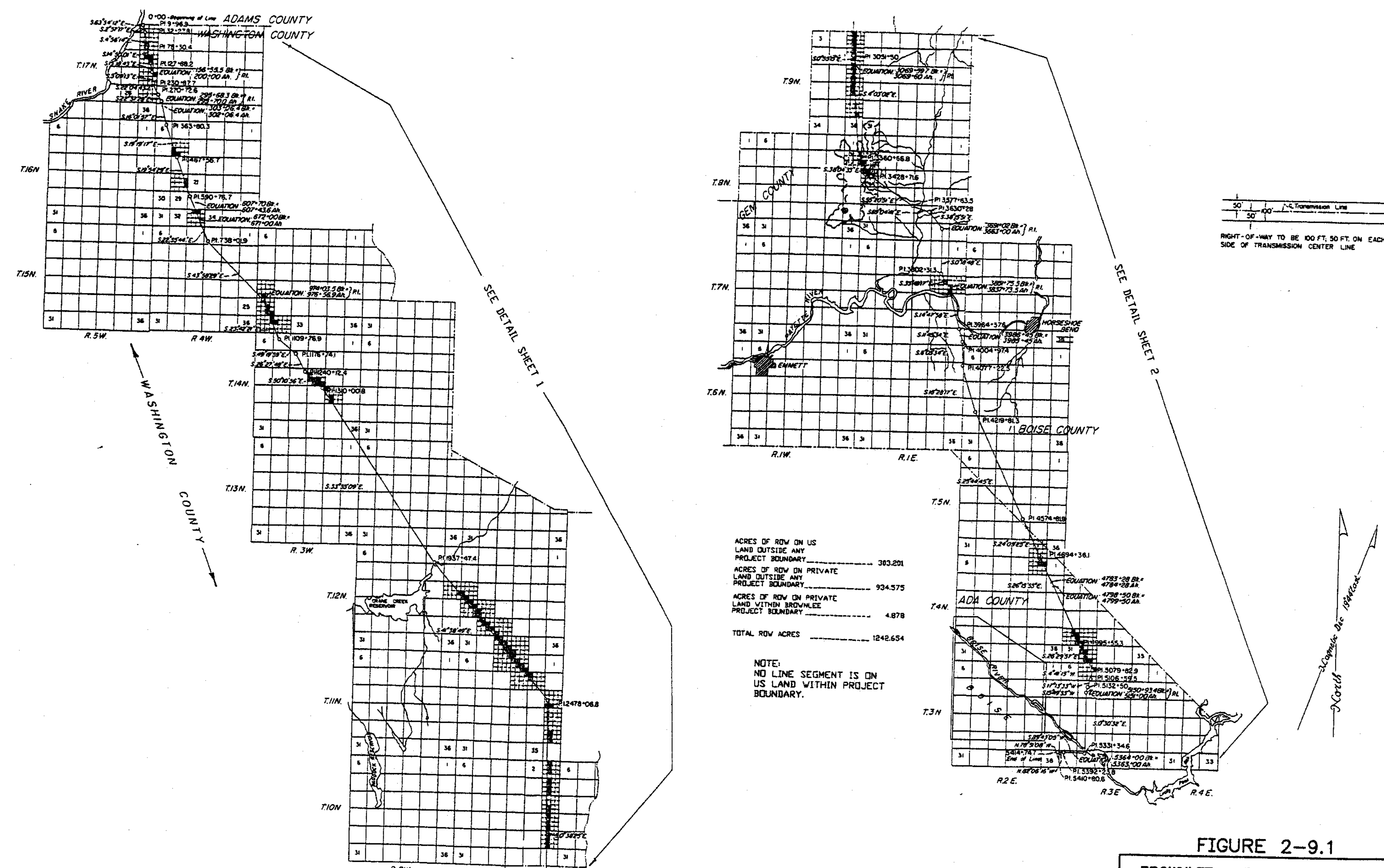
FIGURE 2–8.2.4

BOISE – BRADY No. 2
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



ACRES OF ROW ON US LAND OUTSIDE ANY PROJECT BOUNDARY	303.201
ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY	934.575
ACRES OF ROW ON PRIVATE LAND WITHIN BROWNLEE PROJECT BOUNDARY	4.878
TOTAL ROW ACRES	1242.654

NOTE:
NO LINE SEGMENT IS ON US LAND WITHIN PROJECT BOUNDARY.

Miles of Line on U.S.Government Land — 25.014
Total Miles of Line — 102.519

0 2 4 6 8 10
Scale In Miles

NOTE:
OPERATED AS:
1.BROWNLEE – BOISE BENCH No. 3 AND 4 (911)

FIGURE 2-9.1

BROWNLEE – BOISE BENCH NO. 3 AND 4, 230 kV TRANSMISSION LINES

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

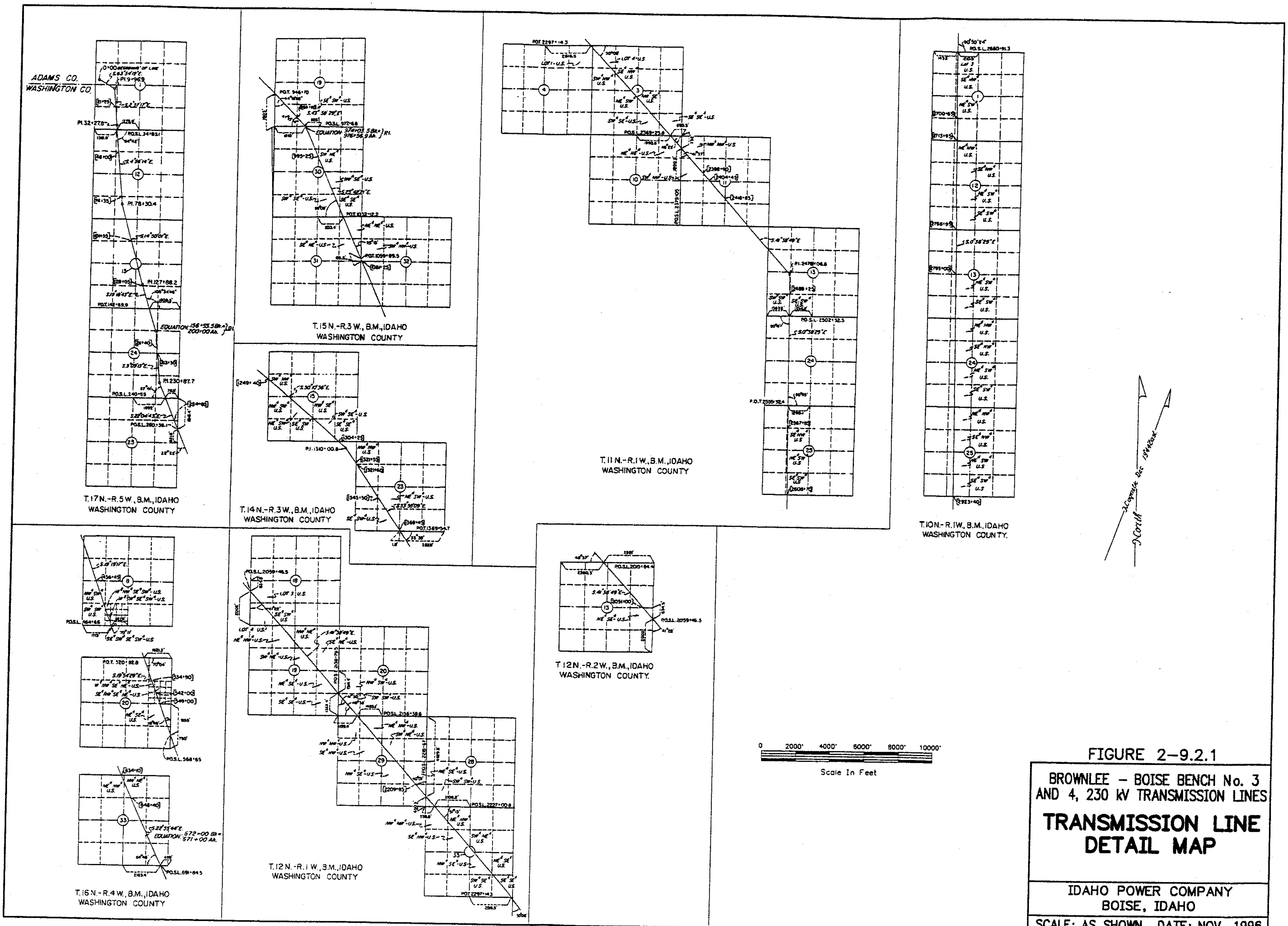


FIGURE 2-9.2.1

BROWNLEE – BOISE BENCH No. 3 AND 4, 230 kV TRANSMISSION LINES

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

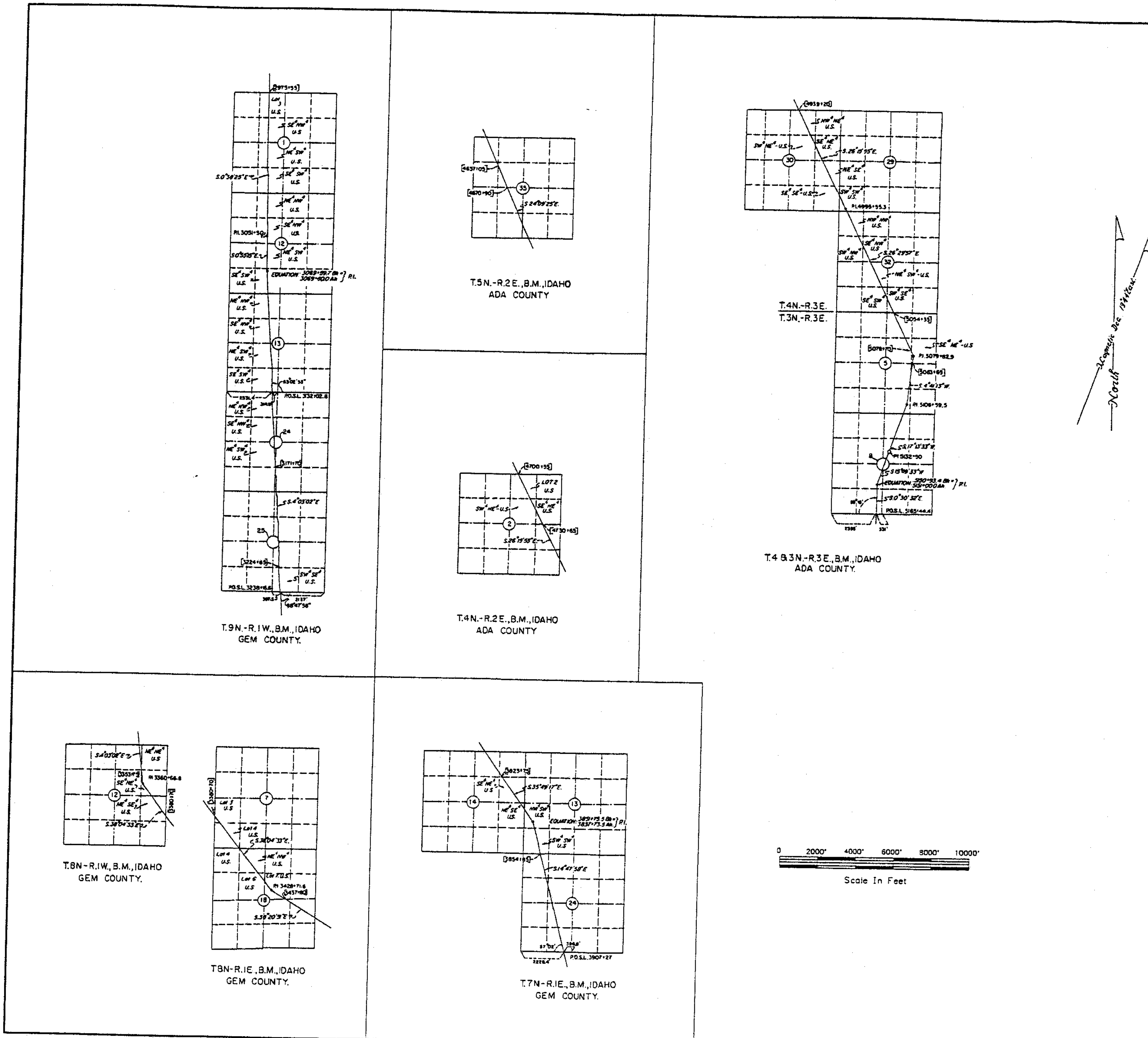


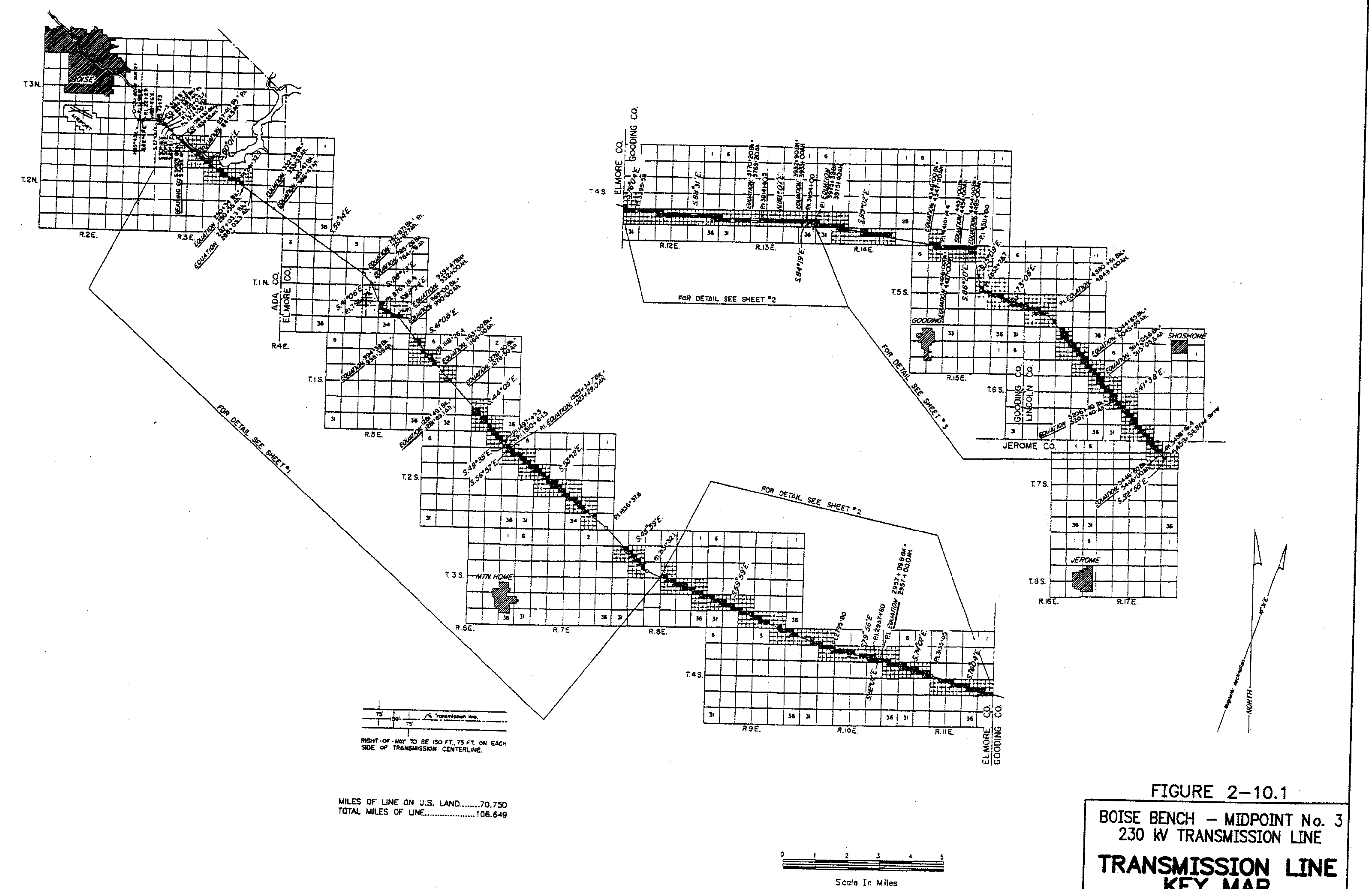
FIGURE 2-9.2.2

BROWNLEE - BOISE BENCH No. 3 AND 4, 230 kV TRANSMISSION LINES

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



MILES OF LINE ON U.S. LAND........70.750
TOTAL MILES OF LINE.....................106.649

NOTE:
OPERATED AS:
1.BOISE BENCH – MIDPOINT No. 3 (912)

FIGURE 2-10.1

BOISE BENCH – MIDPOINT No. 3
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

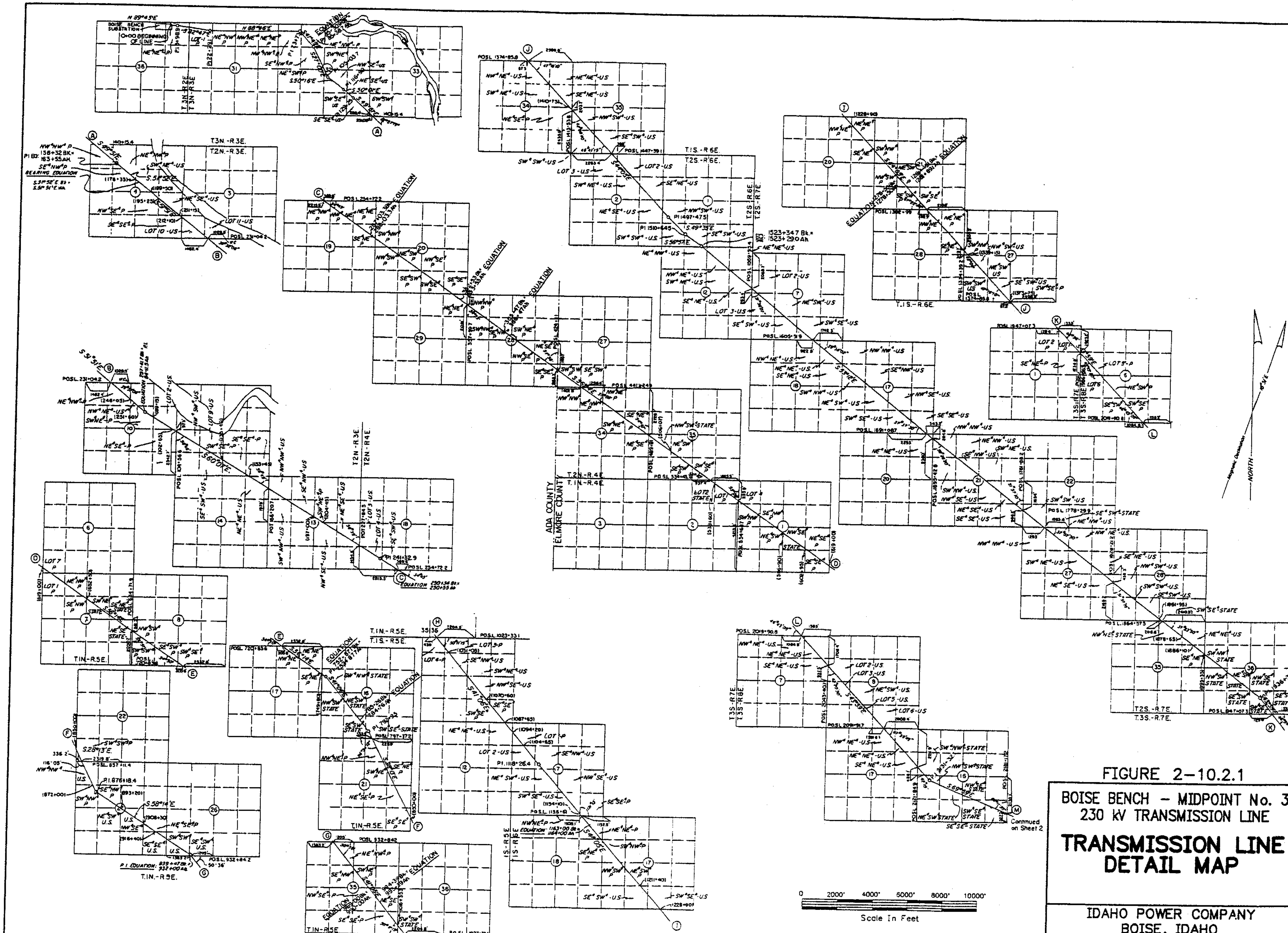


FIGURE 2-10.2.1

BOISE BENCH - MIDPOINT No. 3
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

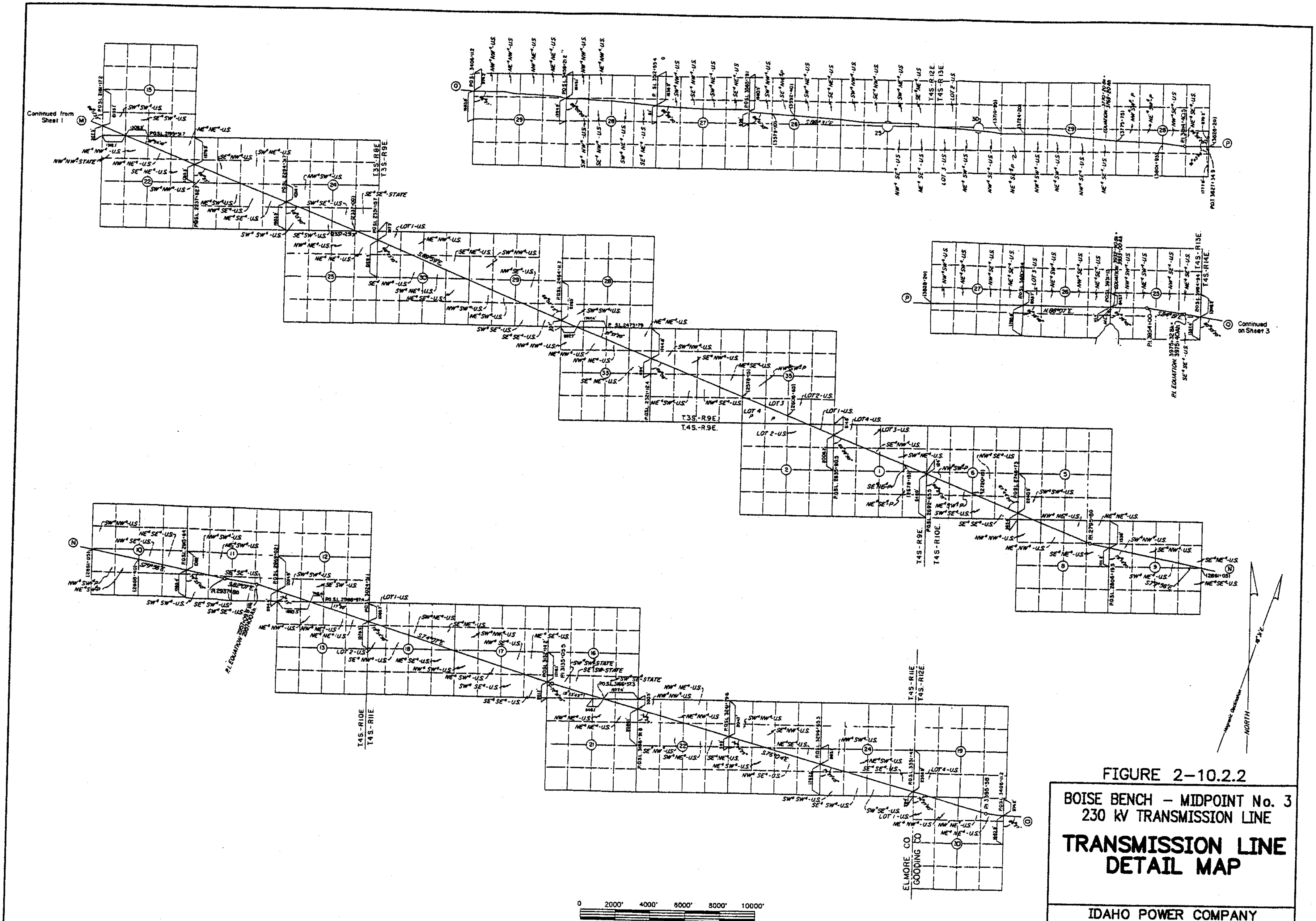


FIGURE 2-10.2.2

BOISE BENCH - MIDPOINT No. 3
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

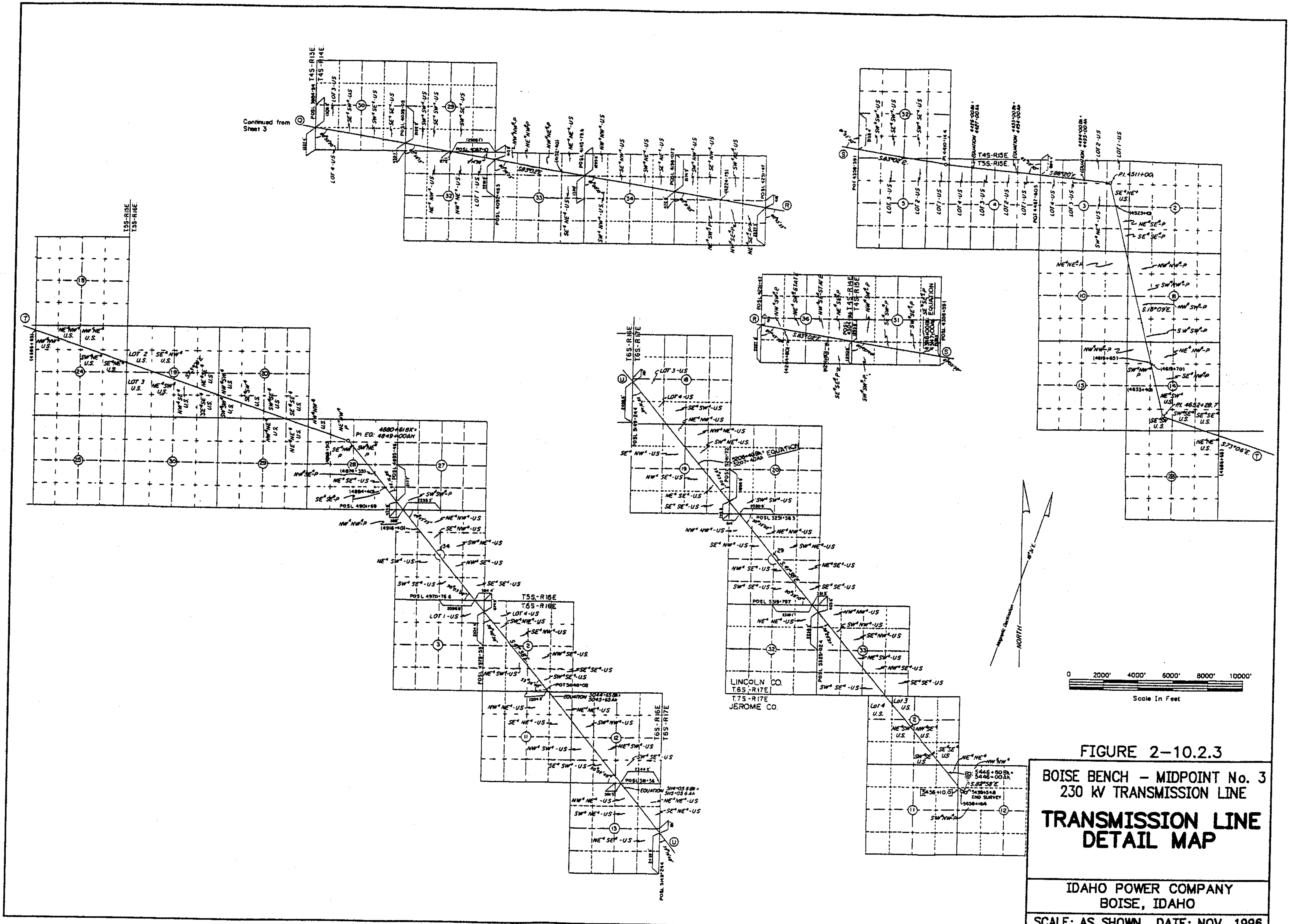


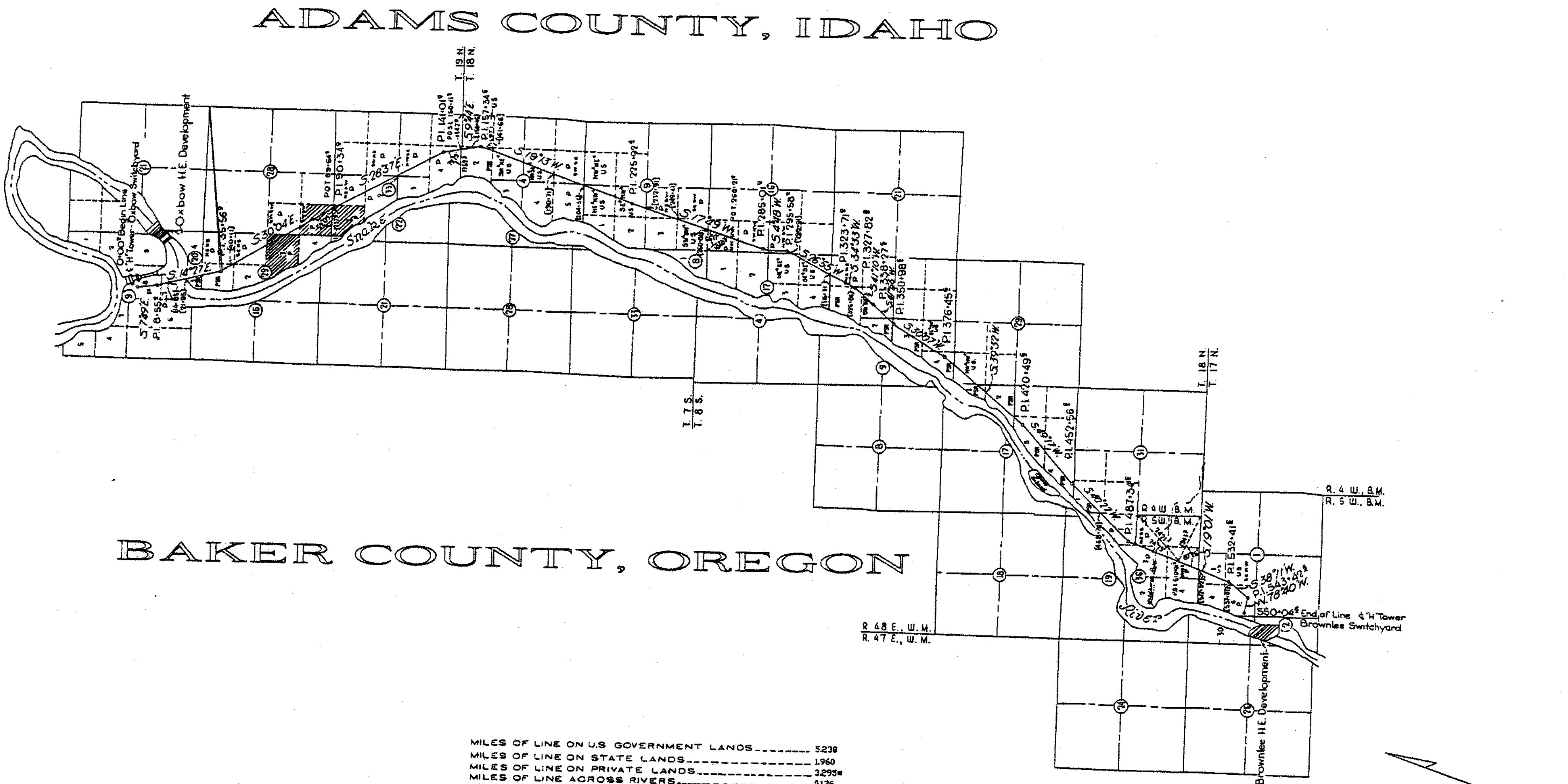
FIGURE 2-10.2.3

BOISE BENCH - MIDPOINT No. 3
230 kV TRANSMISSION LINE

TRANSMISSION LINE DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

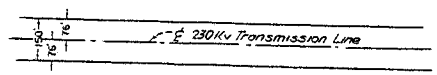


ACRES OF ROW ON U.S. LAND OUTSIDE ANY PROJECT BOUNDARY	71.117
ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY	81.824
ACRES OF ROW ON U.S. LAND WITHIN OXBOW PROJECT BOUNDARY	24.122
ACRES OF ROW ON PRIVATE LAND WITHIN OXBOW PROECT BOUNDARY	5.492
ACRES OF ROW ON PRIVATE LAND WITHIN BROWNLEE PROJECT BOUNDARY	4.366
ACRES OF ROW CROSSING THE SNAKE RIVER WITHIN PROJECT BOUNDARIES	2.479
TOTAL ROW ACRES	189.400

MILES OF LINE ON U.S GOVERNMENT LANDS	5.238
MILES OF LINE ON STATE LANDS	1.960
MILES OF LINE ON PRIVATE LANDS	3.295*
MILES OF LINE ACROSS RIVERS	0.136
TOTAL MILES OF LINE	10.417

* INCLUDES 0.526 MILES ON PRIVATE LANDS (SHOWN ▨) PATENTED SUBJECT TO SEC. 24 OF FEDERAL POWER ACT.

LEGEND:
U.S. ---------- U.S. GOVERNMENT LANDS
P ---------- PRIVATE OR STATE LANDS



Right of way to be 150 feet; 75 feet on either side of centerline

NOTE:
OPERATED AS:
1.OXBOW - BROWNLEE (905)

2000 1000 0 2000 4000 6000 8000
Scale In Feet

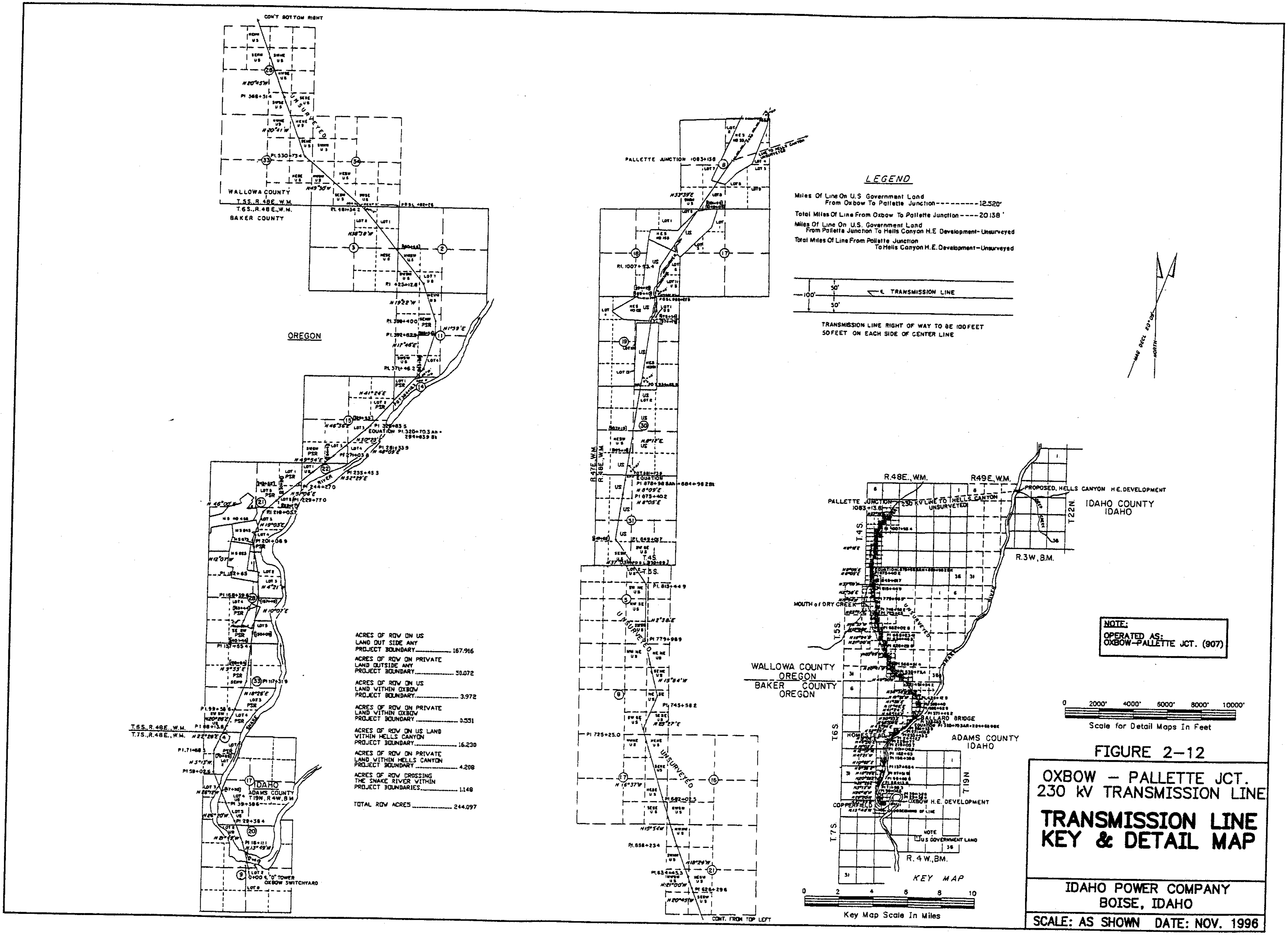
FIGURE 2-11

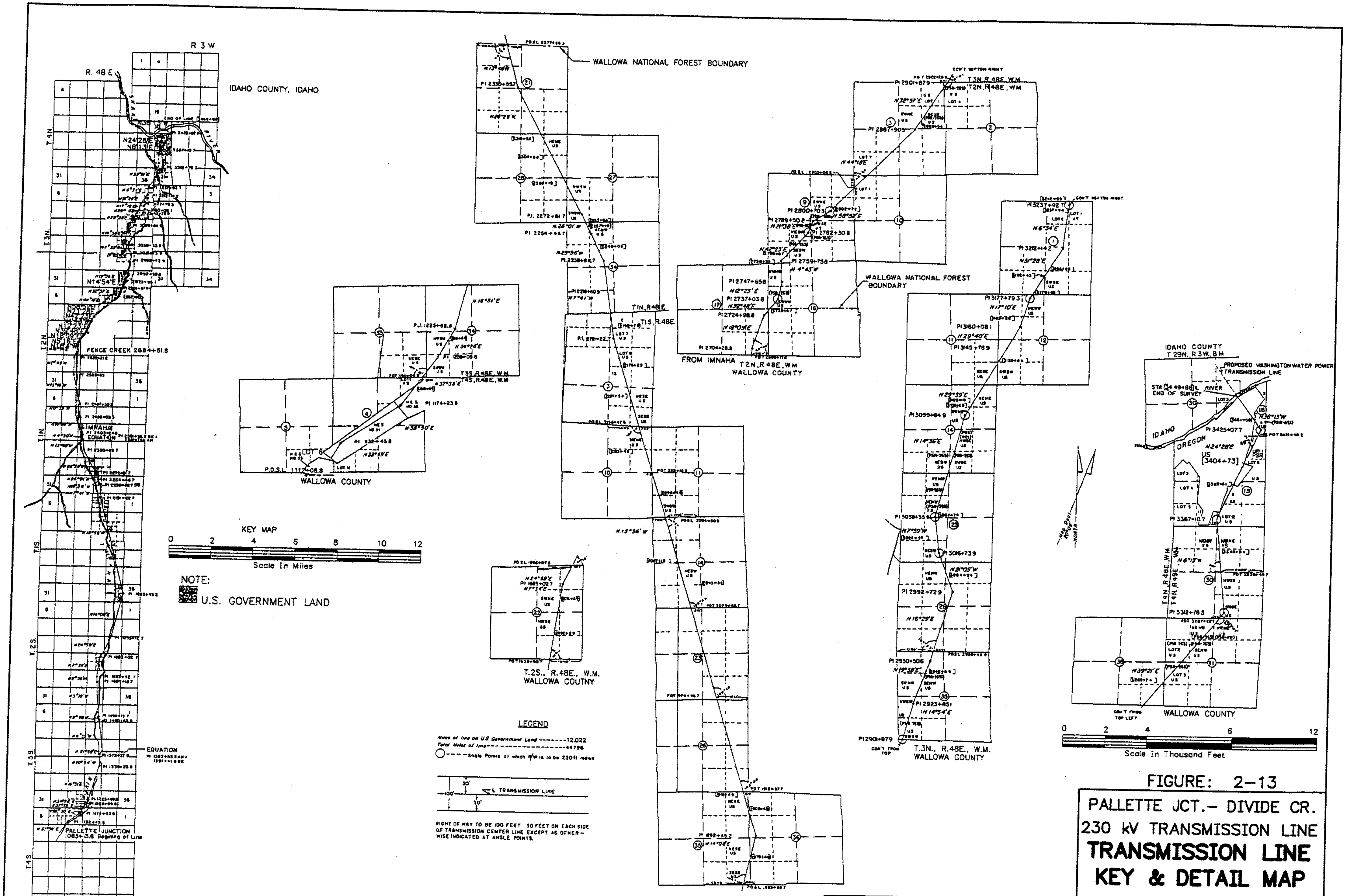
OXBOW - BROWNLEE
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY & DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996


LEGEND
Miles Of Line On U.S Government Land From Oxbow To Pallette Junction----------12.520'
Total Miles Of Line From Oxbow To Pallette Junction----20.138'
Miles Of Line On U.S. Government Land From Pallette Junction To Hells Canyon H.E Development- Unsurveyed
Total Miles Of Line From Pallette Junction To Hells Canyon H.E. Development-Unsurveyed
TRANSMISSION LINE
TRANSMISSION LINE RIGHT OF WAY TO BE 100FEET 50FEET ON EACH SIDE OF CENTER LINE
ACRES OF ROW ON US LAND OUT SIDE ANY PROJECT BOUNDARY 167.916
ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY 50.072
ACRES OF ROW ON US LAND WITHIN OXBOW PROJECT BOUNDARY 3.972
ACRES OF ROW ON PRIVATE LAND WITHIN OXBOW PROJECT BOUNDARY 0.551
ACRES OF ROW ON US LAND WITHIN HELLS CANYON PROJECT BOUNDARY 16.230
ACRES OF ROW ON PRIVATE LAND WITHIN HELLS CANYON PROJECT BOUNDARY 4.208
ACRES OF ROW CROSSING THE SNAKE RIVER WITHIN PROJECT BOUNDARIES 1.148
TOTAL ROW ACRES 244.097
OREGON
WALLOWA COUNTY
BAKER COUNTY
IDAHO
ADAMS COUNTY T19N, R.4W, B.M
PALLETTE JUNCTION 1083+138
OXBOW SWITCHYARD
CON'T BOTTOM RIGHT
CONT. FROM TOP LEFT
UNSURVEYED
R.48E., WM.
R49E, WM.
PROPOSED HELLS CANYON H.E. DEVELOPMENT
IDAHO COUNTY IDAHO
R.3W, B.M.
MOUTH of DRY CREEK
WALLOWA COUNTY OREGON
BAKER COUNTY OREGON
BALLARD BRIDGE
HOMESTEAD
COPPERFIELD
OXBOW H.E. DEVELOPMENT
ADAMS COUNTY IDAHO
R. 4 W., BM.
KEY MAP
Key Map Scale In Miles
NOTE:
OPERATED AS: OXBOW-PALLETTE JCT. (907)
Scale for Detail Maps In Feet
FIGURE 2-12
OXBOW – PALLETTE JCT. 230 kV TRANSMISSION LINE
TRANSMISSION LINE KEY & DETAIL MAP
IDAHO POWER COMPANY BOISE, IDAHO
SCALE: AS SHOWN DATE: NOV. 1996



NOTE:
OPERATED AS:
1. PALLETTE JUNCTION – IMNAHA (908)
2. IMNAHA – DIVIDE CREEK (909)

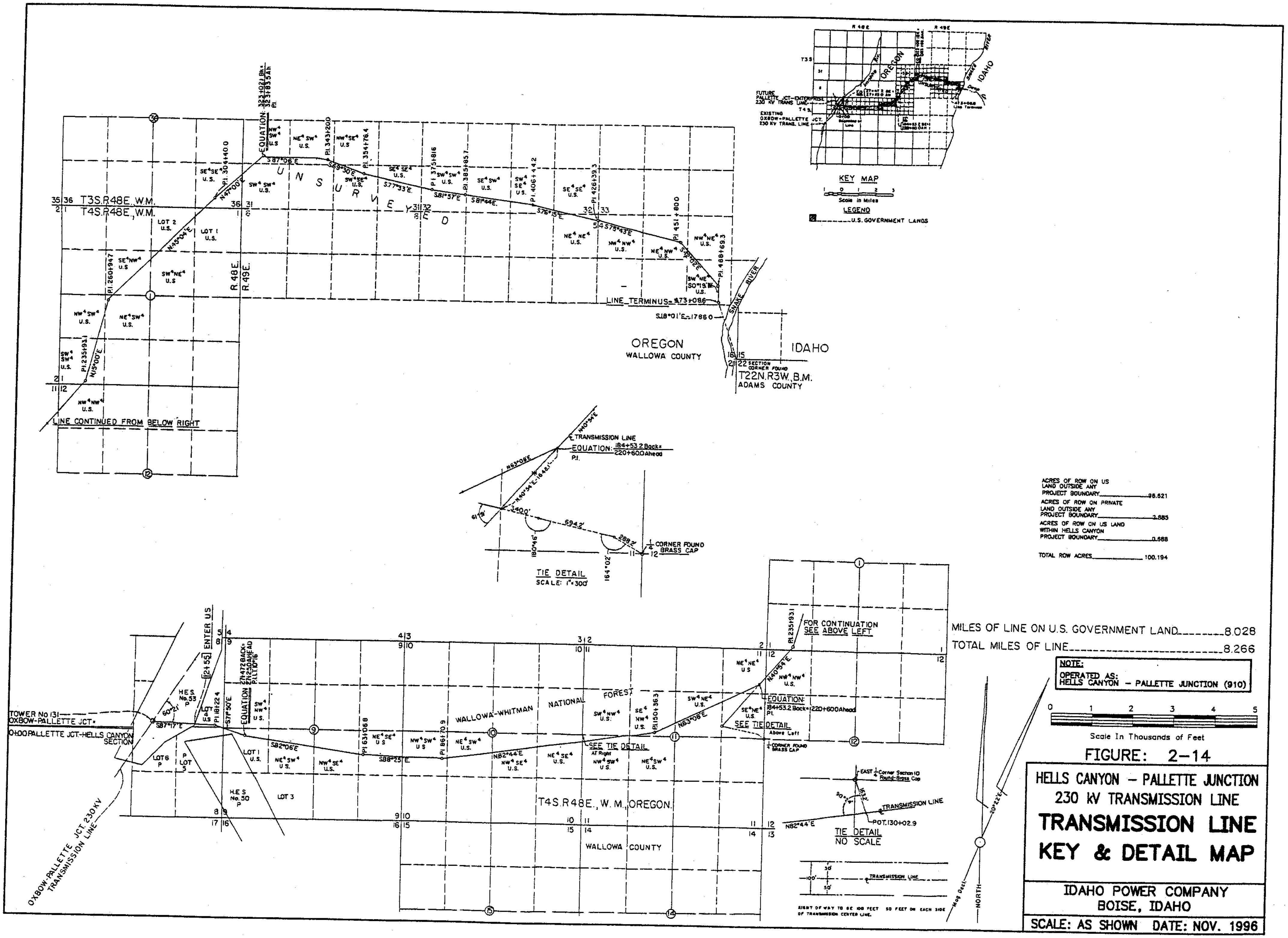
FIGURE: 2–13

PALLETTE JCT.– DIVIDE CR.
230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY & DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



HELLS CANYON - PALLETTE JUNCTION
230 kV TRANSMISSION LINE
TRANSMISSION LINE
KEY & DETAIL MAP
IDAHO POWER COMPANY
BOISE, IDAHO
SCALE: AS SHOWN DATE: NOV. 1996
FIGURE: 2-14
NOTE:
OPERATED AS:
HELLS CANYON - PALLETTE JUNCTION (910)
MILES OF LINE ON U.S. GOVERNMENT LAND 8.028
TOTAL MILES OF LINE 8.266
ACRES OF ROW ON US LAND OUTSIDE ANY PROJECT BOUNDARY 96.521
ACRES OF ROW ON PRIVATE LAND OUTSIDE ANY PROJECT BOUNDARY 2.885
ACRES OF ROW ON US LAND WITHIN HELLS CANYON PROJECT BOUNDARY 0.688
TOTAL ROW ACRES 100.194
Scale In Thousands of Feet
KEY MAP
Scale in Miles
LEGEND
U.S. GOVERNMENT LANDS
T3S.R48E.,W.M.
T4S.R48E.,W.M.
UNSURVEYED
LINE TERMINUS
OREGON
WALLOWA COUNTY
IDAHO
T22N.R3W.,B.M.
ADAMS COUNTY
SNAKE RIVER
LINE CONTINUED FROM BELOW RIGHT
FOR CONTINUATION SEE ABOVE LEFT
TIE DETAIL
SCALE: 1"=300'
TIE DETAIL
NO SCALE
WALLOWA-WHITMAN NATIONAL FOREST
T4S.R48E., W. M., OREGON
WALLOWA COUNTY
TOWER No 131 OXBOW-PALLETTE JCT
0+00 PALLETTE JCT-HELLS CANYON SECTION
OXBOW-PALLETTE JCT 230 KV TRANSMISSION LINE
ENTER US
RIGHT OF WAY TO BE 100 FEET 50 FEET ON EACH SIDE OF TRANSMISSION CENTER LINE.
NORTH

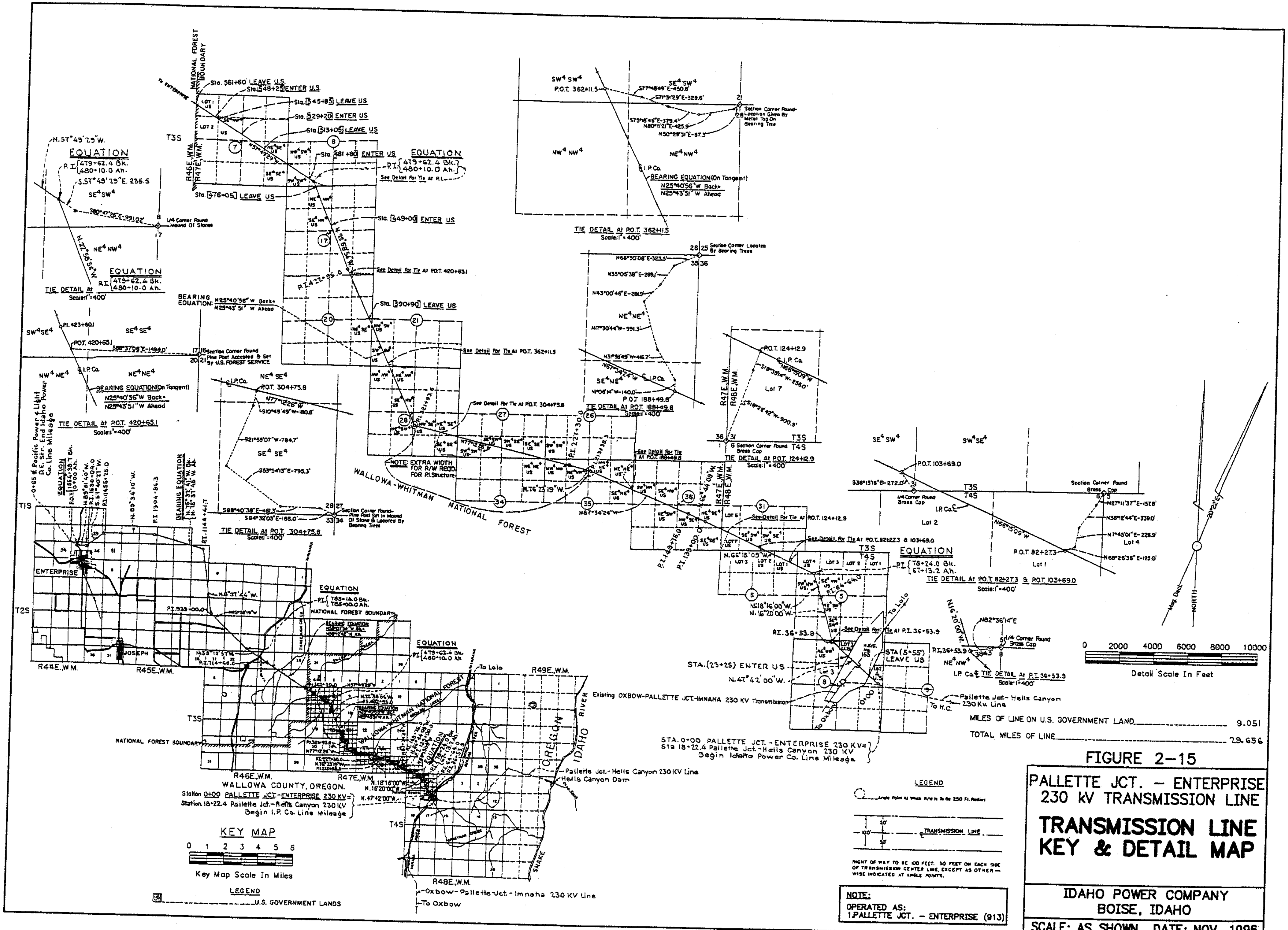


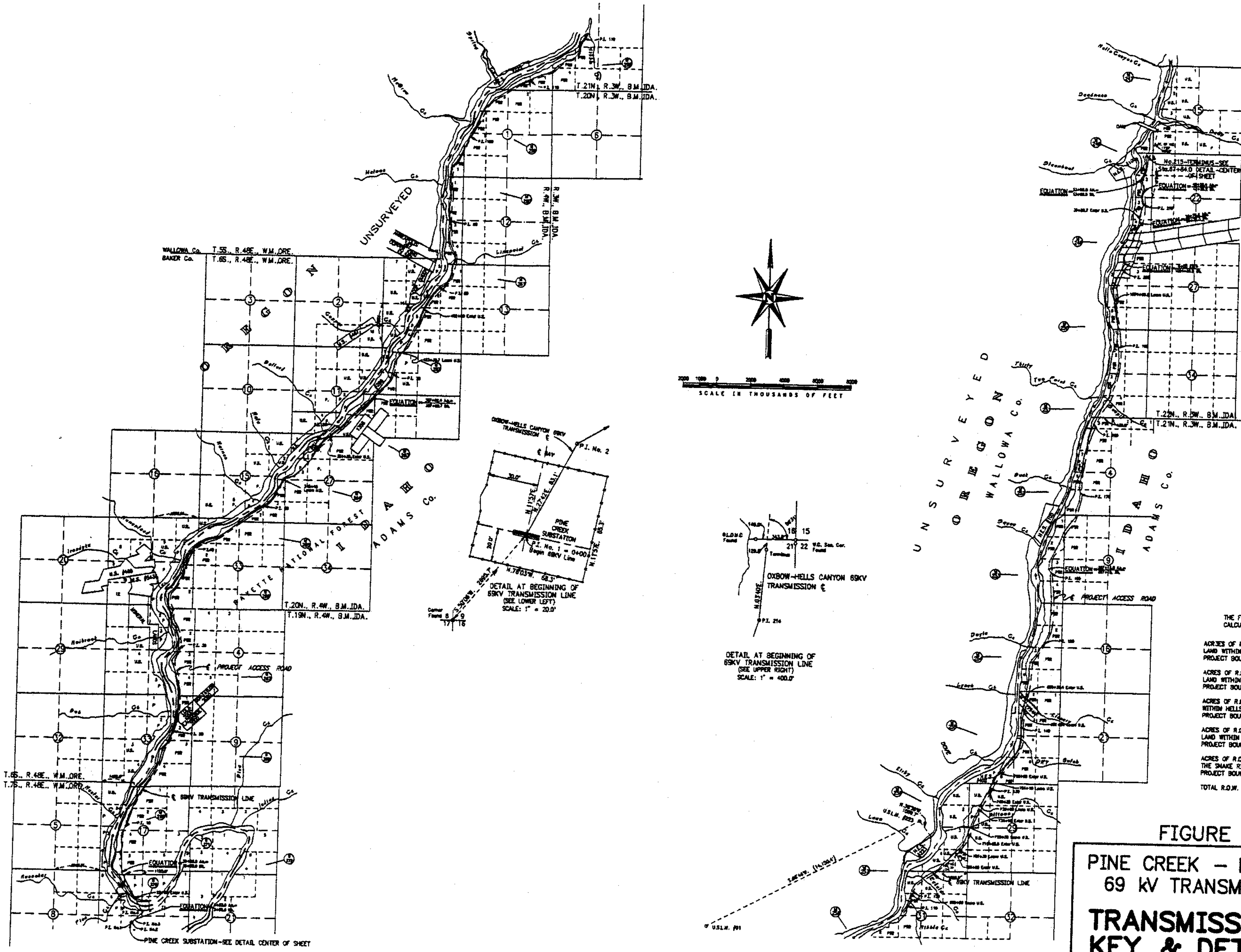
FIGURE 2-15

PALLETTE JCT. - ENTERPRISE 230 kV TRANSMISSION LINE

TRANSMISSION LINE KEY & DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996



THE FOLLOWING ACREAGES WERE CALCULATED USING A 50' R.O.W.

ACRES OF R.O.W. ON U.S LAND WITHIN OXBOW PROJECT BOUNDARY	1.815
ACRES OF R.O.W. ON PRIVATE LAND WITHIN OXBOW PROJECT BOUNDARY	1.948
ACRES OF R.O.W. ON U.S. LAND WITHIN HELLS CANYON PROJECT BOUNDARY	114.295
ACRES OF R.O.W. ON PRIVATE LAND WITHIN HELLS CANYON PROJECT BOUNDARY	13.836
ACRES OF R.O.W. CROSSING THE SNAKE RIVER WITHIN PROJECT BOUNDARIES	0.654
TOTAL R.O.W. ACRES	132.546

	IDAHO	OREGON
MILES OF LINE ON U.S. GOVERNMENT LAND	19.125	
TOTAL MILES OF LINE	21.574	0.348
TOTAL MILES OF LINE (IDAHO & OREGON)	21.922	

NOTE:
OPERATED AS:
1.PINE CREEK – HELLS CANYON (945)

FIGURE 2–16

PINE CREEK – HELLS CANYON 69 kV TRANSMISSION LINE

TRANSMISSION LINE KEY & DETAIL MAP

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

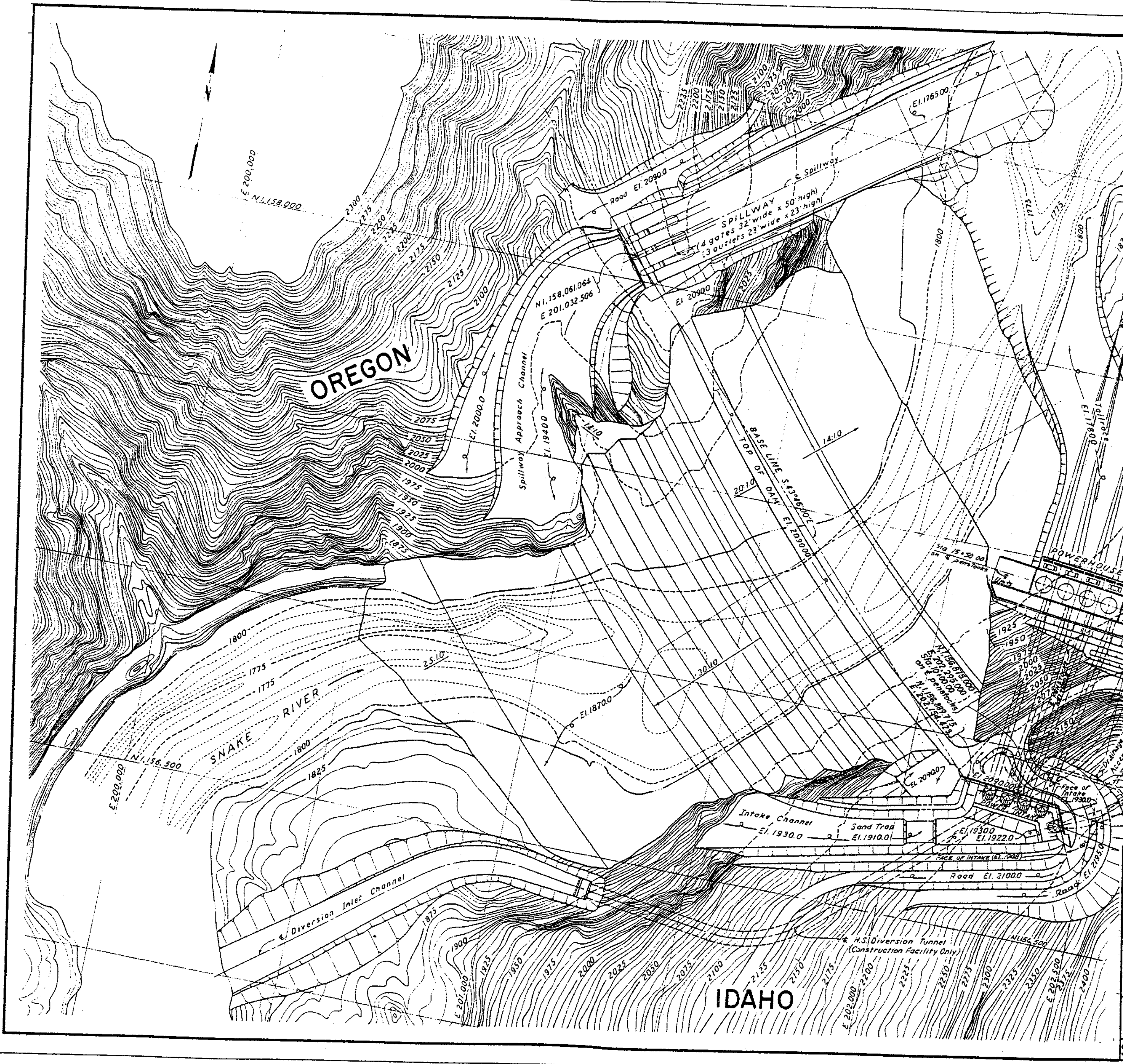


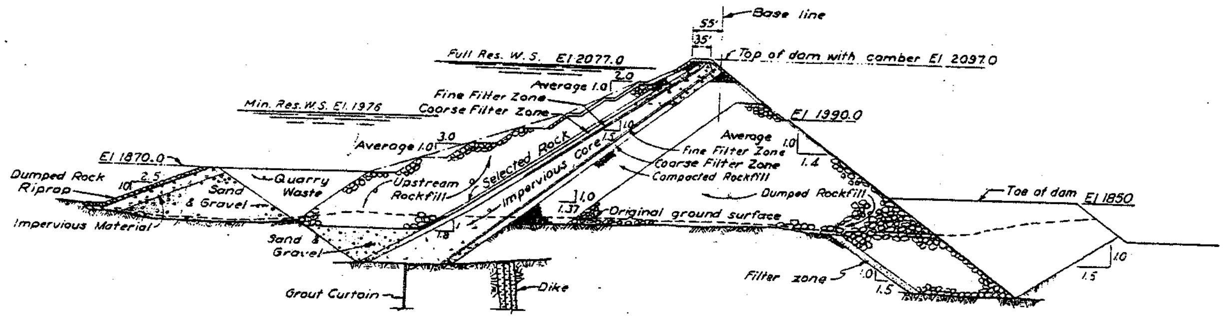
FIGURE: 3-1

BROWNLEE DEVELOPMENT

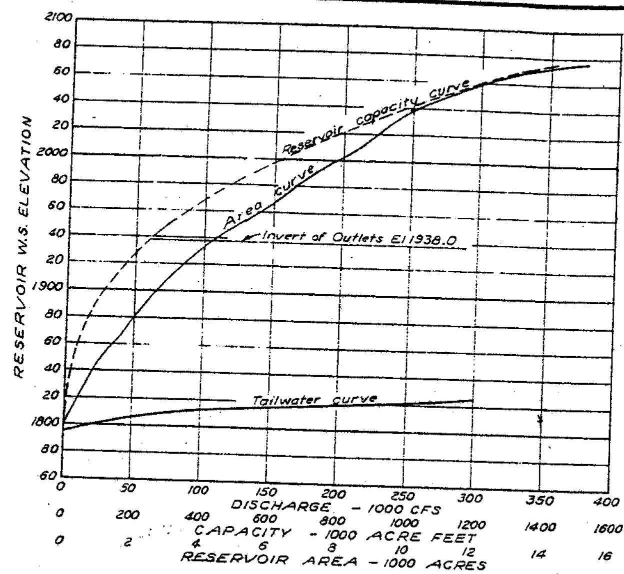
GENERAL PLAN OF PROJECT

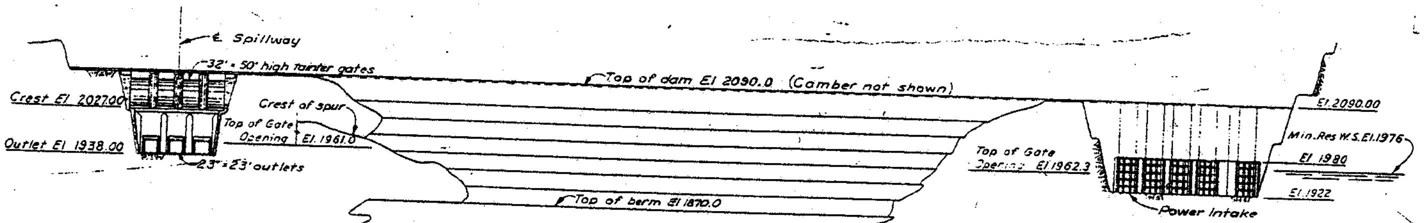
IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996



MAXIMUM SECTION THROUGH DAM
Scale 1" = 100'





DEVELOPED UPSTREAM ELEVATION
OF SPILLWAY, DAM, AND POWER INTAKE
Scale 1" = 100'

FIGURE: 3-2

BROWNLEE DEVELOPMENT

DAM ELEVATION AND SECTION

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

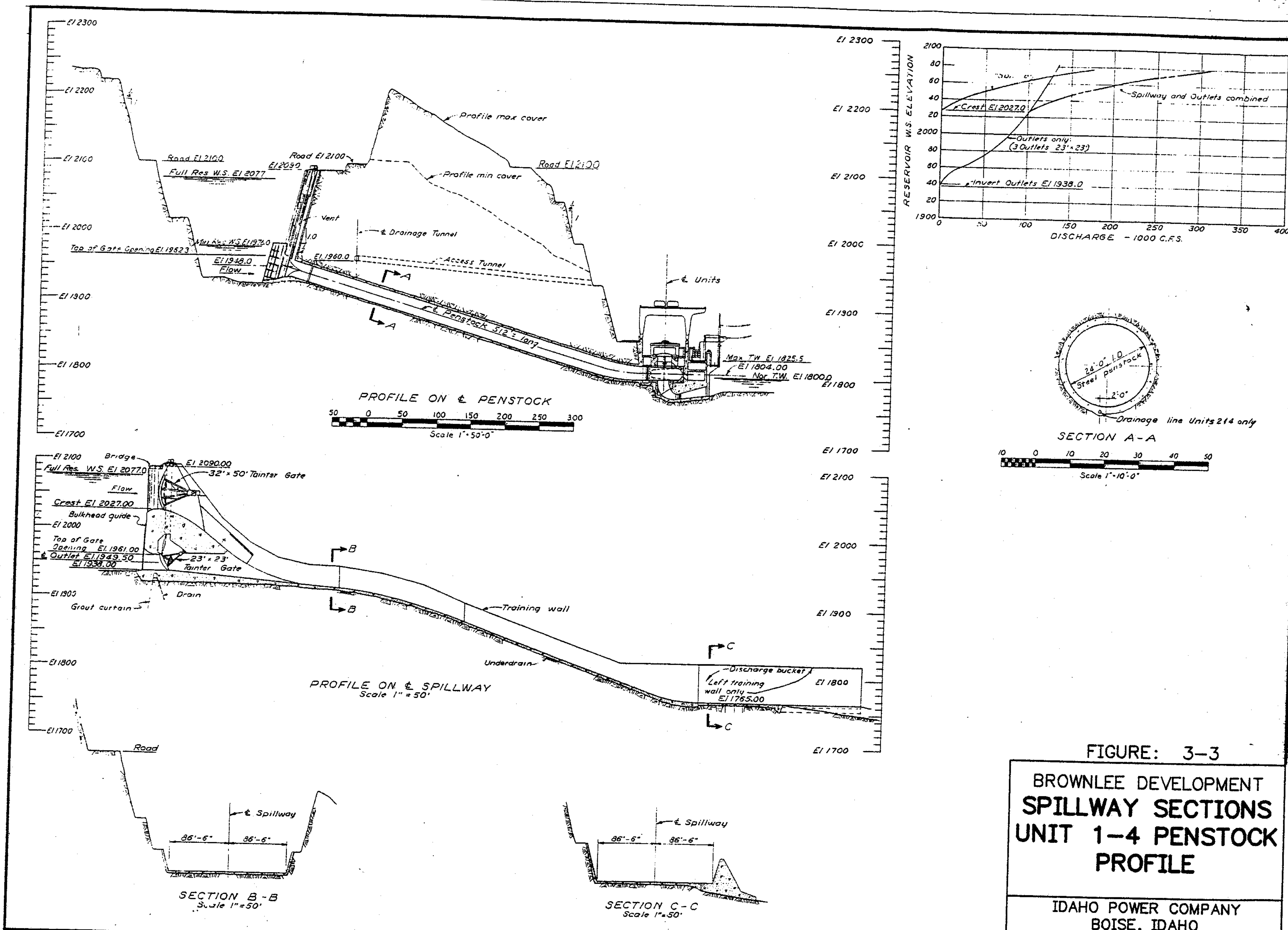


FIGURE: 3-3

BROWNLEE DEVELOPMENT

SPILLWAY SECTIONS UNIT 1-4 PENSTOCK PROFILE

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

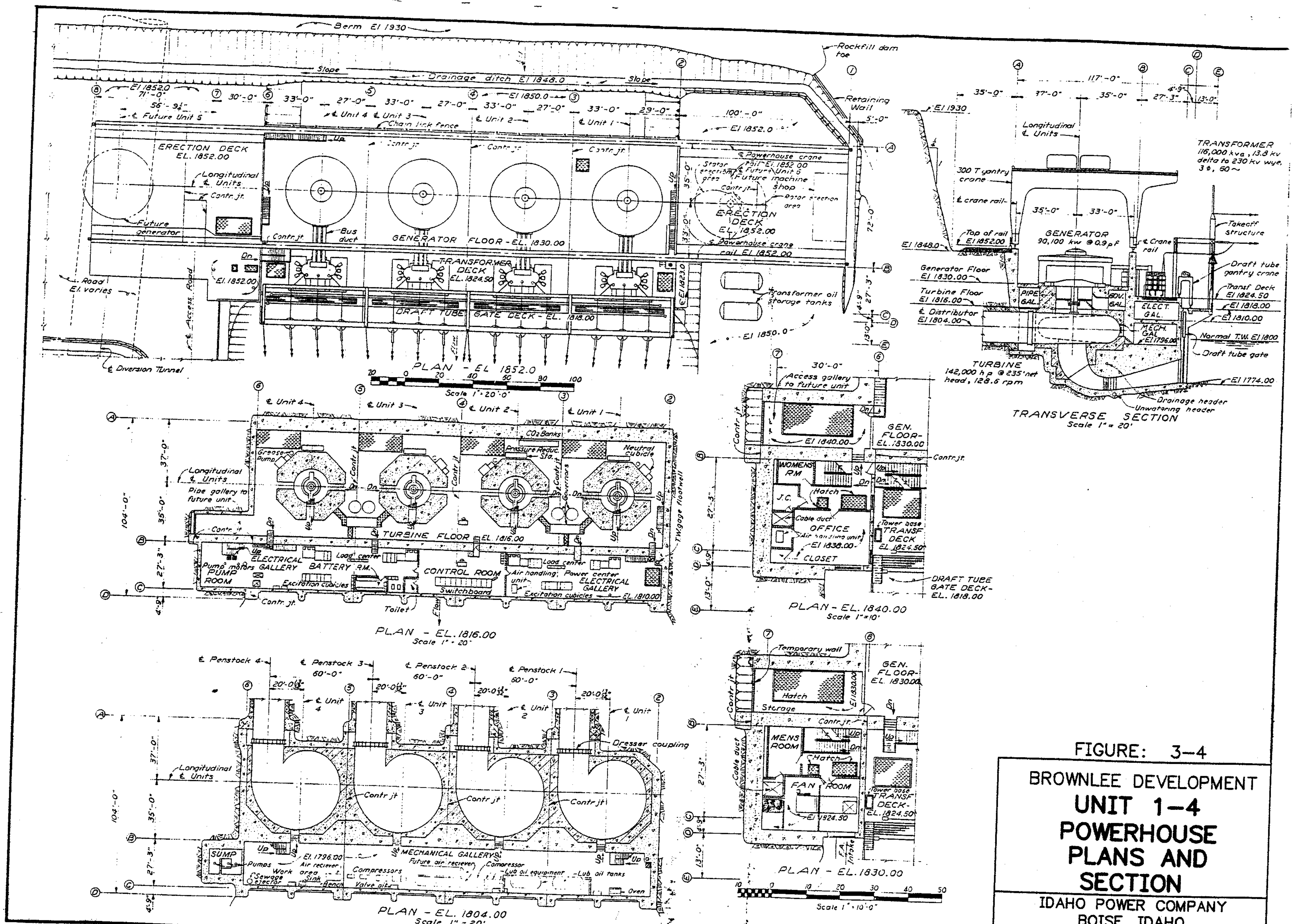


FIGURE: 3-4

BROWNLEE DEVELOPMENT

UNIT 1-4 POWERHOUSE PLANS AND SECTION

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

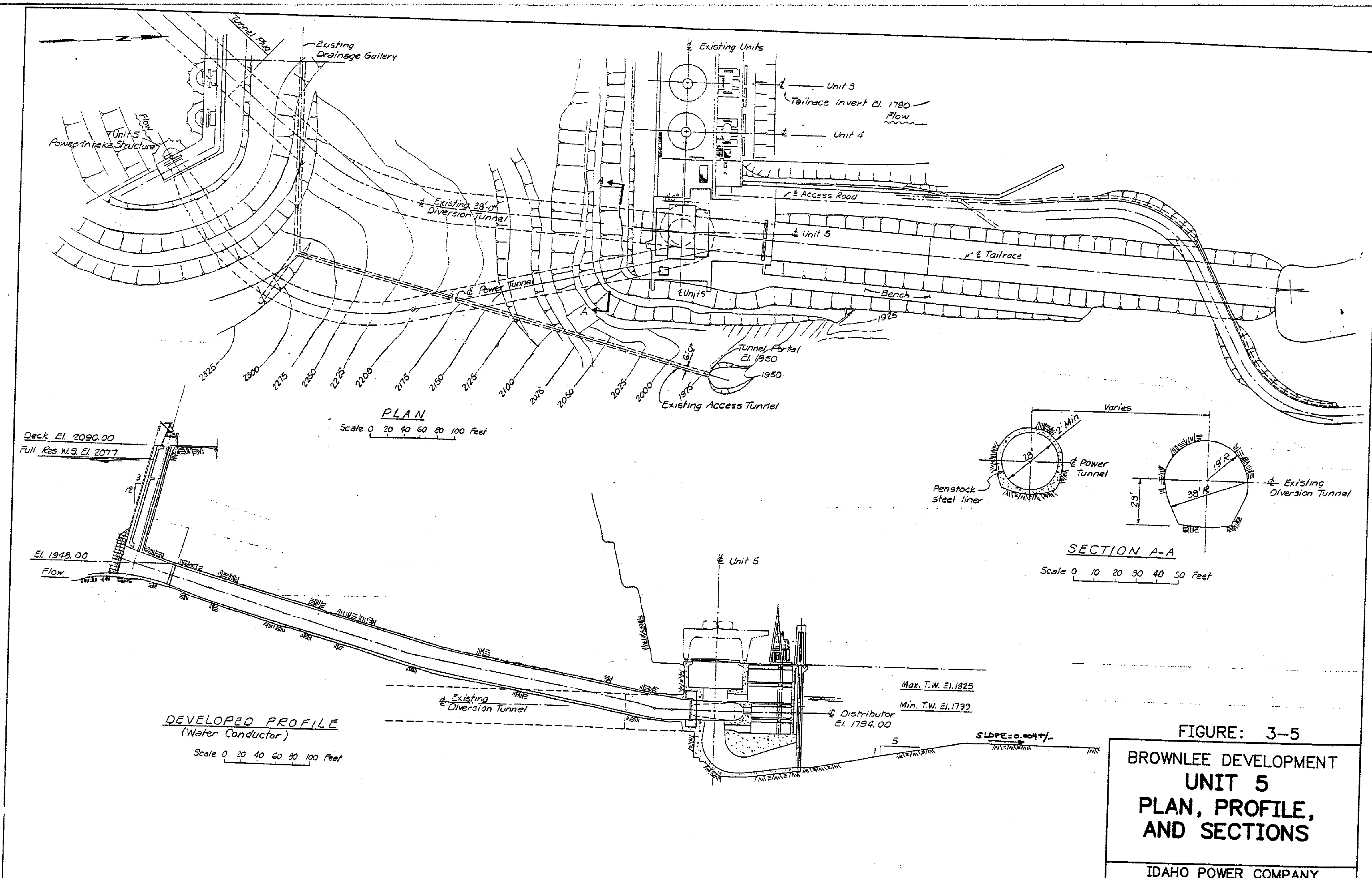


FIGURE: 3-5

BROWNLEE DEVELOPMENT
UNIT 5
PLAN, PROFILE, AND SECTIONS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

FIGURE: 3–6

OWBOW DEVELOPMENT

GENERAL PLAN OF PROJECT

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

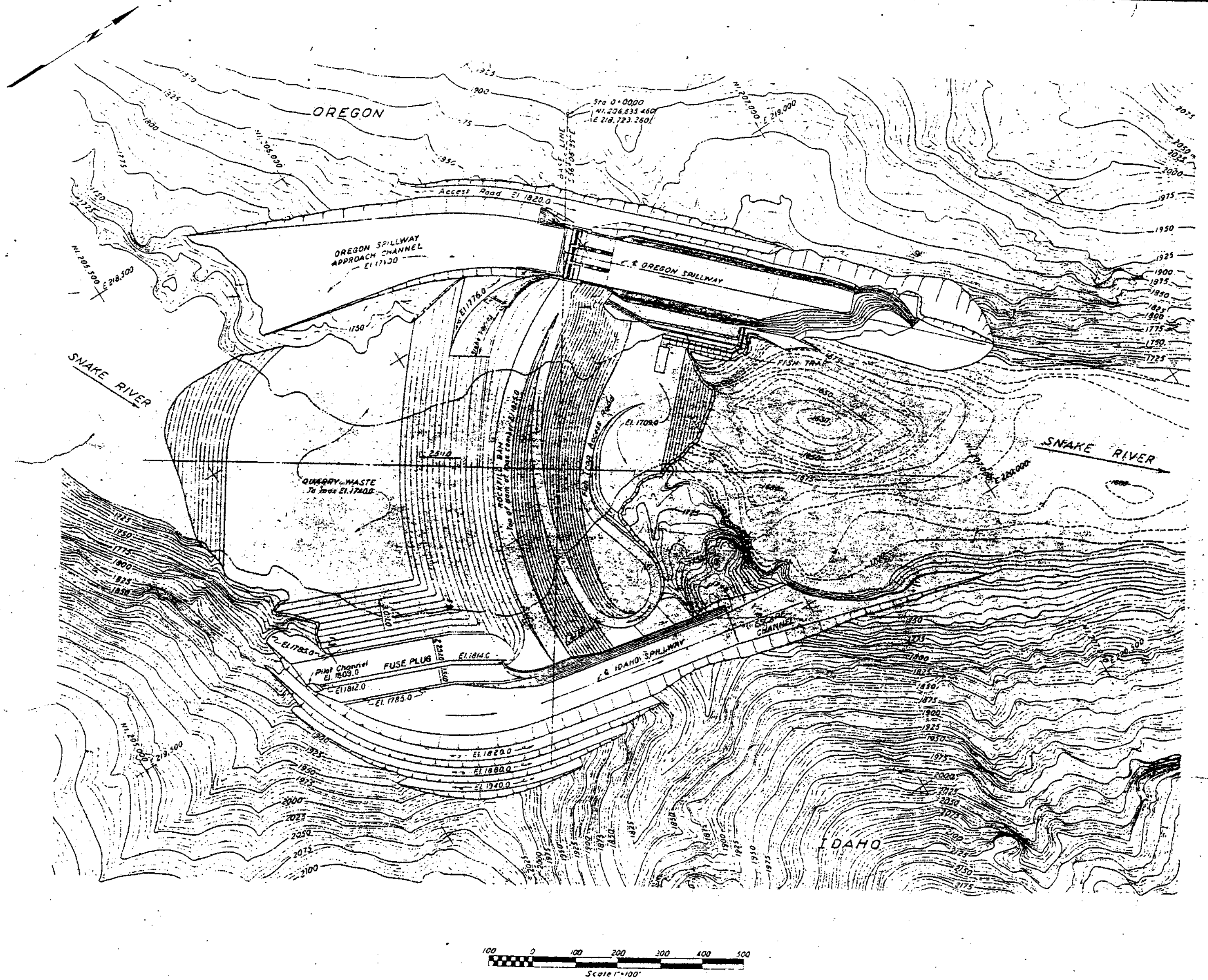


FIGURE: 3-7

OXBOW DEVELOPMENT

DAM AND SPILLWAYS PLAN

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE:AS SHOWN DATE: NOV.1996

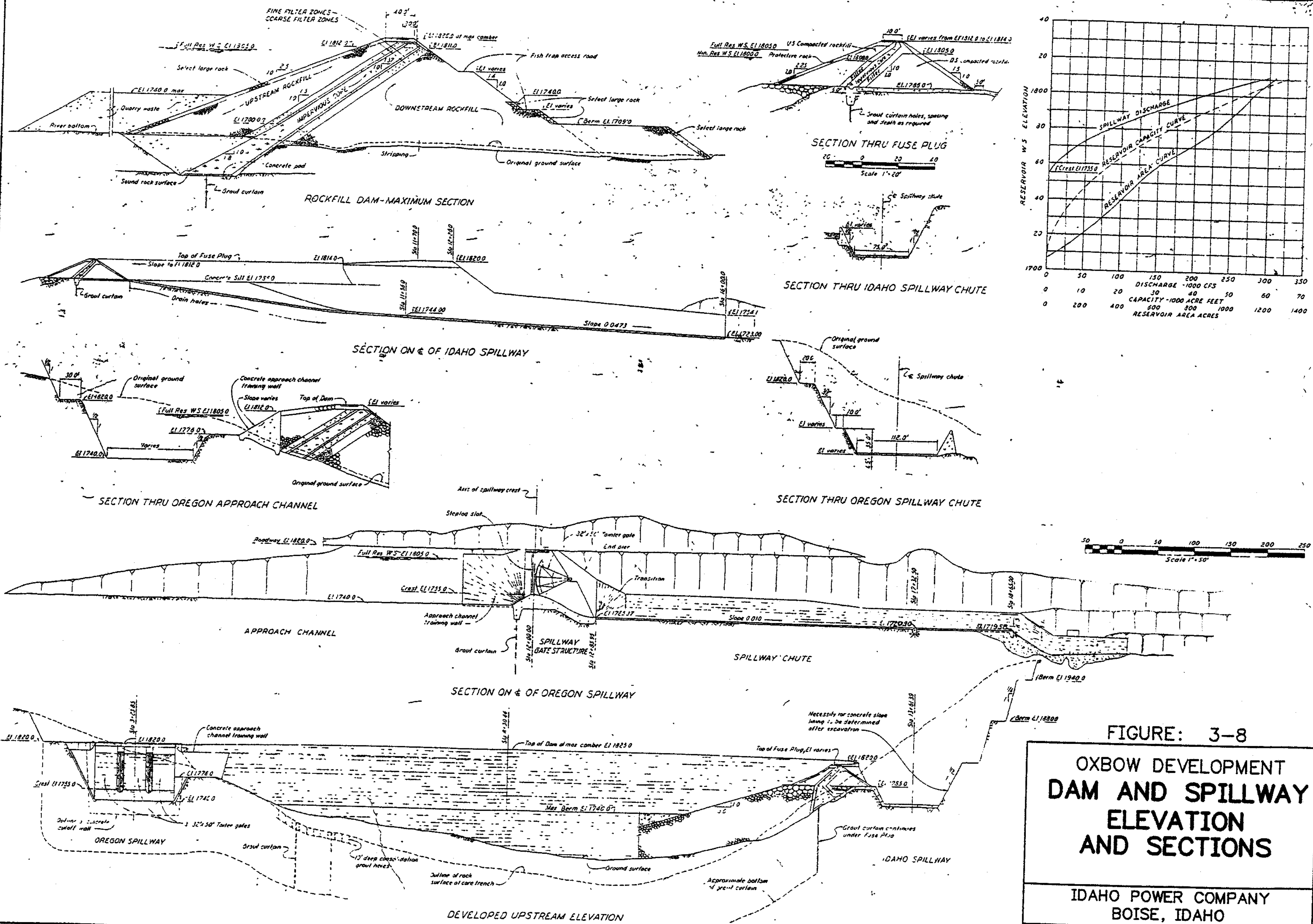


FIGURE: 3-8

OXBOW DEVELOPMENT

DAM AND SPILLWAY ELEVATION AND SECTIONS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE:AS SHOWN DATE: NOV.1996

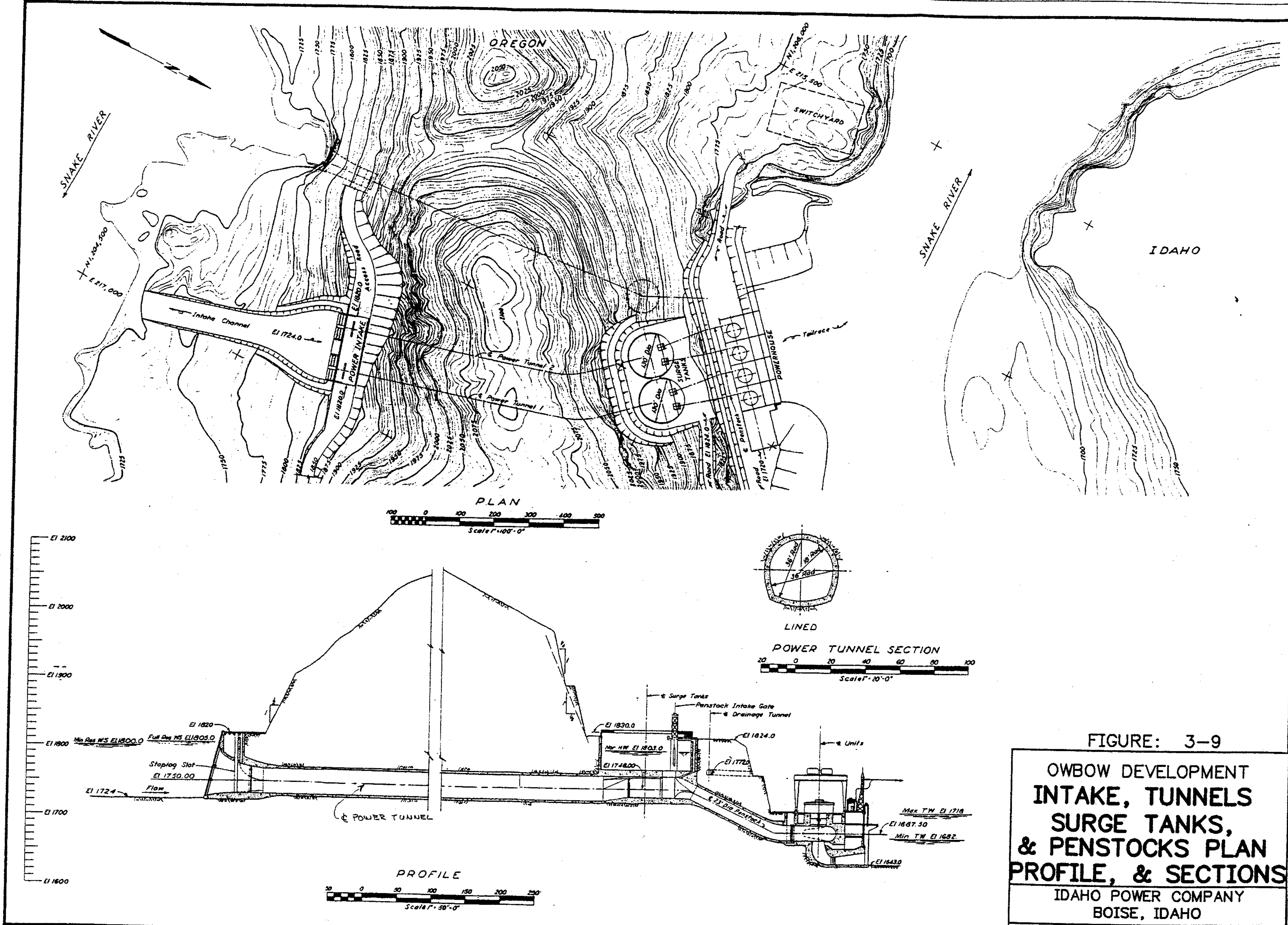


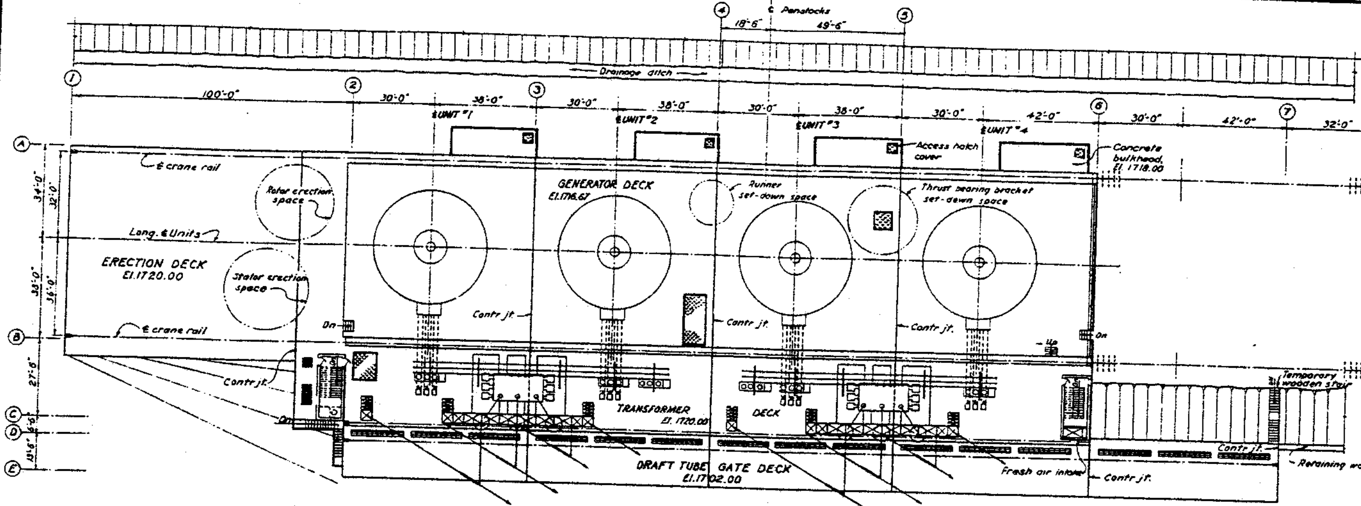
FIGURE: 3-9

OWBOW DEVELOPMENT

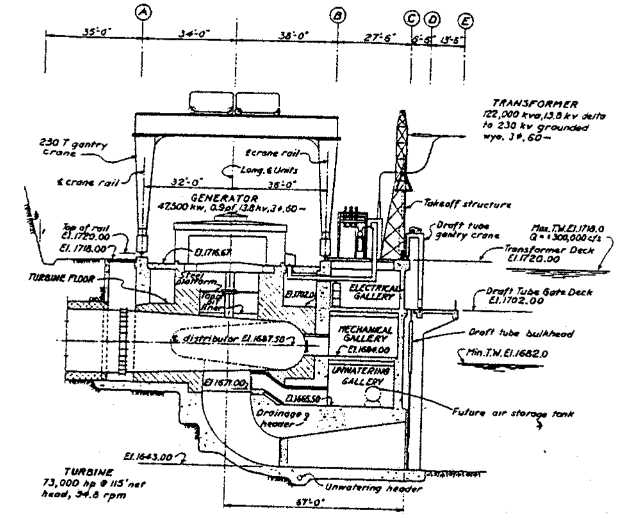
INTAKE, TUNNELS SURGE TANKS, & PENSTOCKS PLAN PROFILE, & SECTIONS

IDAHO POWER COMPANY
BOISE, IDAHO

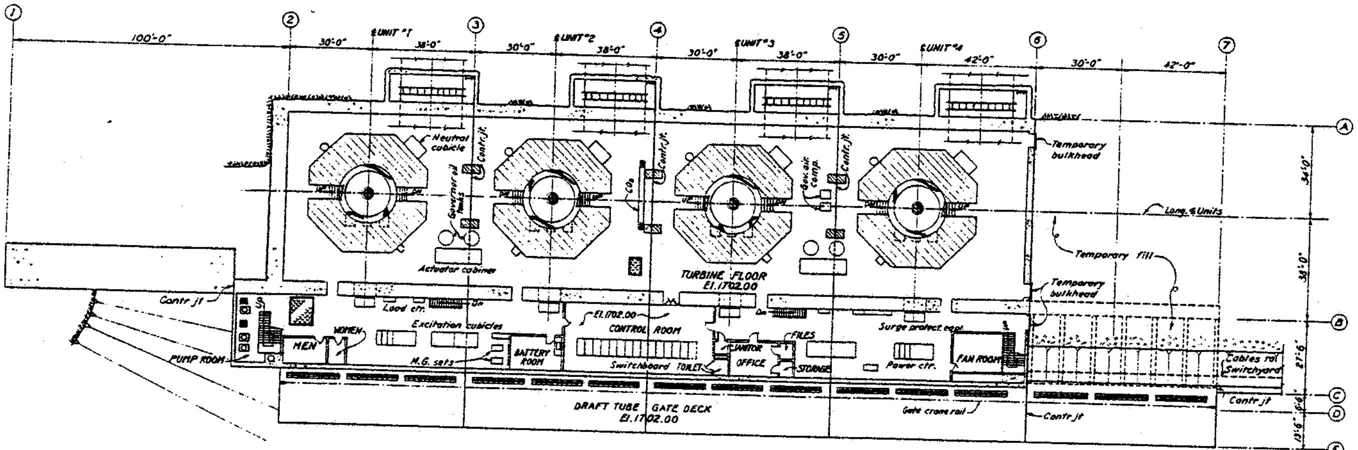
SCALE: AS SHOWN DATE: NOV.1996



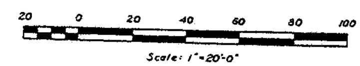
PLAN - ELEV. 1720.00
Scale: 1"=20'

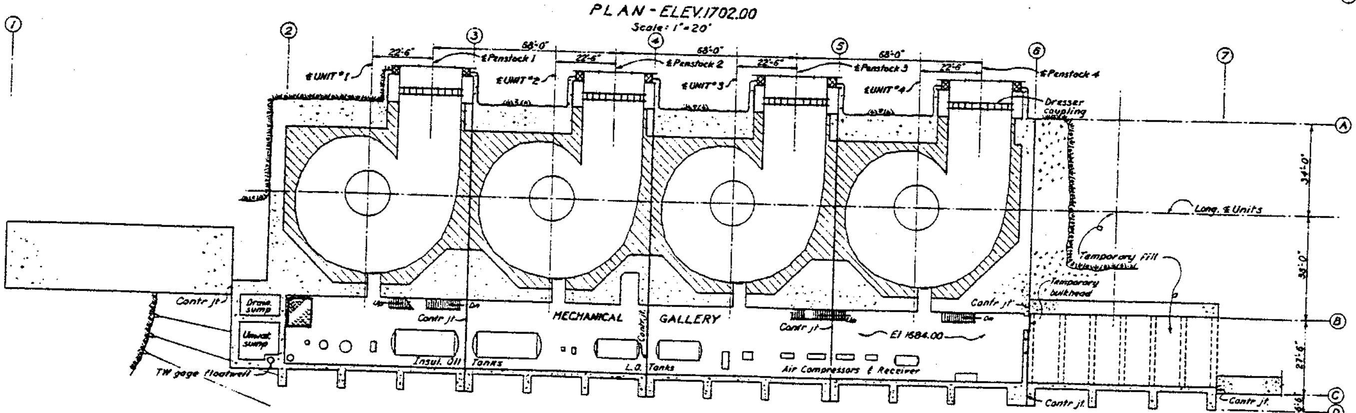


TRANSVERSE SECTION
Scale: 1"=20'



PLAN - ELEV. 1702.00
Scale: 1"=20'





PLAN - ELEV. 1687.50
Scale: 1"=20'

FIGURE: 3-10

OXBOW DEVELOPMENT

POWERHOUSE PLANS AND SECTION

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

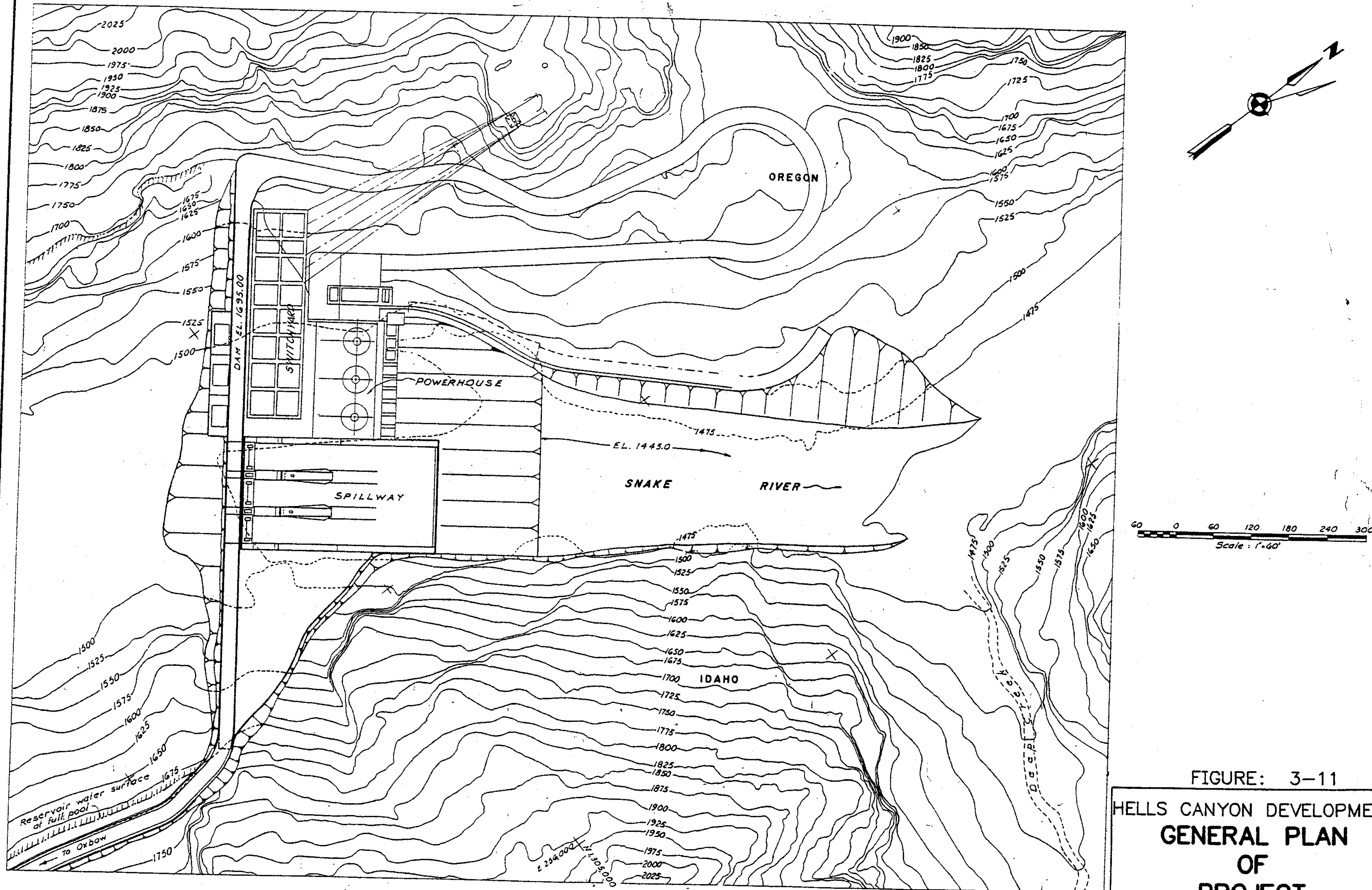


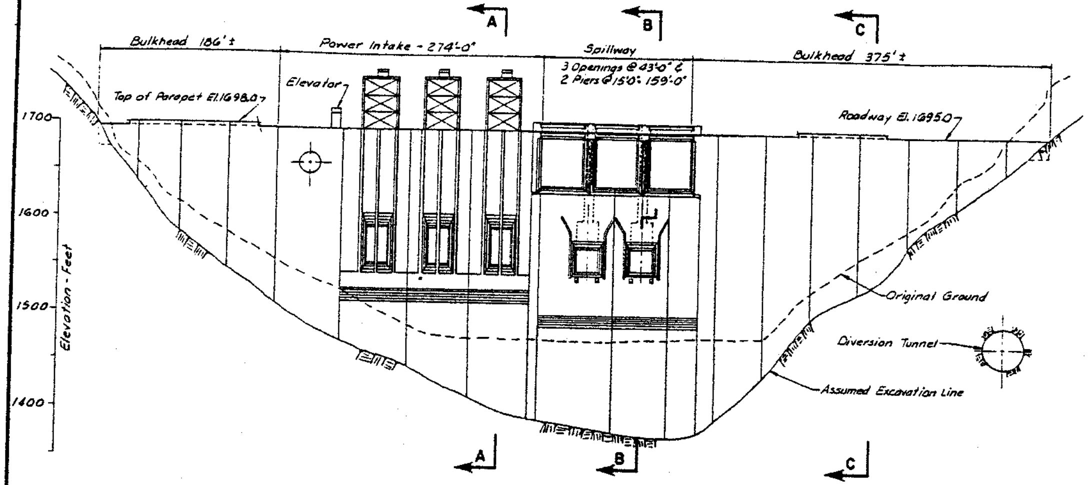
FIGURE: 3-11

HELLS CANYON DEVELOPMENT

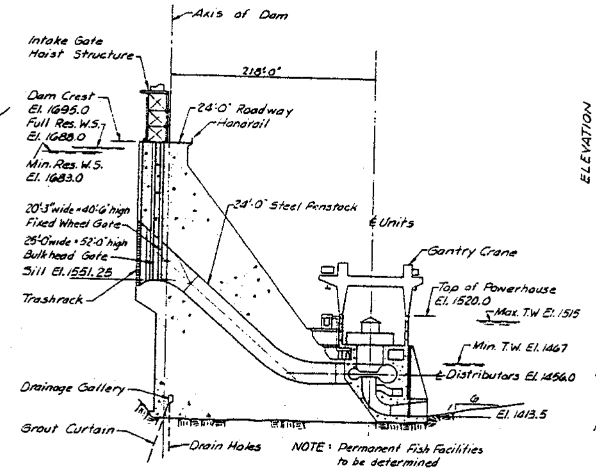
GENERAL PLAN OF PROJECT

IDAHO POWER COMPANY
BOISE, IDAHO

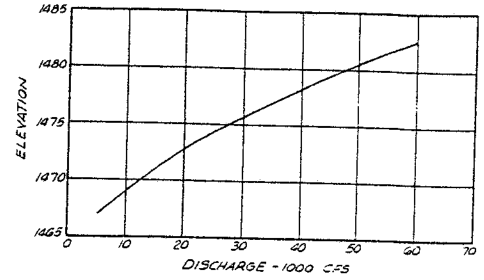
SCALE:AS SHOWN DATE: NOV.1996



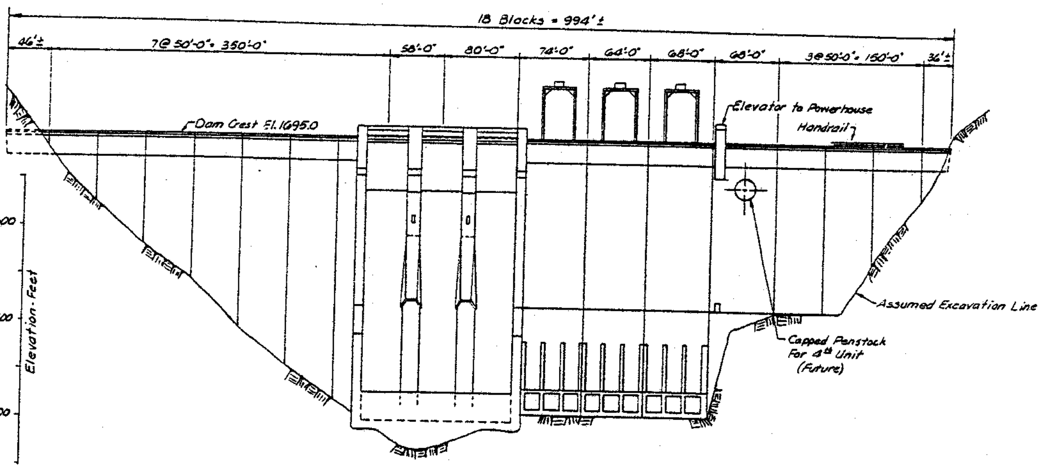
UPSTREAM ELEVATION



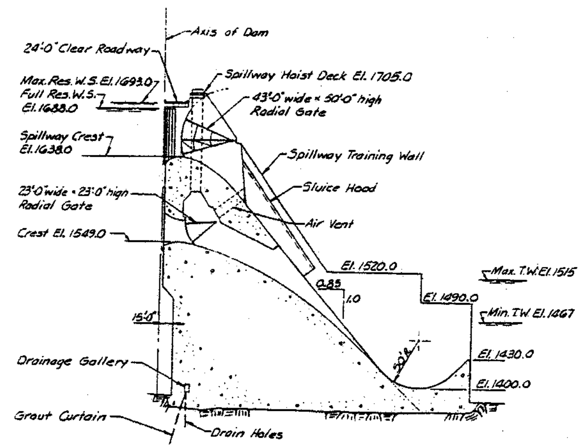
SECTION A-A



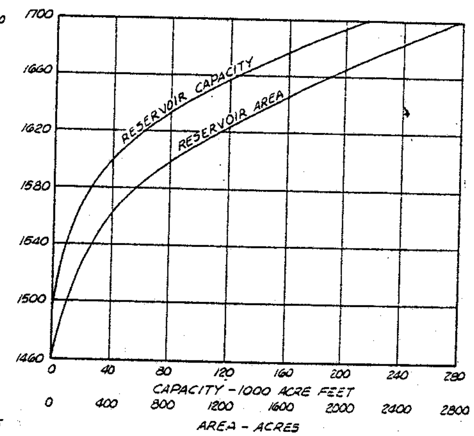
TAILWATER RATING CURVE



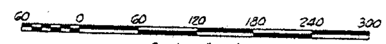
DOWNSTREAM ELEVATION



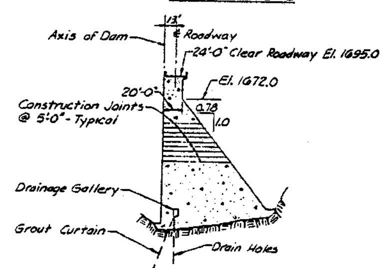
SECTION B-B



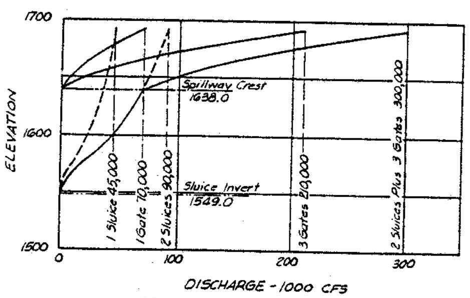
AREA-CAPACITY CURVES



Scale : 1" = 60'



SECTION C-C



SPILLWAY RATING CURVE

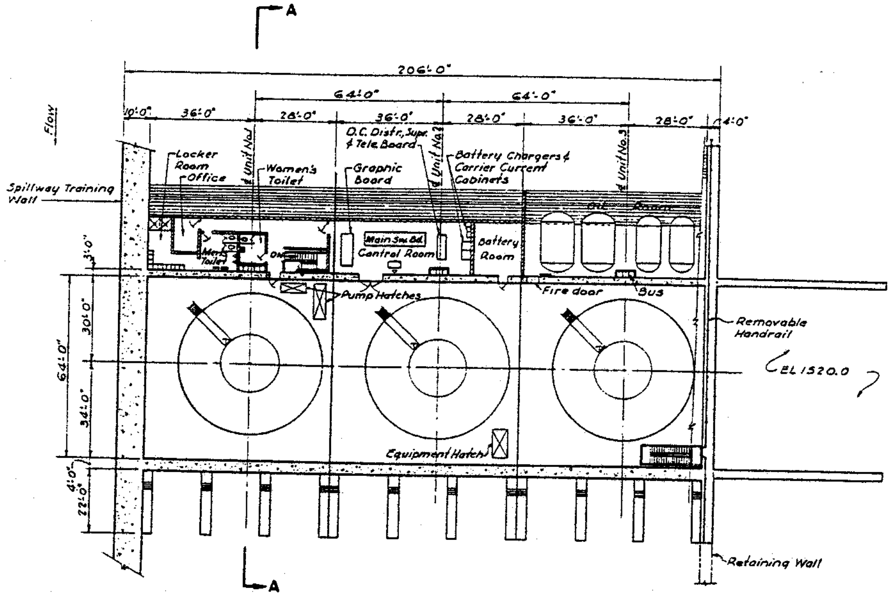
FIGURE: 3-12

HELLS CANYON DEVELOPMENT

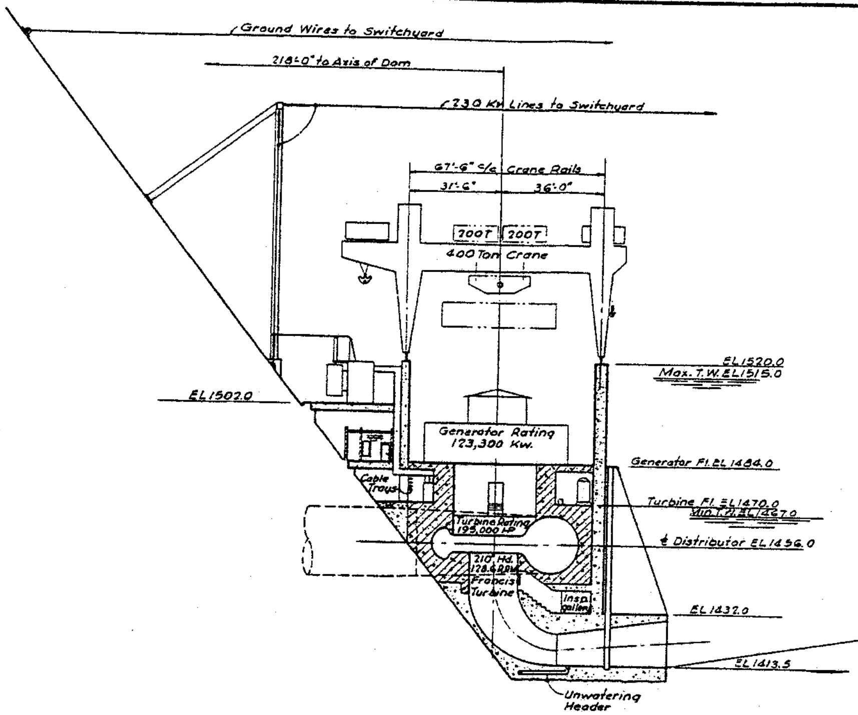
ELEVATIONS AND SECTIONS

IDAHO POWER COMPANY
BOISE, IDAHO

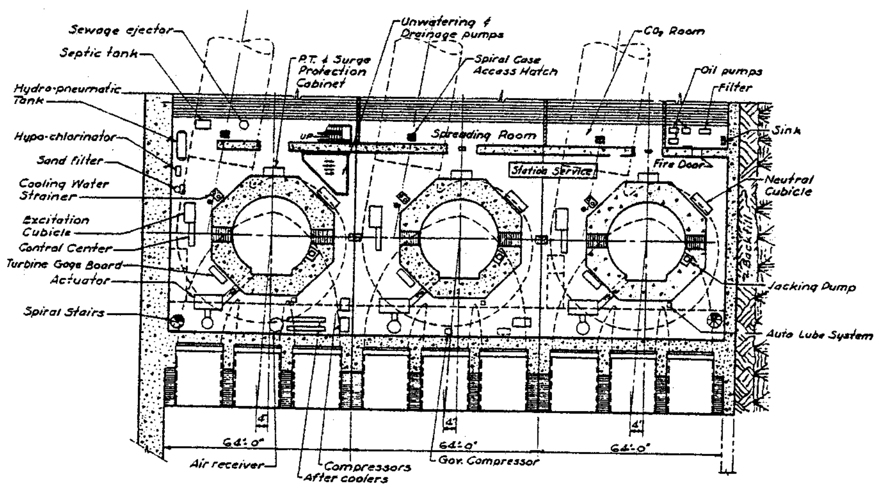
SCALE: AS SHOWN DATE: NOV. 1996



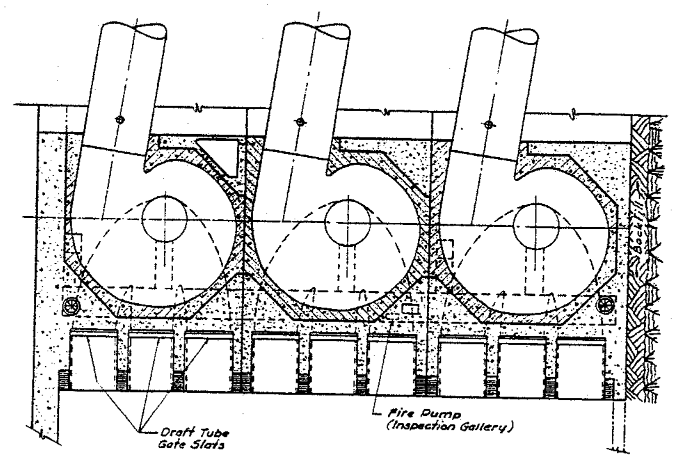
PLAN
GENERATOR FLOOR EL1484.0



TRANSVERSE SECTION
THROUGH ℄ OF UNIT NO.1
A-A



PLAN
TURBINE FLOOR EL1470.0



PLAN
℄ DISTRIBUTOR EL1456.0

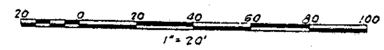


FIGURE: 3-13

HELLS CANYON DEVELOPMENT

POWERHOUSE PLAN AND SECTION VIEWS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

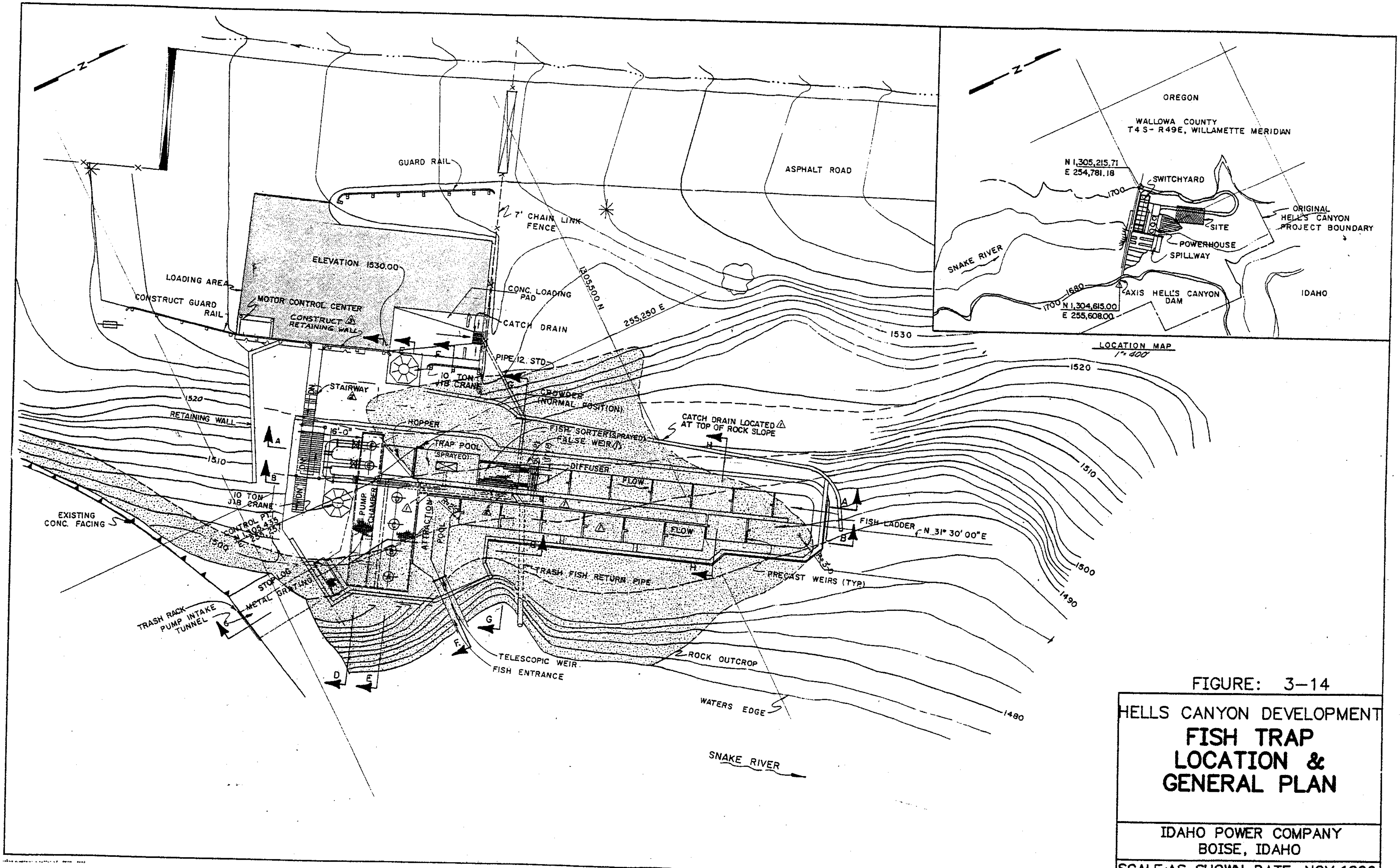


FIGURE: 3–14

HELLS CANYON DEVELOPMENT

FISH TRAP LOCATION & GENERAL PLAN

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV.1996

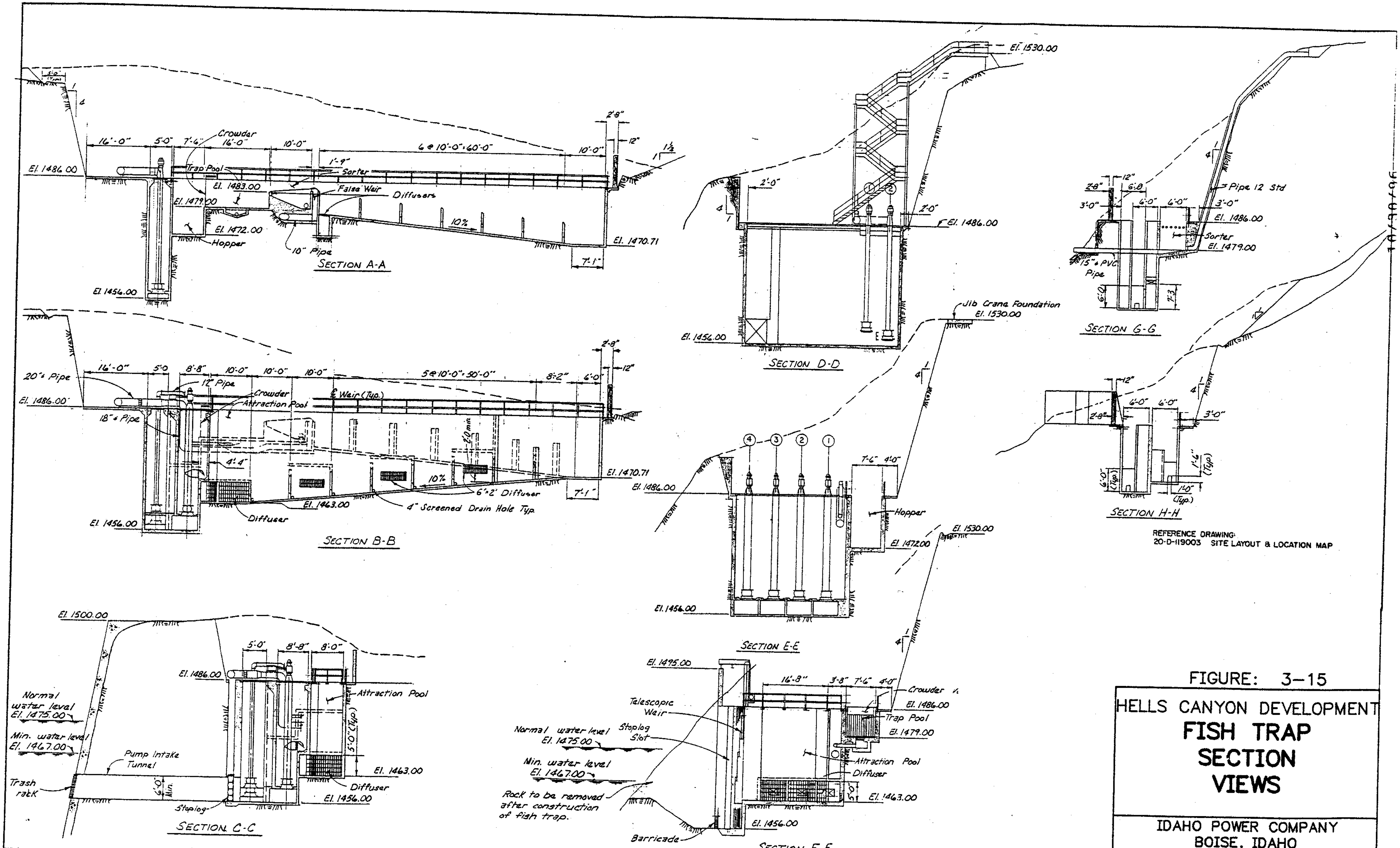


FIGURE: 3–15

HELLS CANYON DEVELOPMENT

FISH TRAP SECTION VIEWS

IDAHO POWER COMPANY
BOISE, IDAHO

SCALE: AS SHOWN DATE: NOV. 1996

BROWNLEE RESERVOIR: AREA AND CAPACITY CURVES

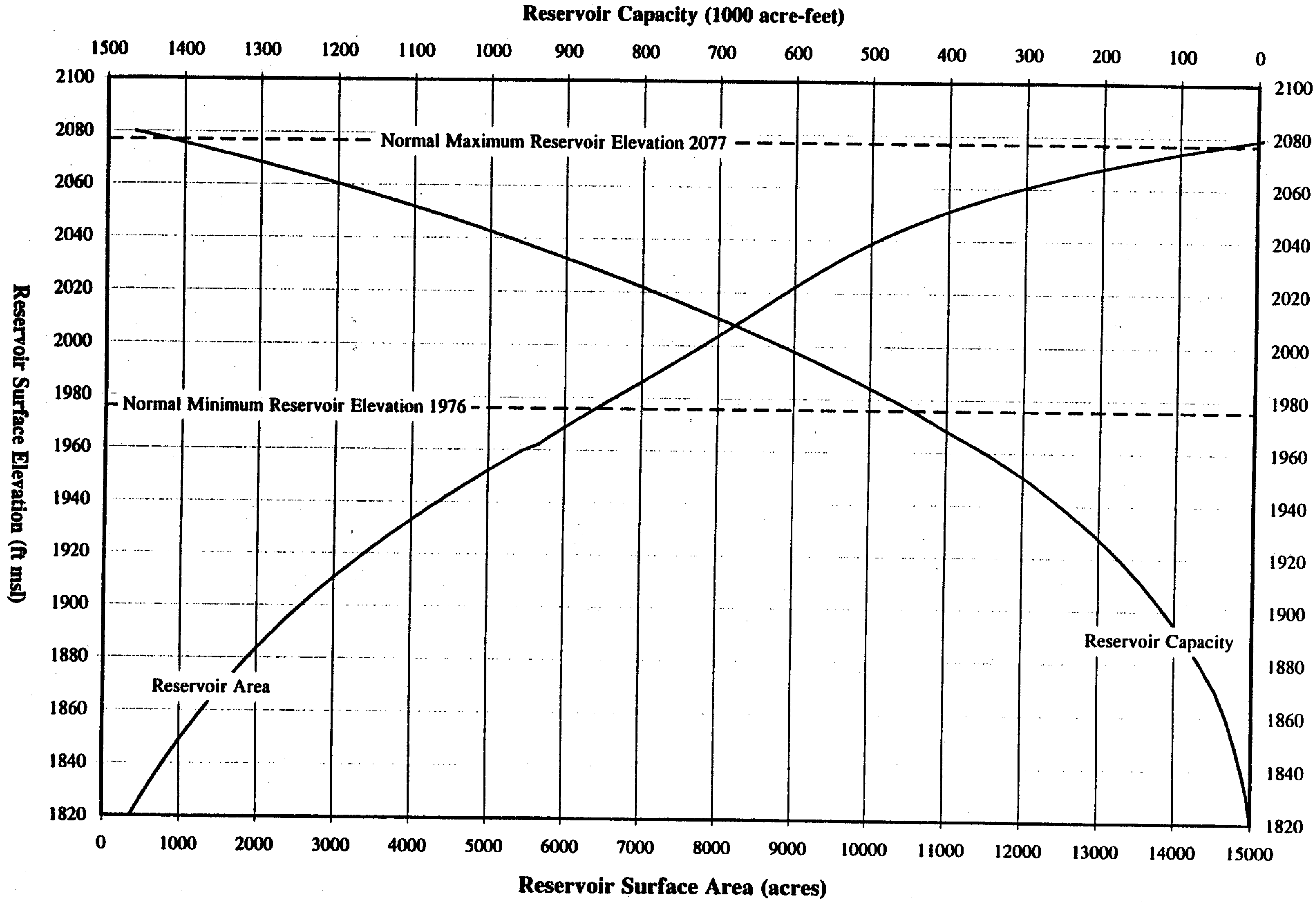


Figure 4-1

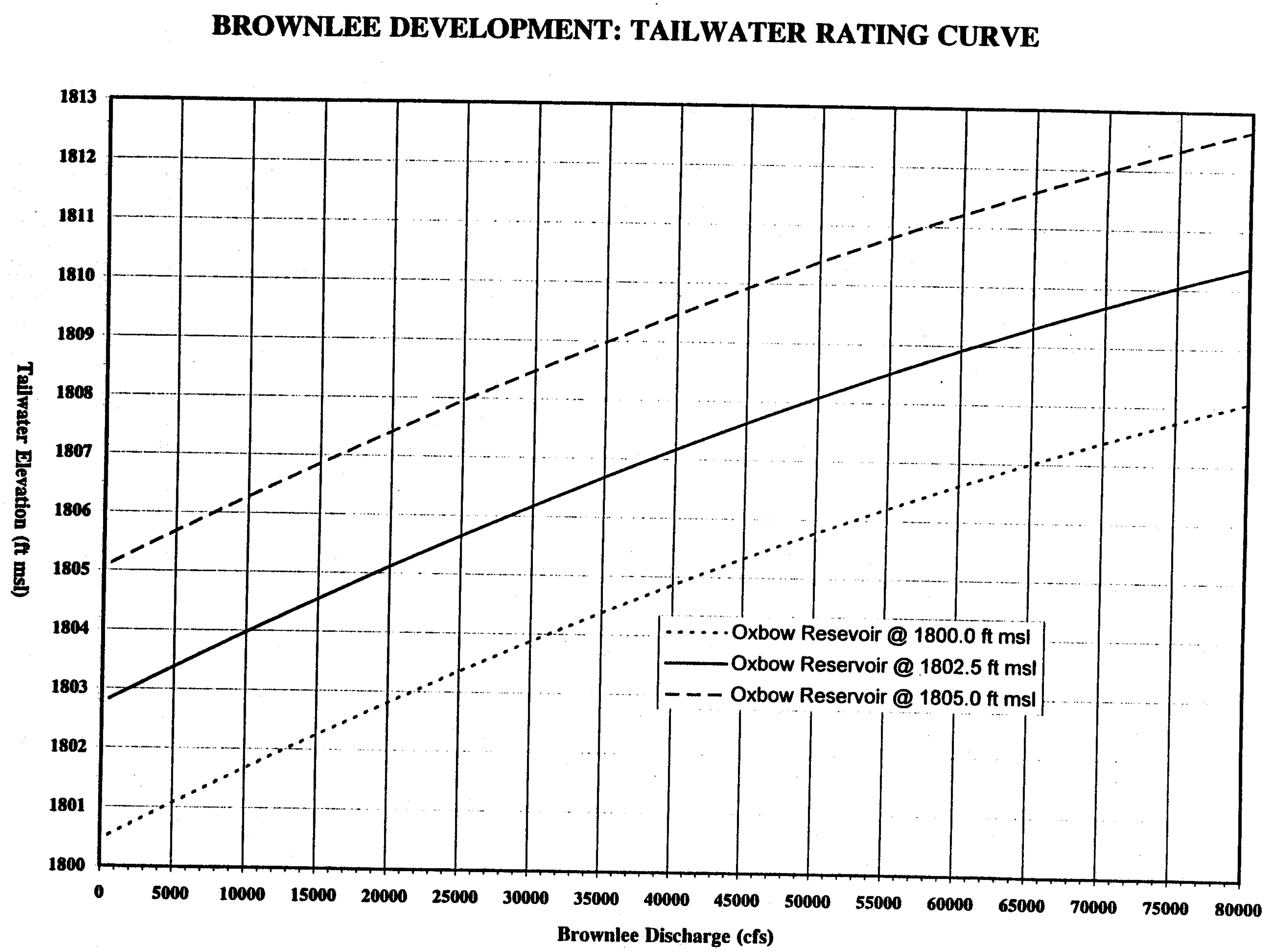

BROWNLEE DEVELOPMENT: TAILWATER RATING CURVE
Tailwater Elevation (ft msl)
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
Brownlee Discharge (cfs)
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000
60000
65000
70000
75000
80000
Oxbow Resevoir @ 1800.0 ft msl
Oxbow Reservoir @ 1802.5 ft msl
Oxbow Reservoir @ 1805.0 ft msl

Figure 4-2

BROWNLEE POWER PLANT: HEAD vs. CAPACITY CURVE

BASED ON I.P.C. EXPERIENCE CURVE AND HITACHI CAVITATION GUARANTEE CURVE

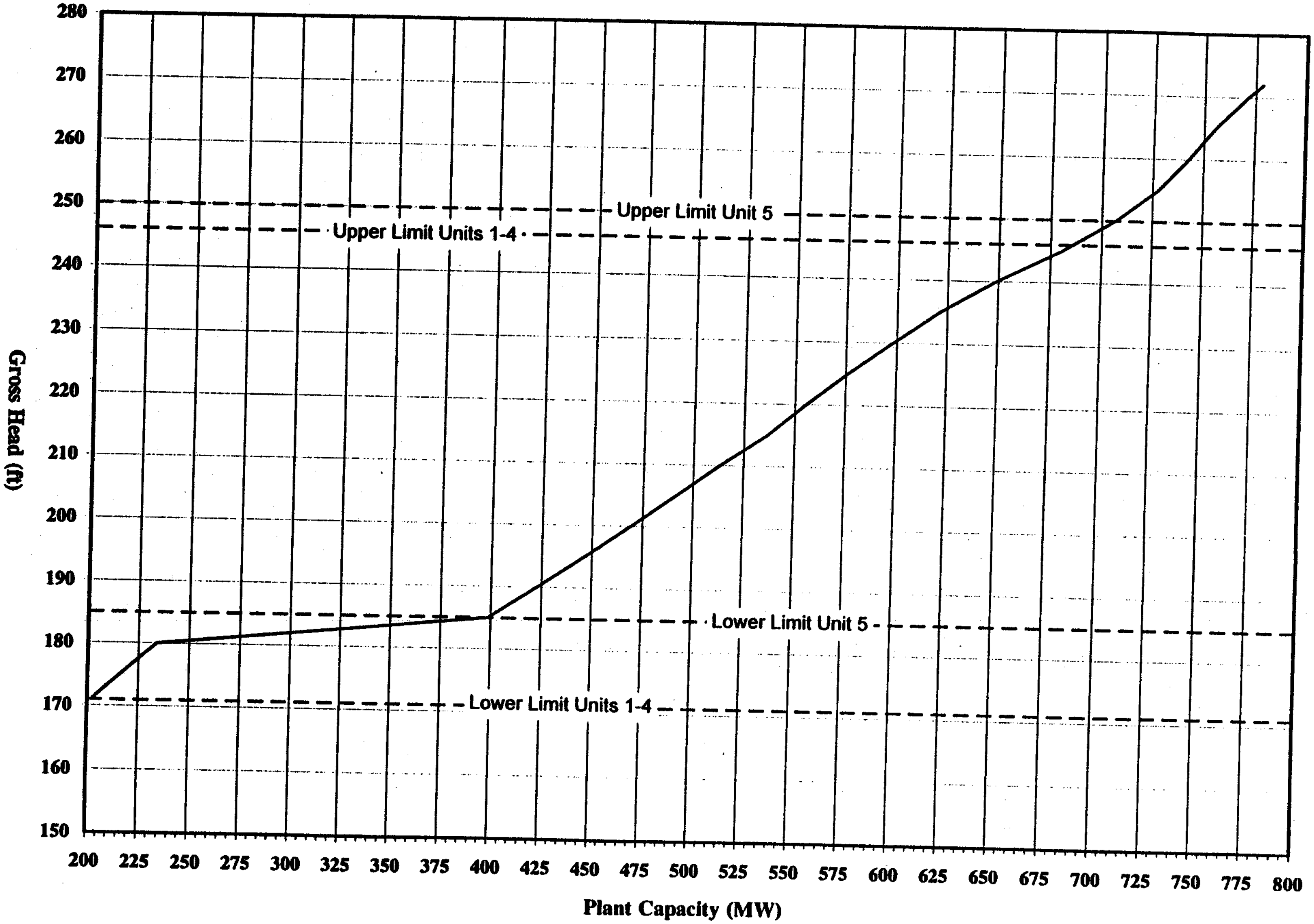


Figure 4-3

OXBOW RESERVOIR: AREA AND CAPACITY CURVES

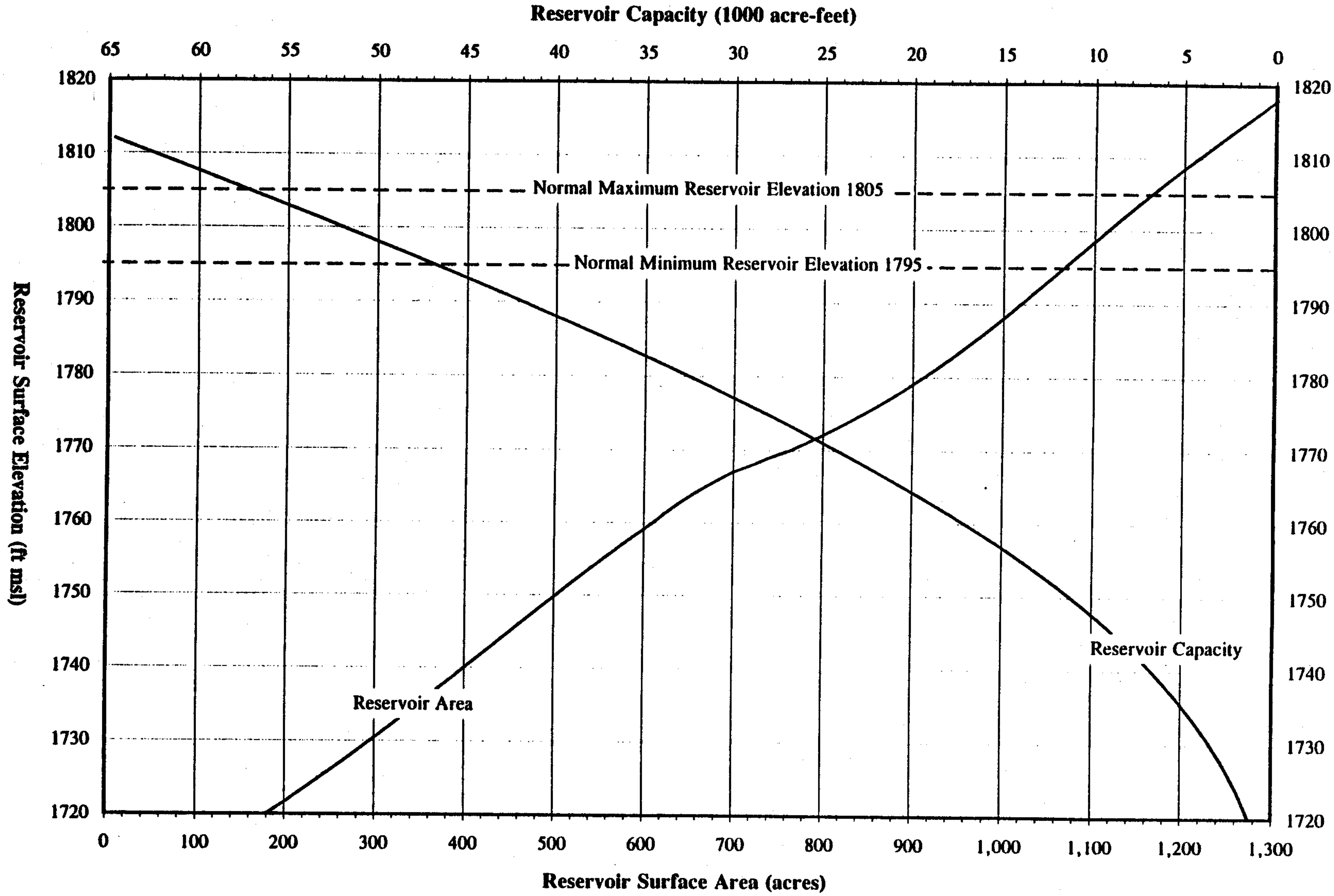


Figure 4-4

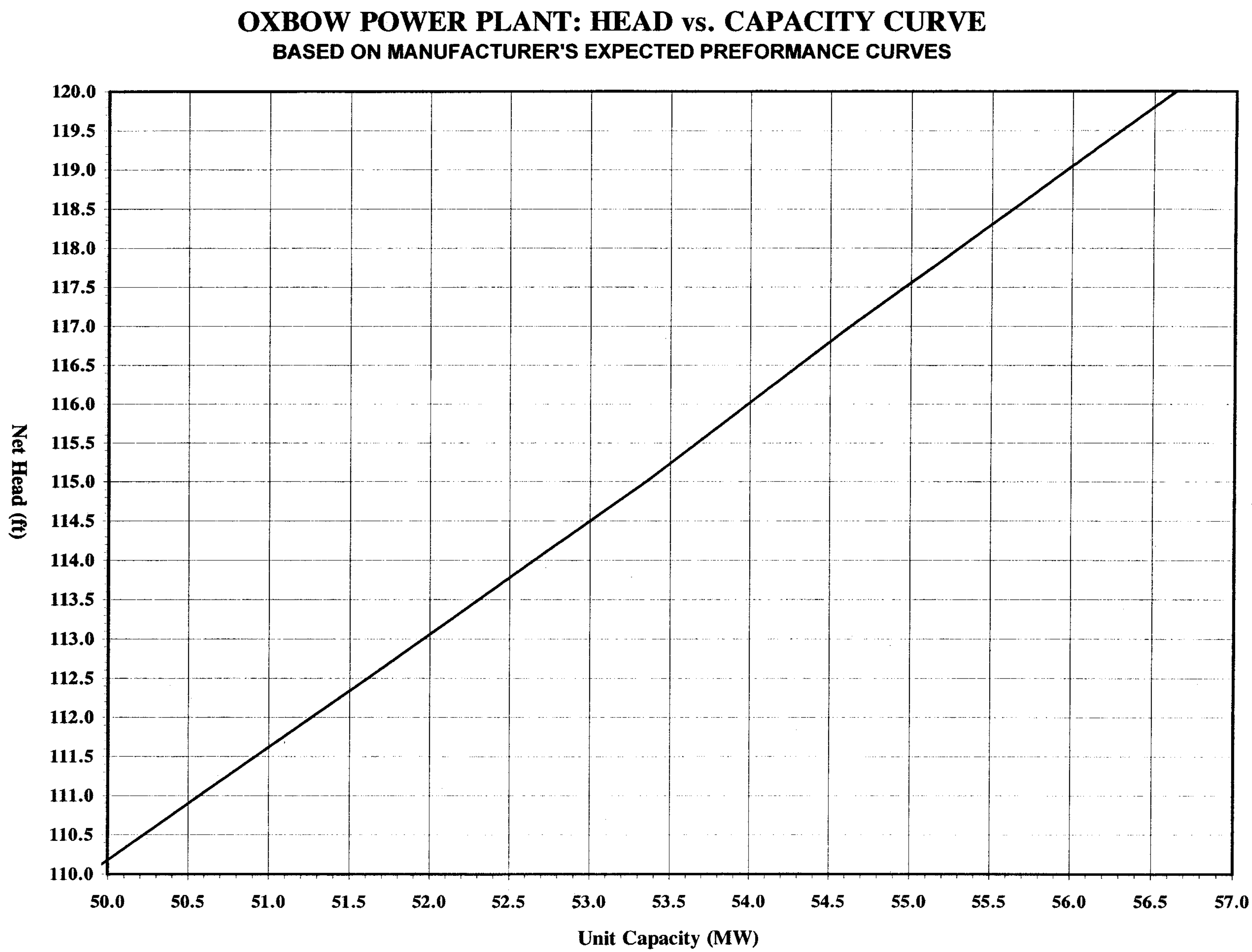

OXBOW POWER PLANT: HEAD vs. CAPACITY CURVE
BASED ON MANUFACTURER'S EXPECTED PREFORMANCE CURVES
Net Head (ft)
120.0
119.5
119.0
118.5
118.0
117.5
117.0
116.5
116.0
115.5
115.0
114.5
114.0
113.5
113.0
112.5
112.0
111.5
111.0
110.5
110.0
50.0
50.5
51.0
51.5
52.0
52.5
53.0
53.5
54.0
54.5
55.0
55.5
56.0
56.5
57.0
Unit Capacity (MW)

Figure 4-5

HELLS CANYON RESERVOIR: AREA AND CAPACITY CURVES

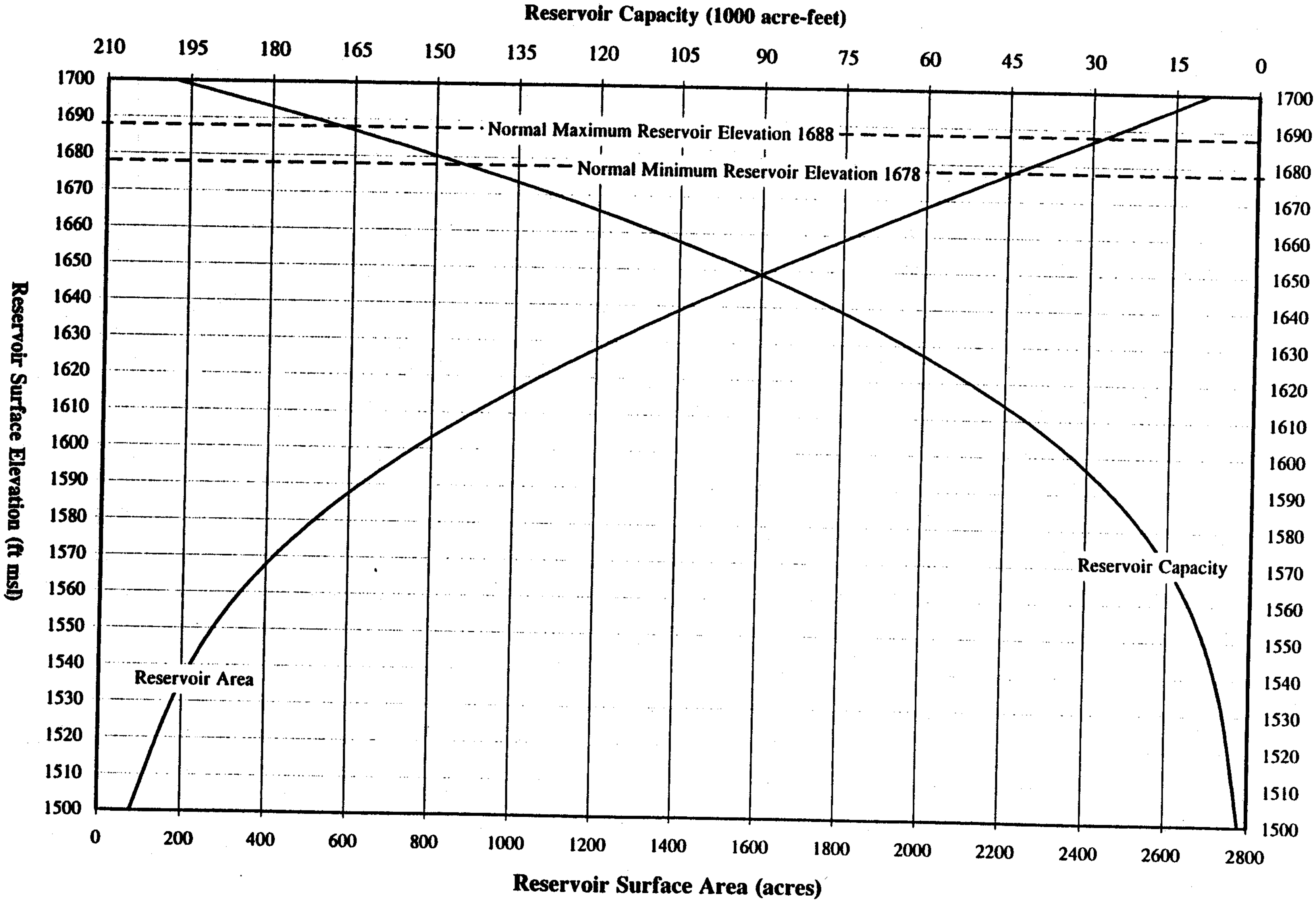


Figure 4-6

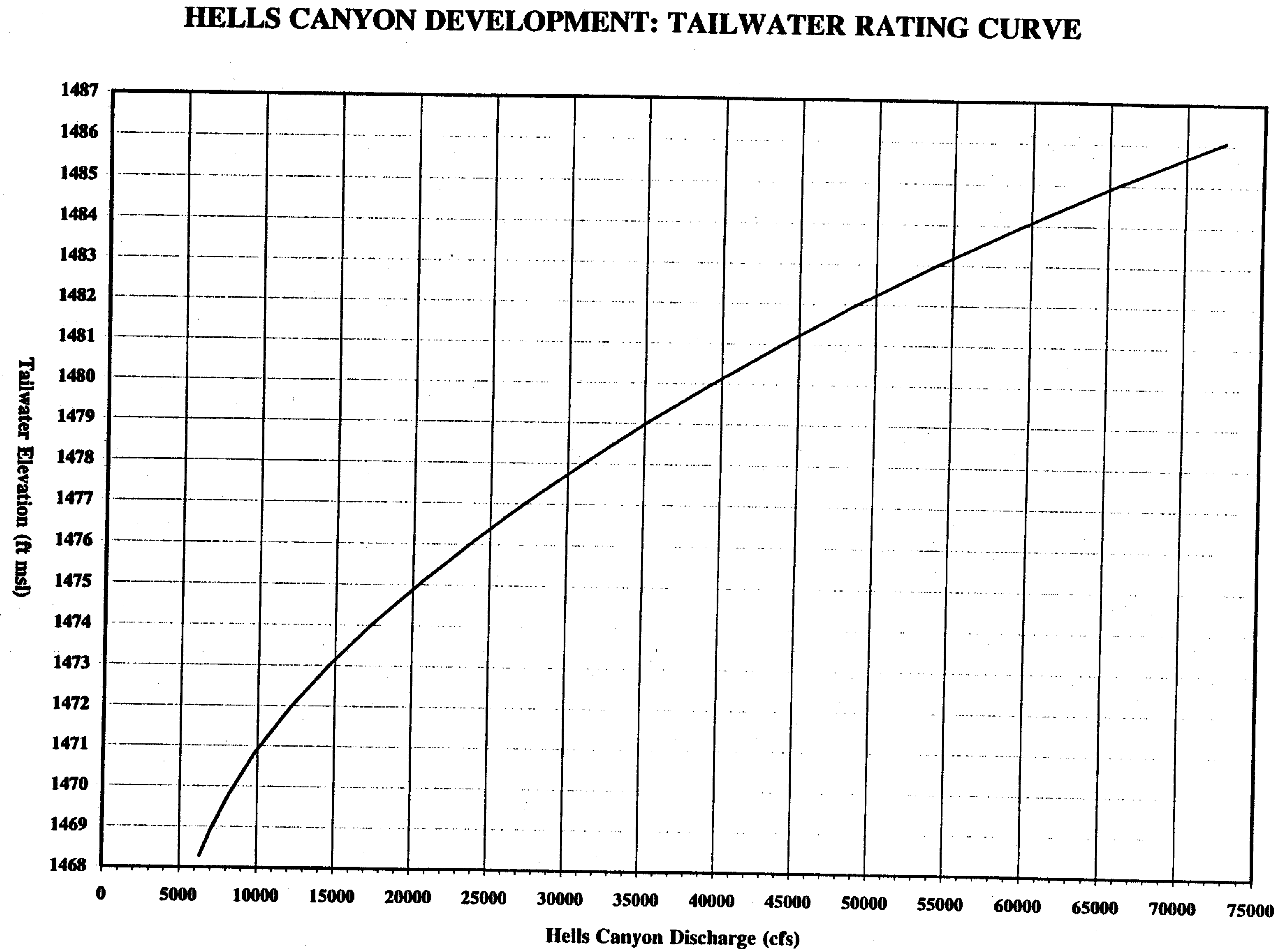

HELLS CANYON DEVELOPMENT: TAILWATER RATING CURVE
Tailwater Elevation (ft msl)
1487
1486
1485
1484
1483
1482
1481
1480
1479
1478
1477
1476
1475
1474
1473
1472
1471
1470
1469
1468
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000
60000
65000
70000
75000
Hells Canyon Discharge (cfs)

Figure 4-7

HELLS CANYON POWER PLANT: HEAD vs. CAPACITY CURVE

BASED ON MANUFACTURER'S EXPECTED PERFORMANCE CURVES

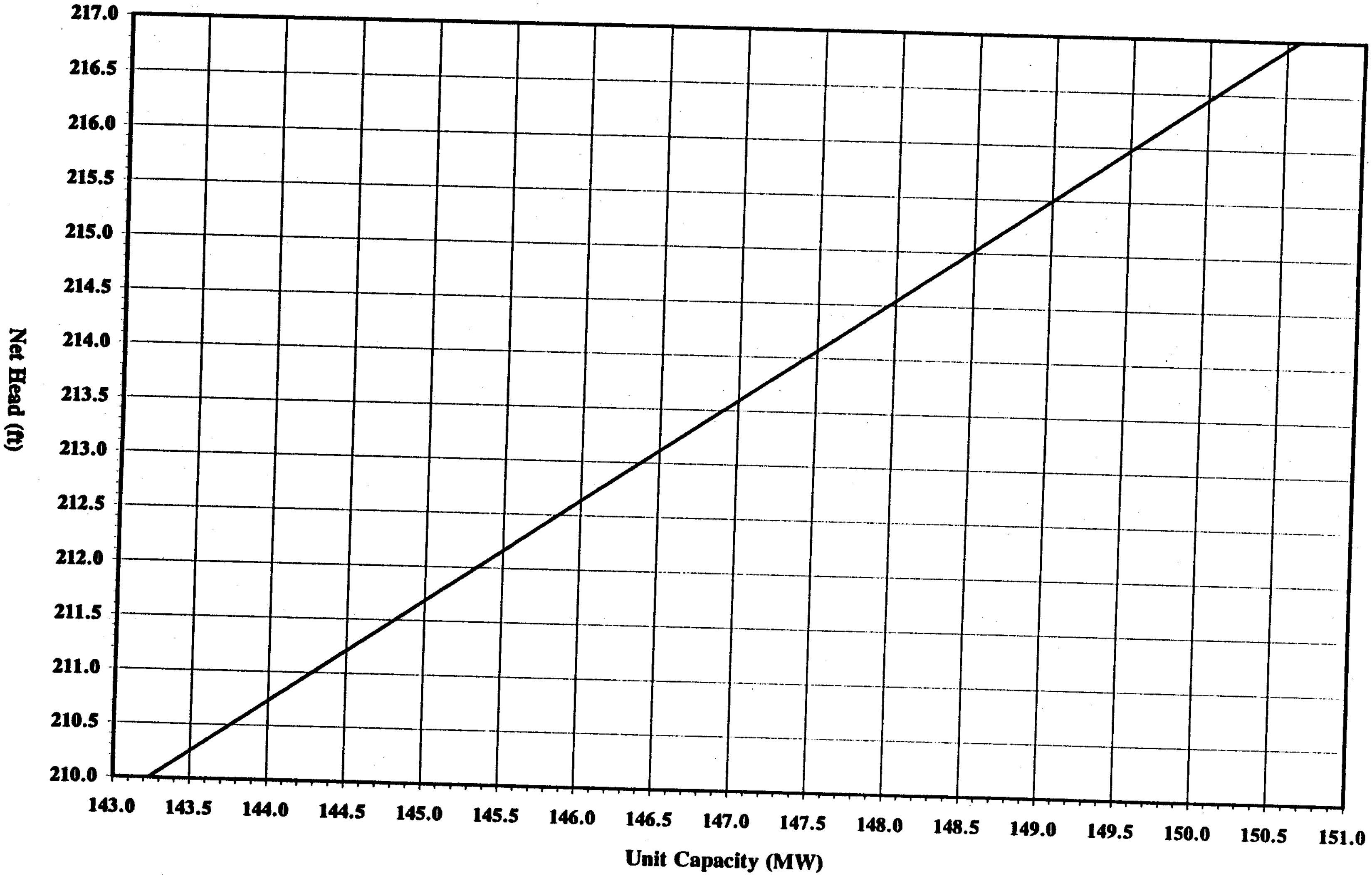
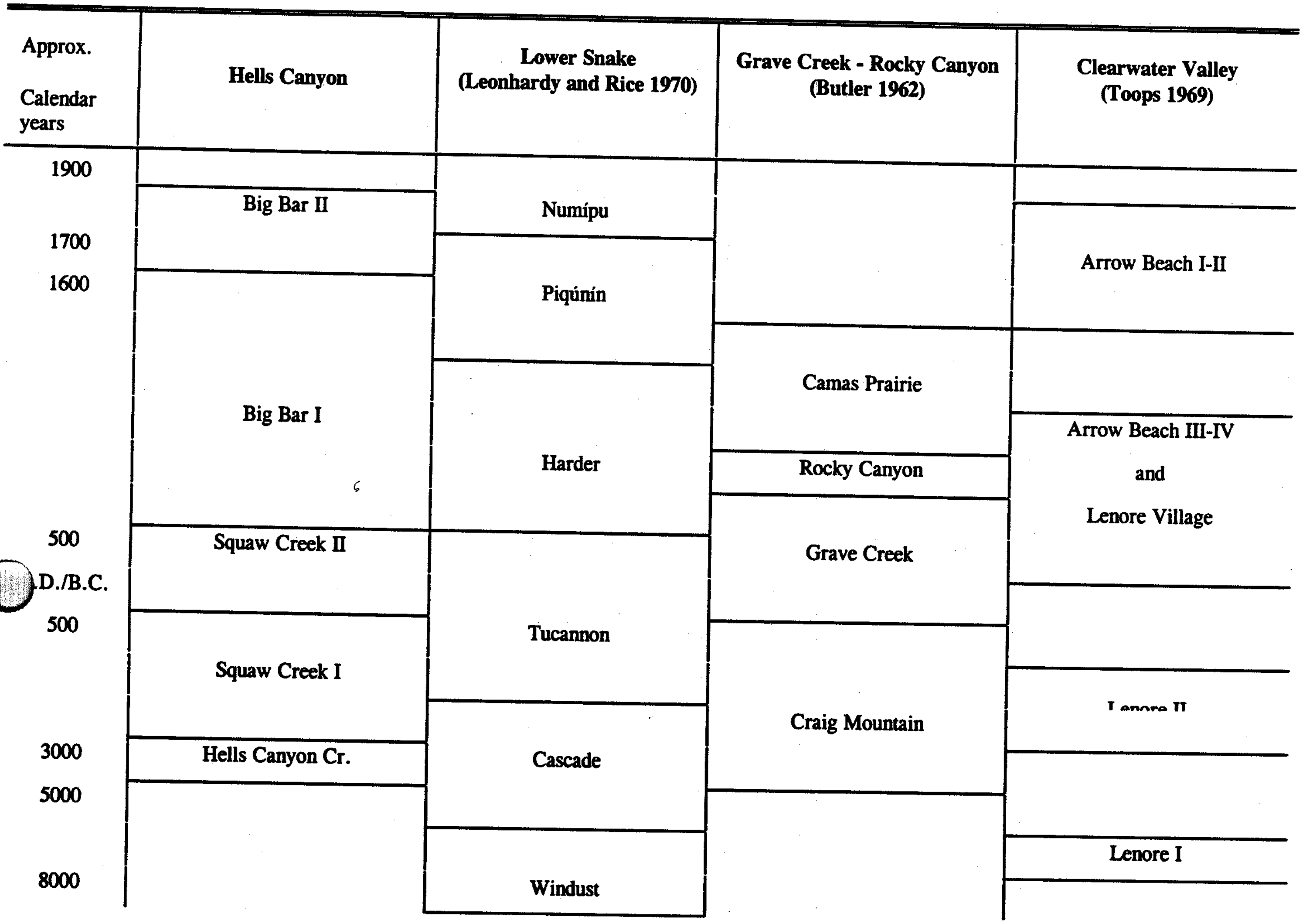
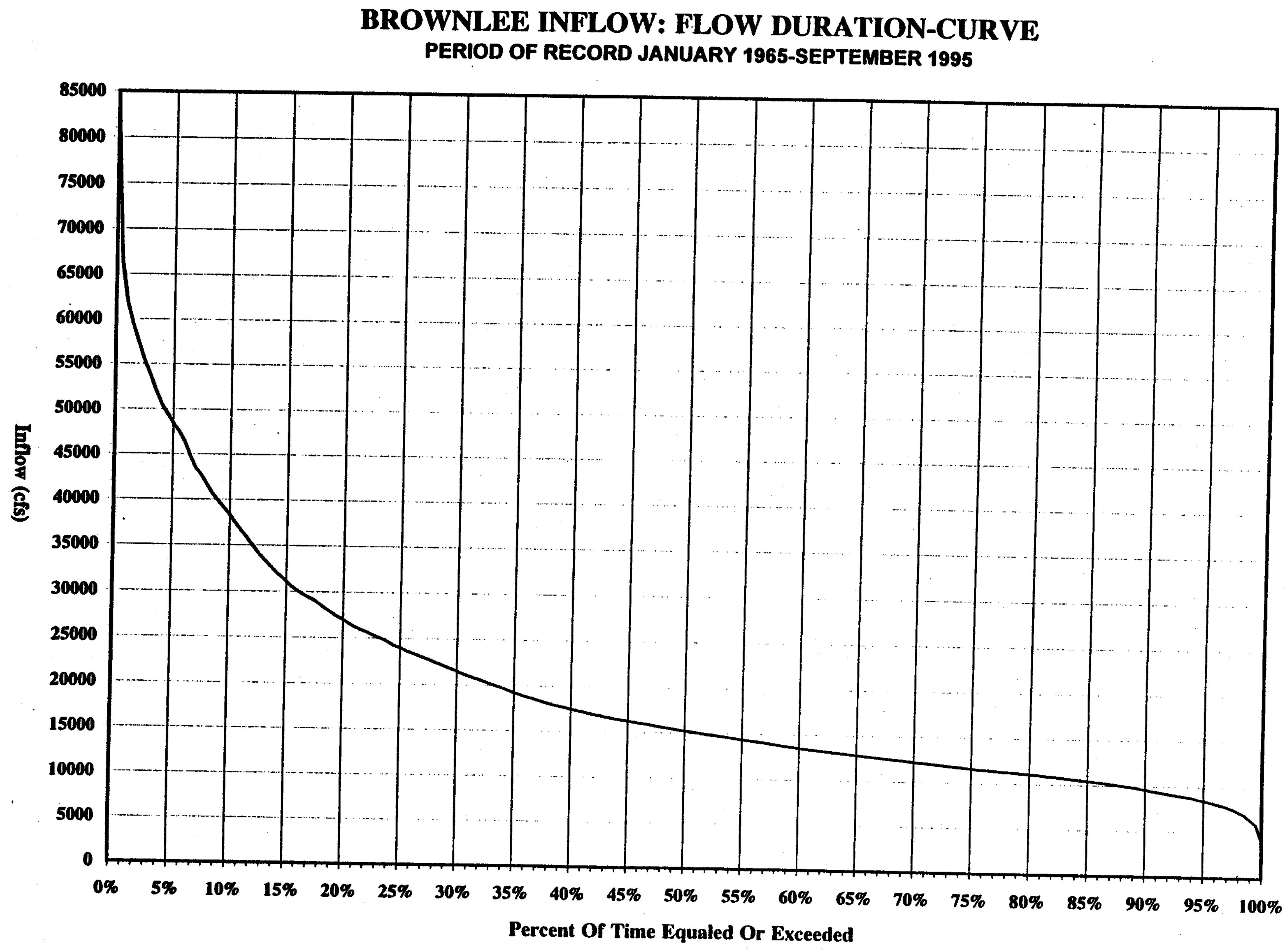


Figure 4-8

Figure 5-1 The Hells Canyon cultural sequence as seen from the perspective of Hells Canyon Creek Rockshelter in the Inner Gorge locality. (Reproduced from Pavesic 1971:192, quoted in Reid et al. 1991:104).





BROWNLEE INFLOW: FLOW DURATION-CURVE
PERIOD OF RECORD JANUARY 1965-SEPTEMBER 1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent Of Time Equaled Or Exceeded

Figure 6-1

BROWNLEE INFLOW: FLOW DURATION CURVE - JANUARY

1965-1995

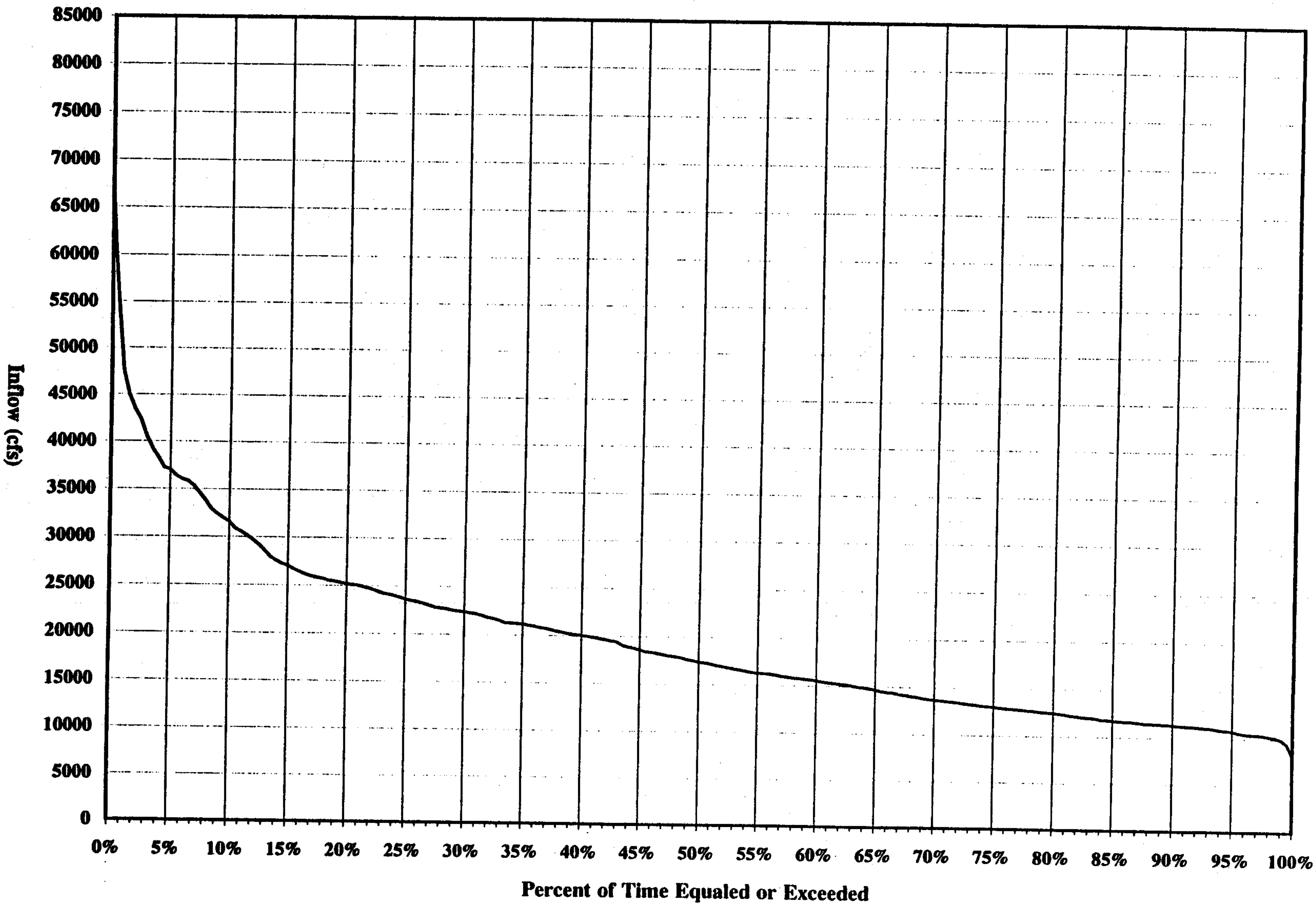


Figure 6-2.1

BROWNLEE INFLOW: FLOW DURATION CURVE - FEBRUARY
1965-1995

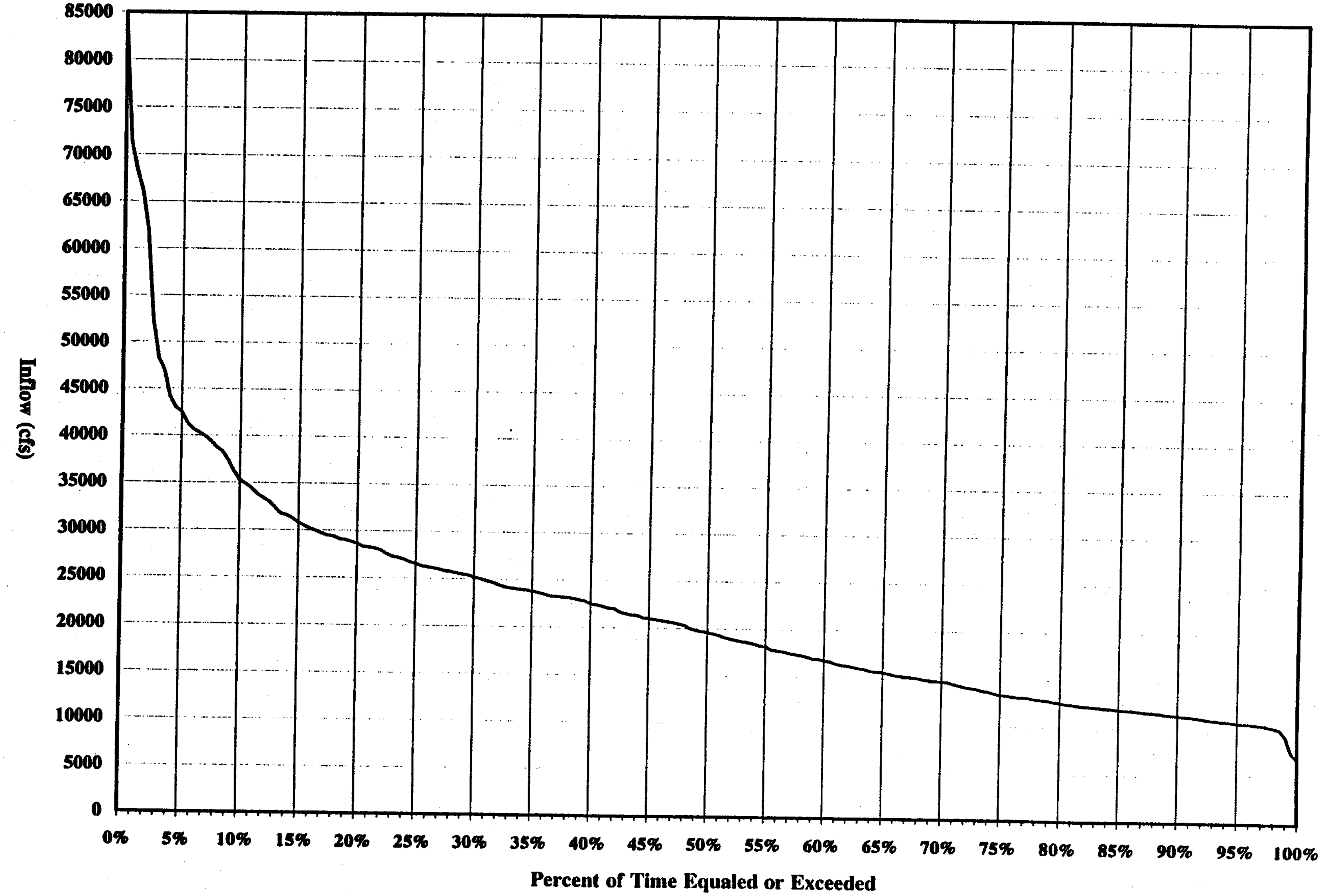
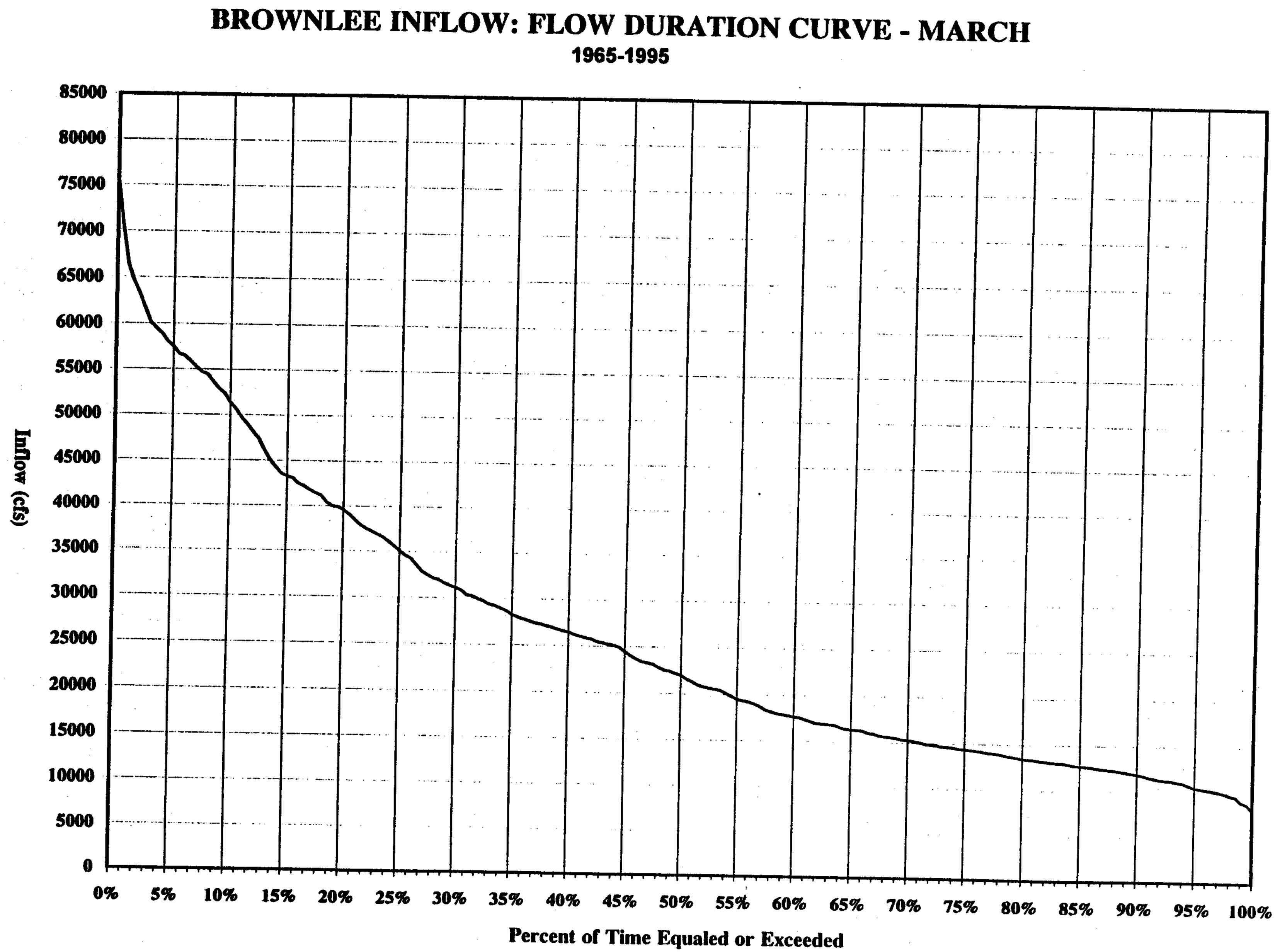
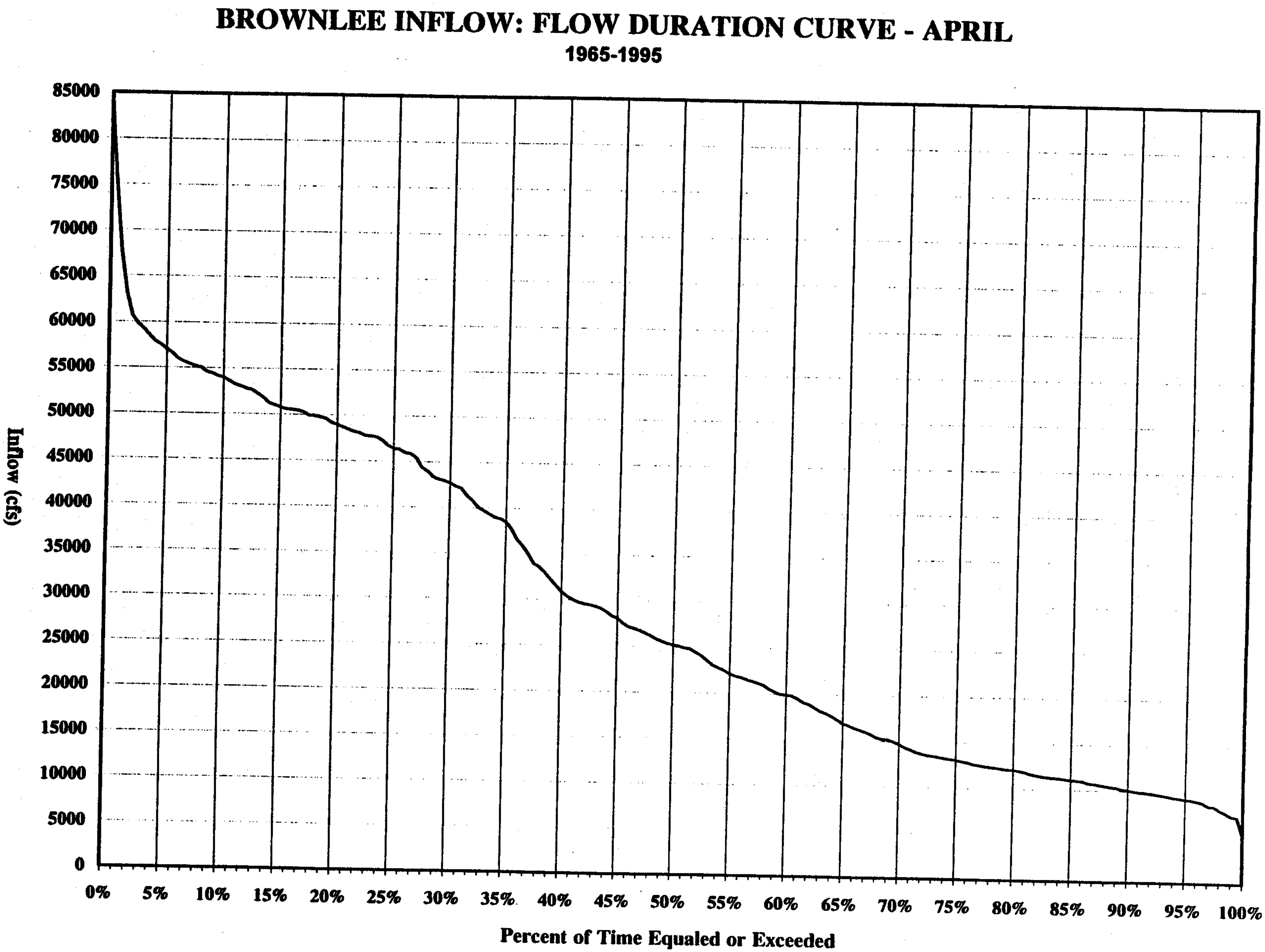


Figure 6-2.2



BROWNLEE INFLOW: FLOW DURATION CURVE - MARCH
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6.2.3



BROWNLEE INFLOW: FLOW DURATION CURVE - APRIL
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6-2.4

BROWNLEE INFLOW: FLOW DURATION CURVE - MAY
1965-1995

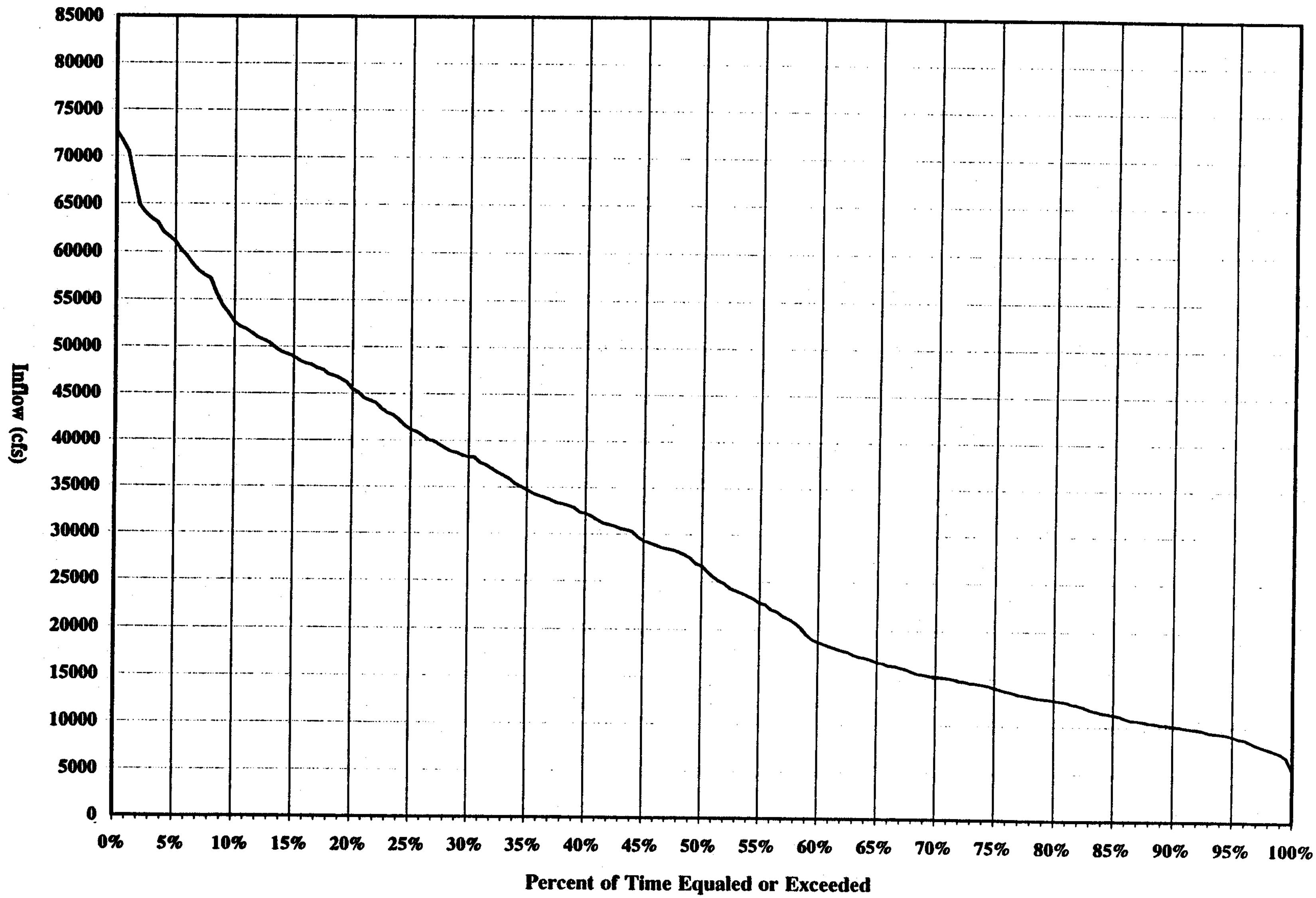


Figure 6-2.5

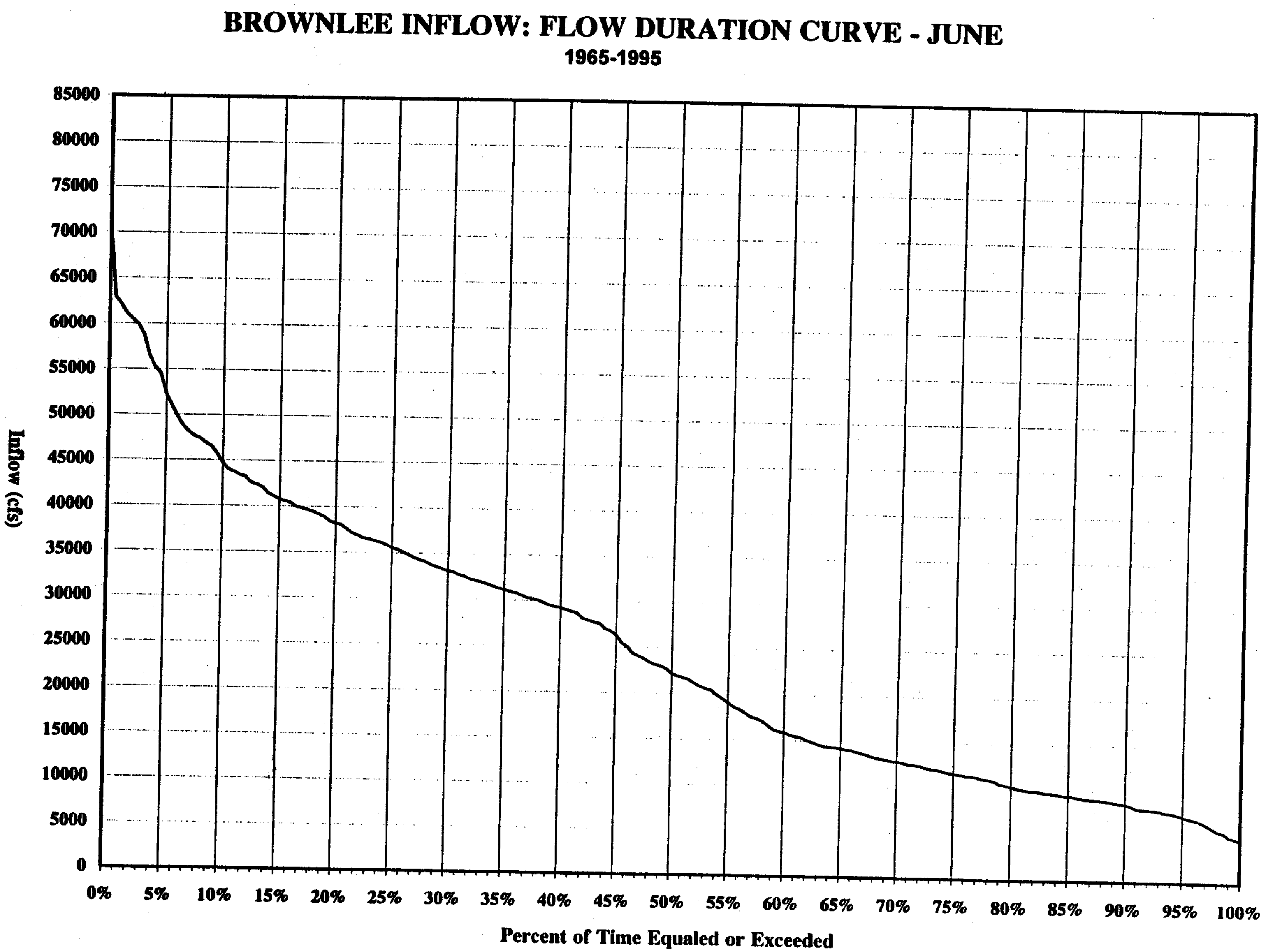

BROWNLEE INFLOW: FLOW DURATION CURVE - JUNE
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6.2.6

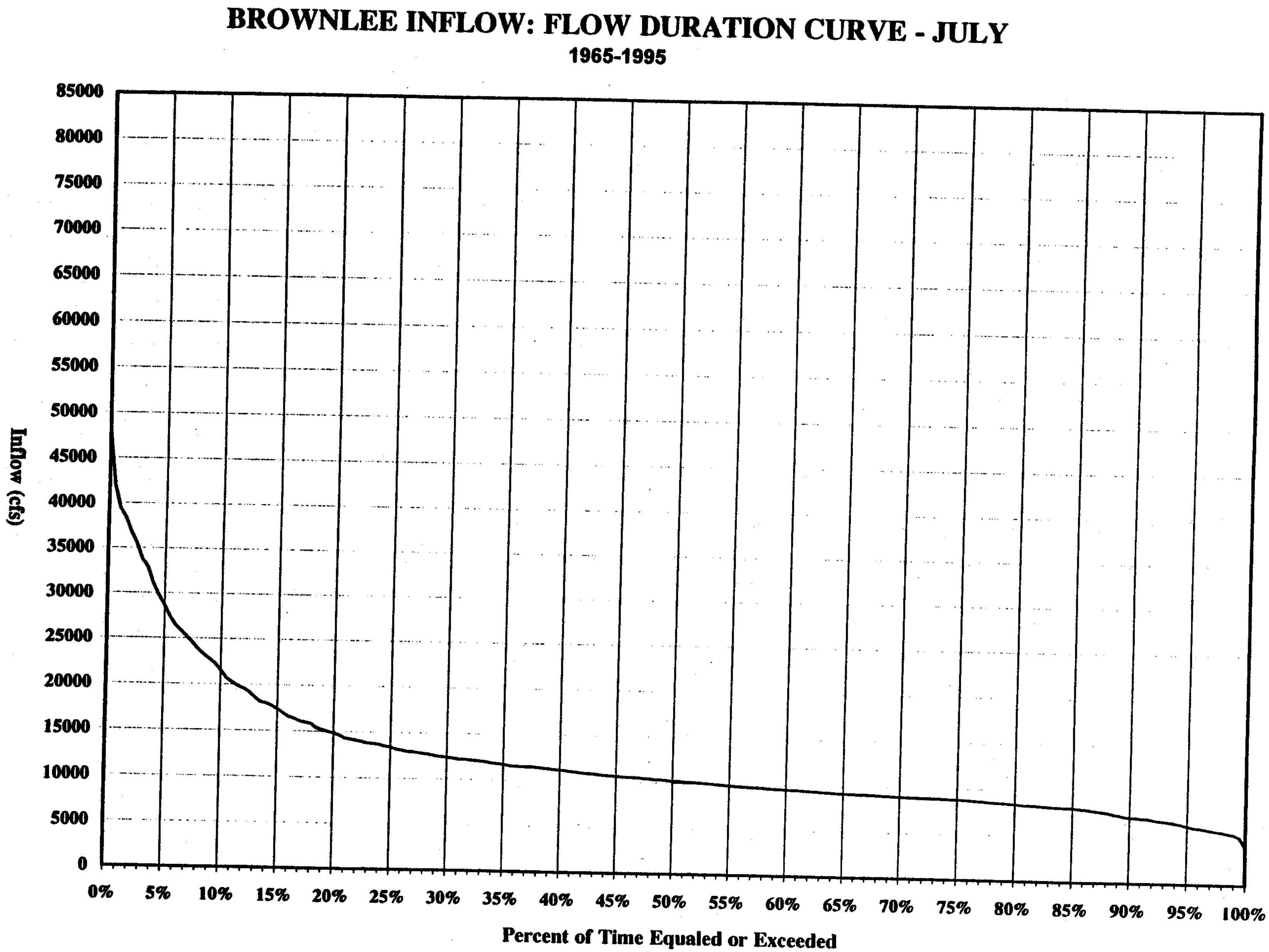

BROWNLEE INFLOW: FLOW DURATION CURVE - JULY
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6-2.7

BROWNLEE INFLOW: FLOW DURATION CURVE - AUGUST

1965-1995

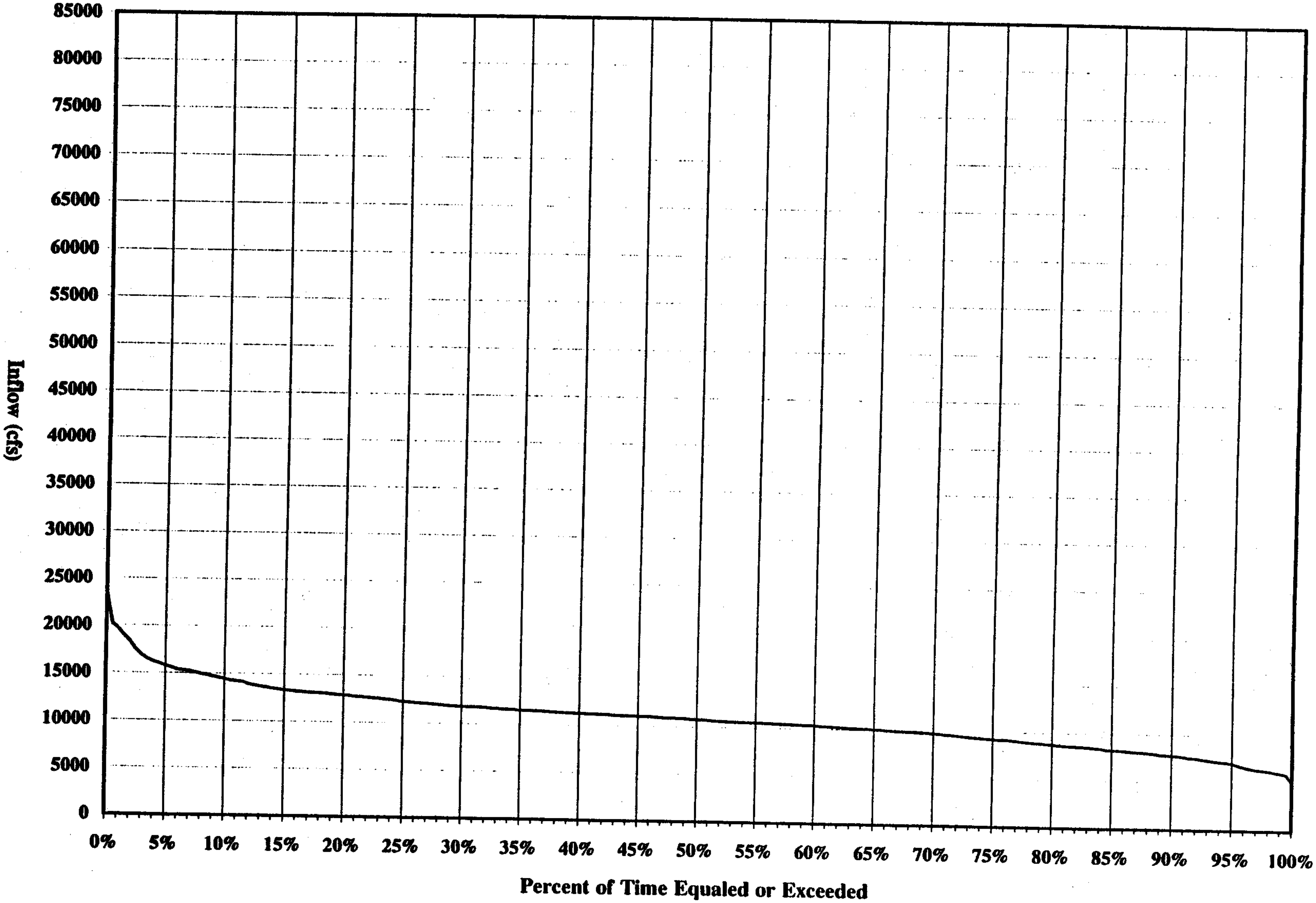
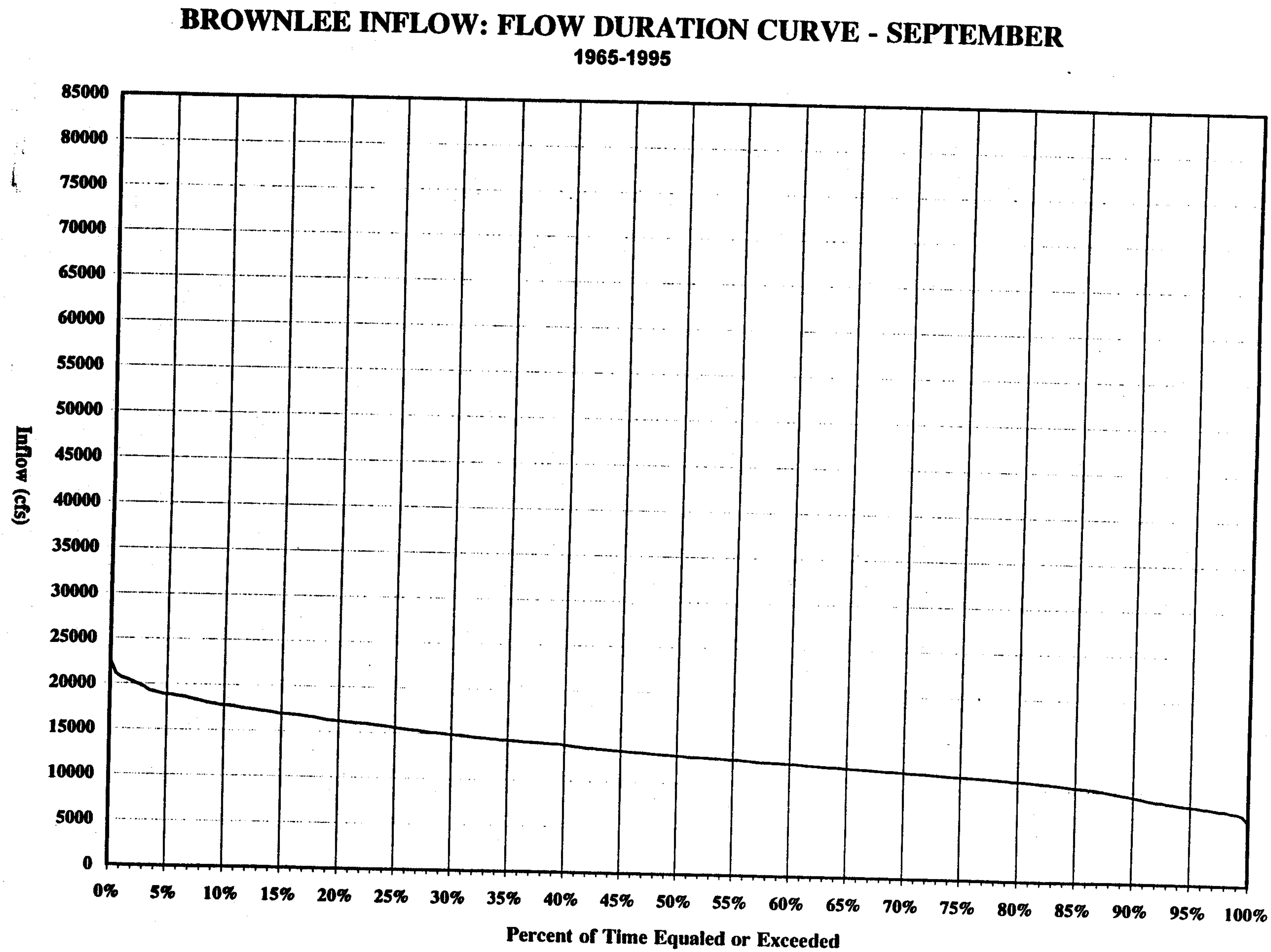


Figure 6-2.8



BROWNLEE INFLOW: FLOW DURATION CURVE - SEPTEMBER
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6.2.9

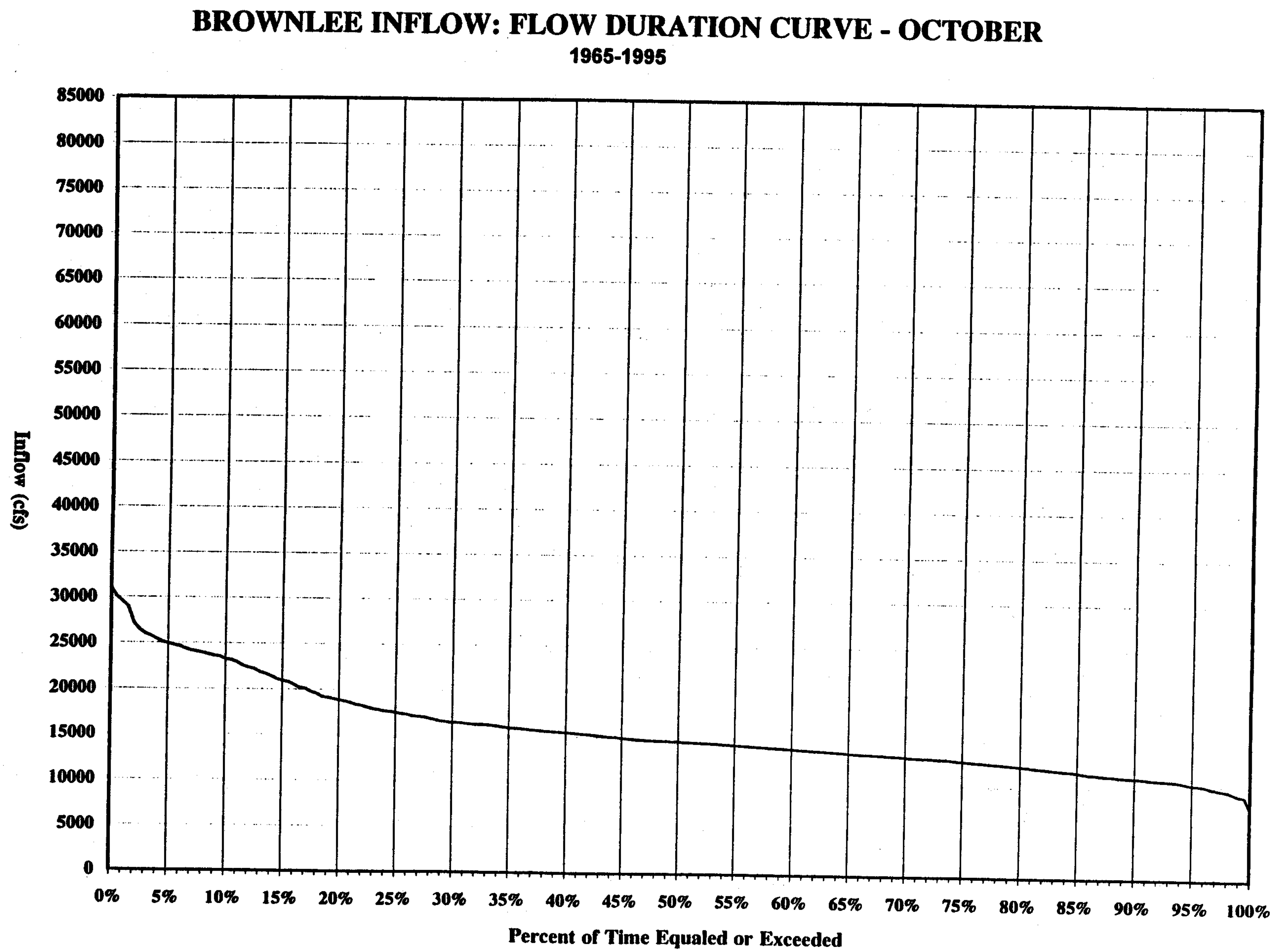

BROWNLEE INFLOW: FLOW DURATION CURVE - OCTOBER
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6-2.10

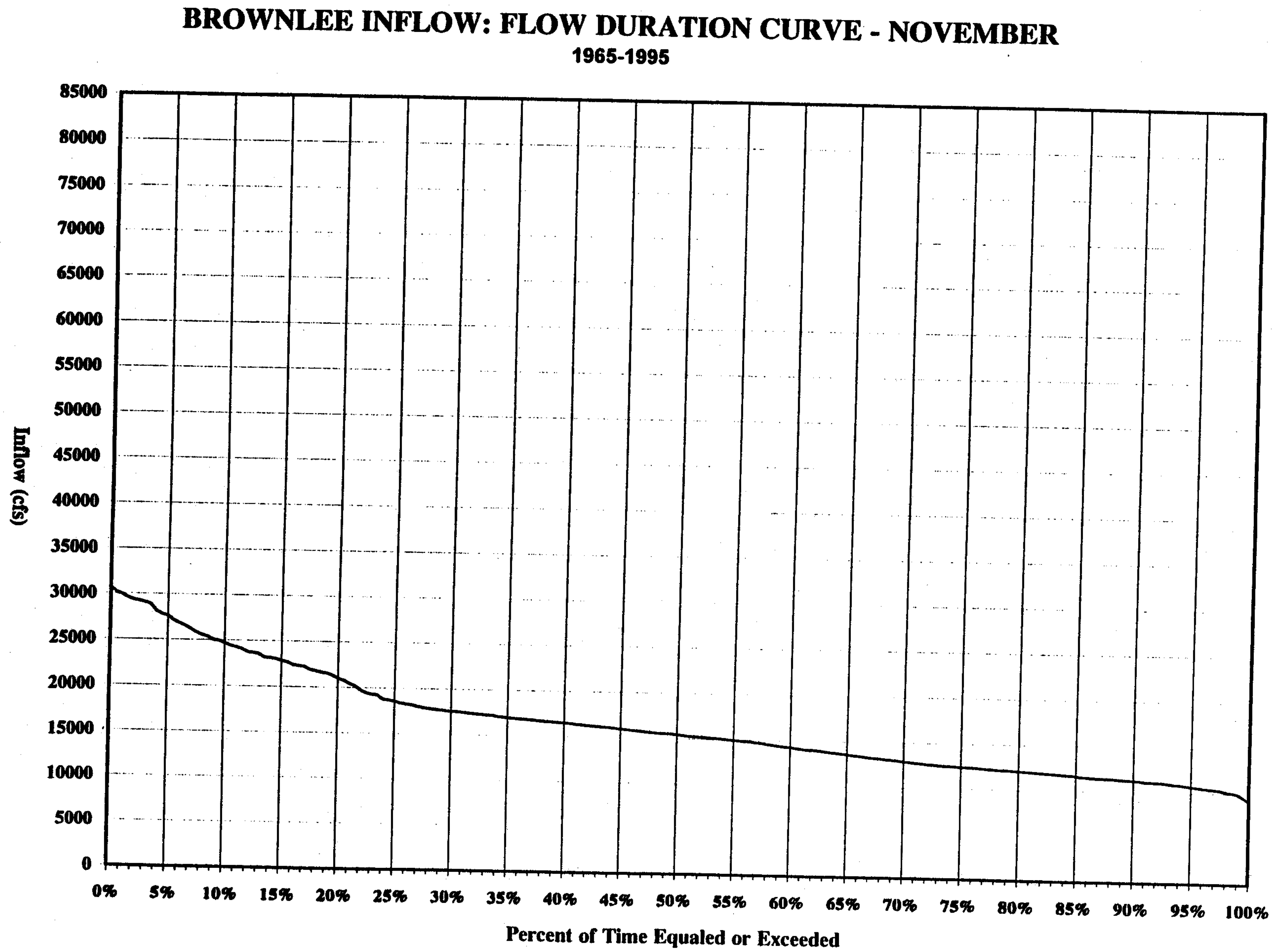

BROWNLEE INFLOW: FLOW DURATION CURVE - NOVEMBER
1965-1995
Inflow (cfs)
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Percent of Time Equaled or Exceeded

Figure 6.2.11

BROWNLEE INFLOW: FLOW DURATION CURVE - DECEMBER

1965-1995

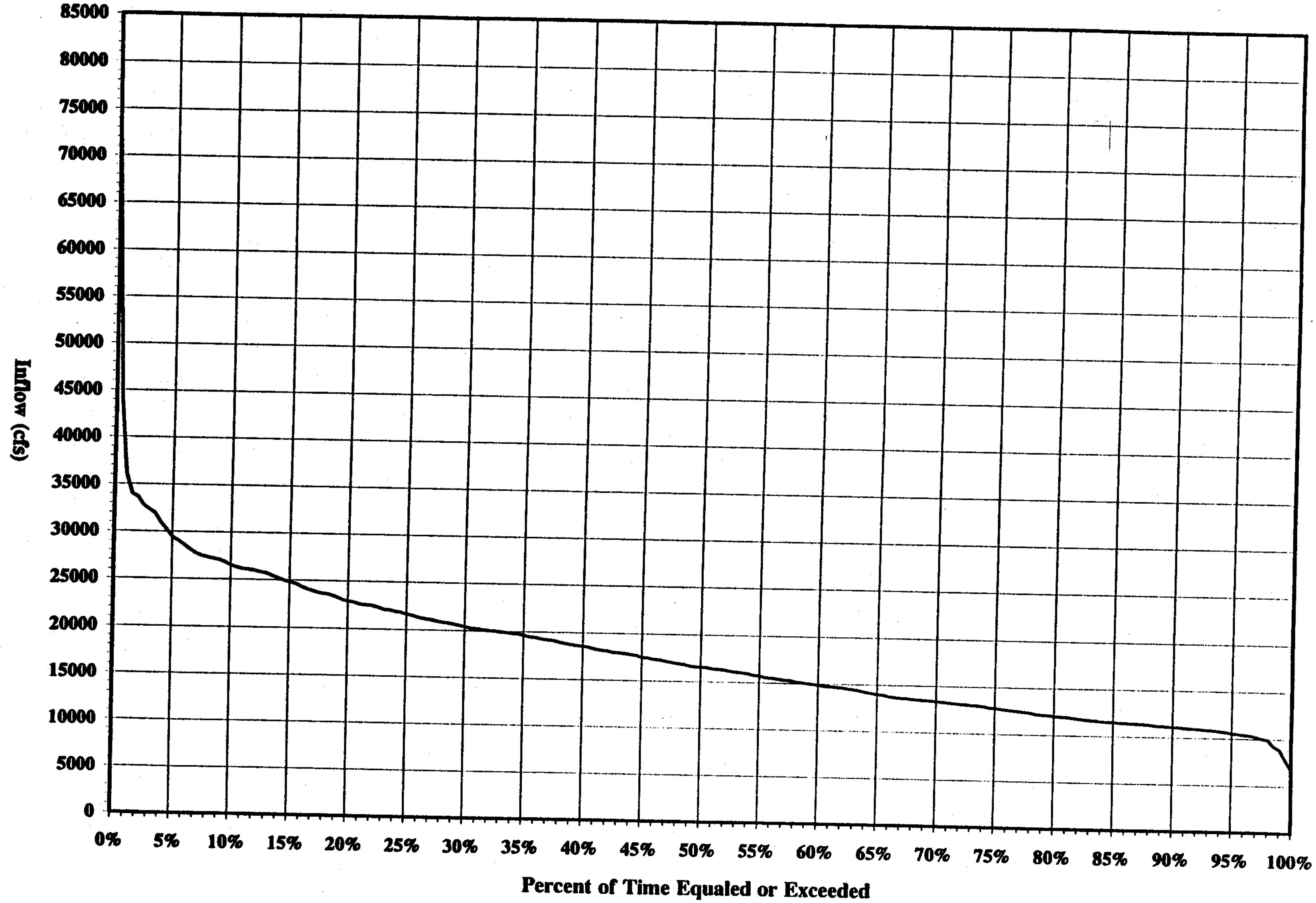


Figure 6-2.12

BROWNLEE INFLOW: MEAN FLOW HYDROGRAPH

PERIOD OF RECORD JANUARY 1965-SEPTEMBER 1995

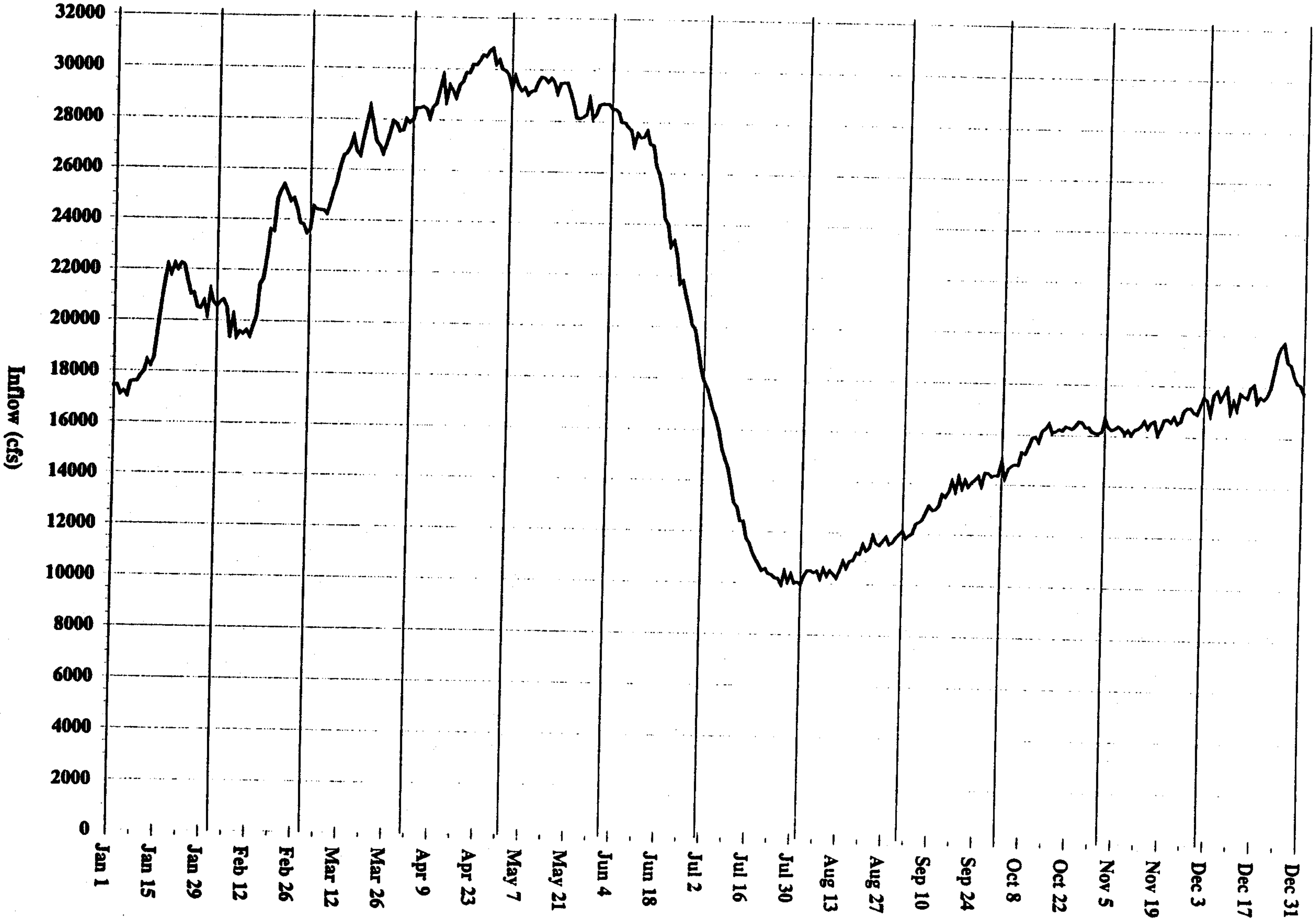


Figure 6-3

BROWNLEE MEAN FLOW HYDROGRAPH-JANUARY

1965-1995

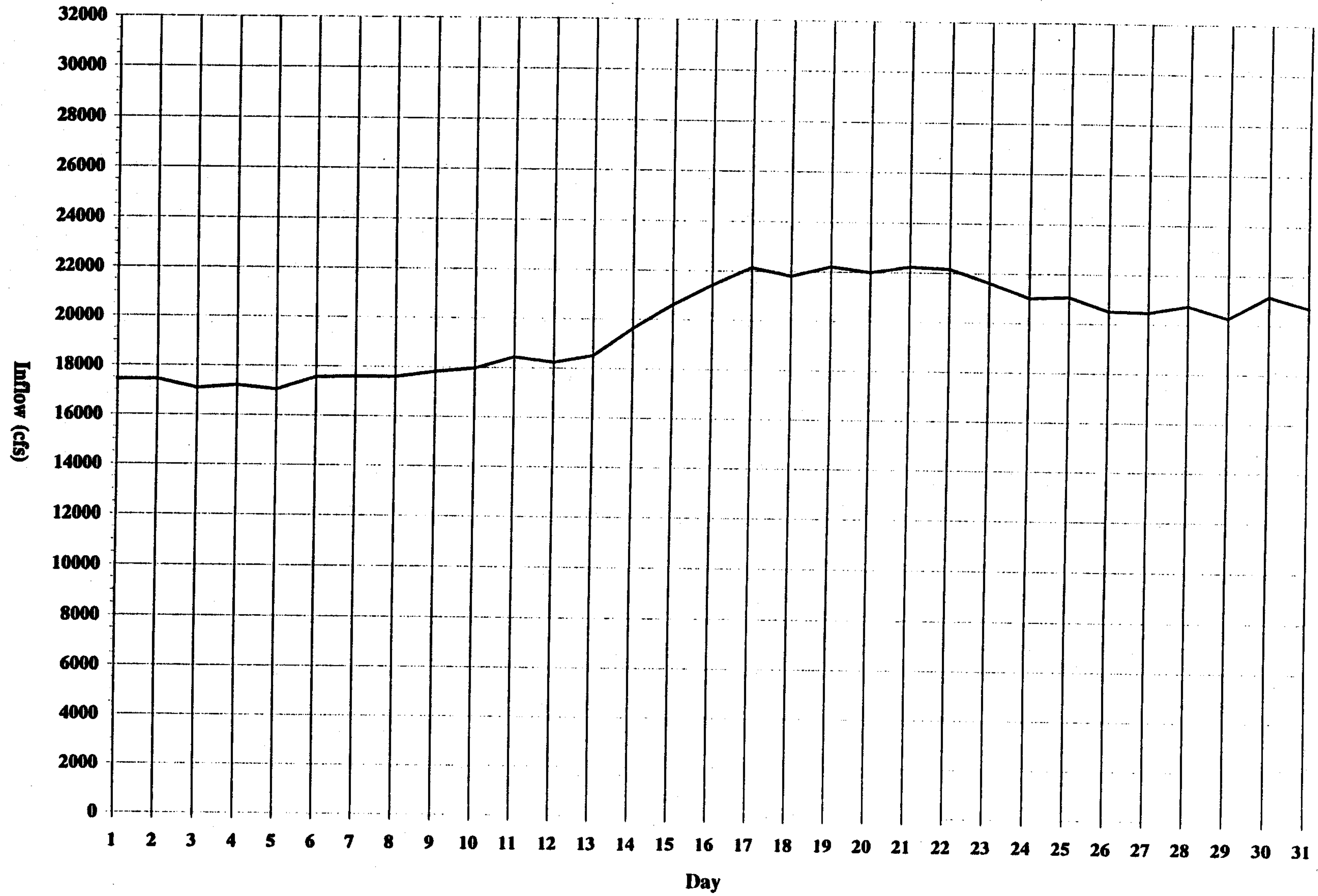


Figure 6-4.1

BROWNLEE MEAN FLOW HYDROGRAPH-FEBRUARY

1965-1995

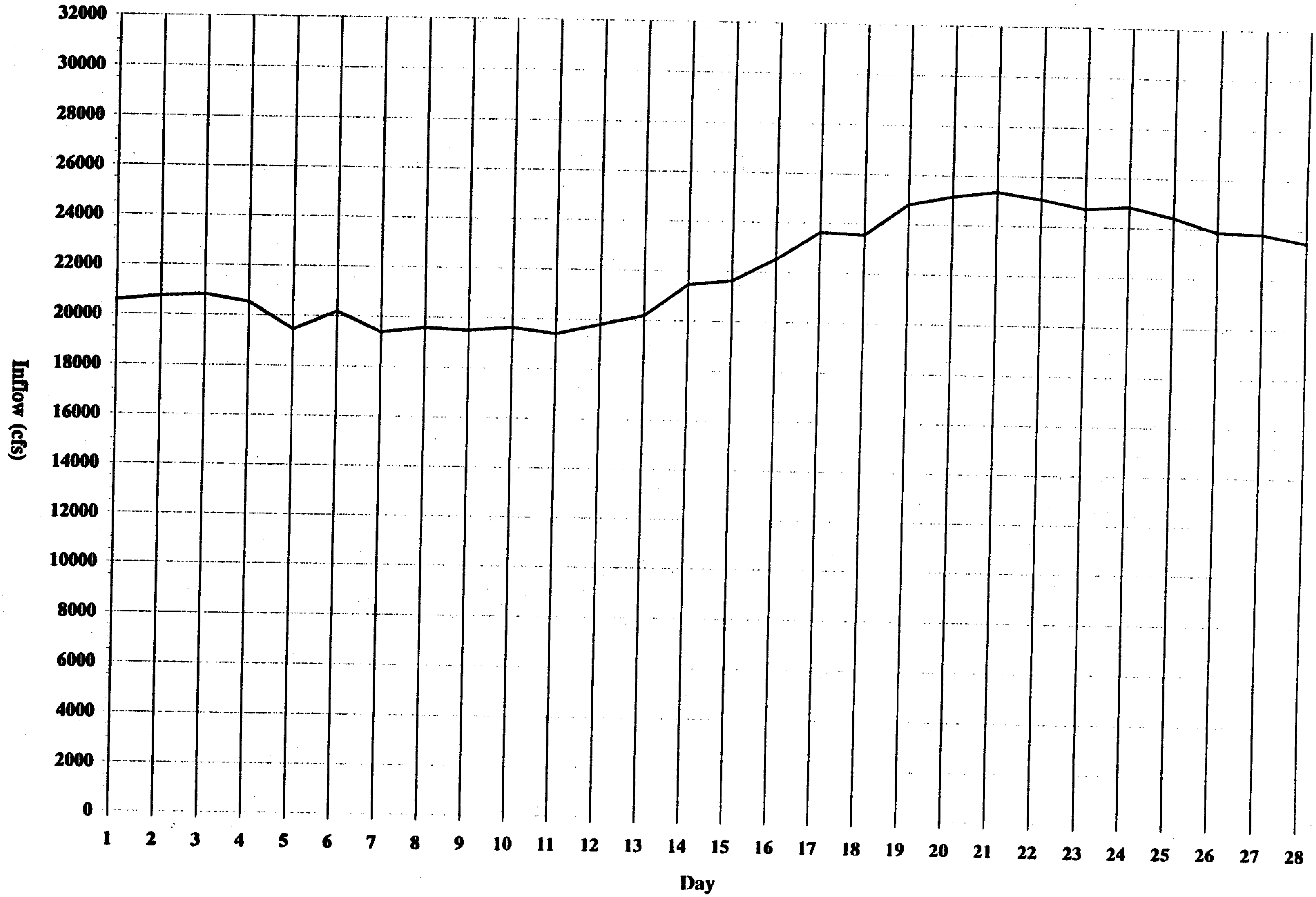


Figure 6-4.2

BROWNLEE MEAN FLOW HYDROGRAPH-MARCH

1965-1995

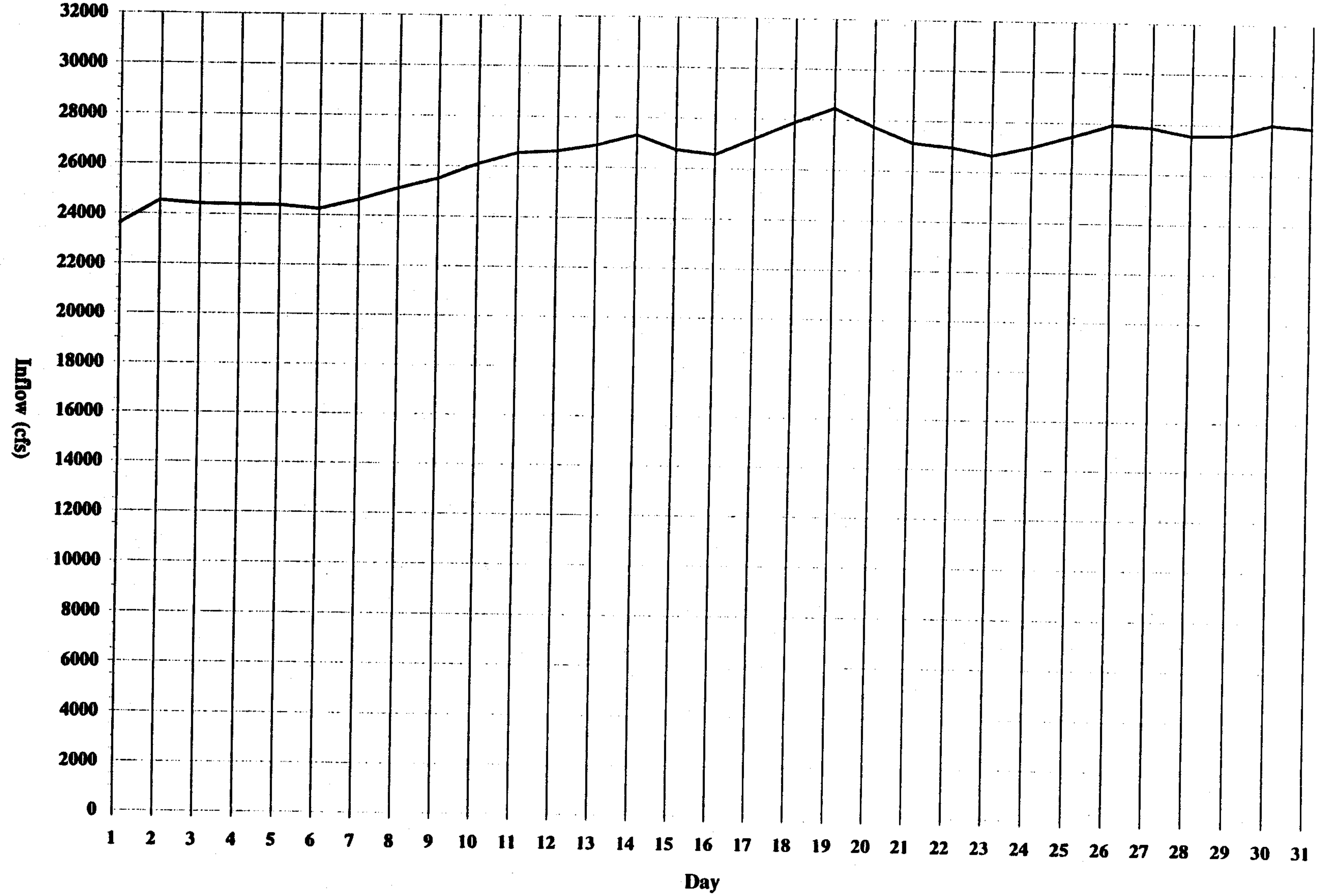
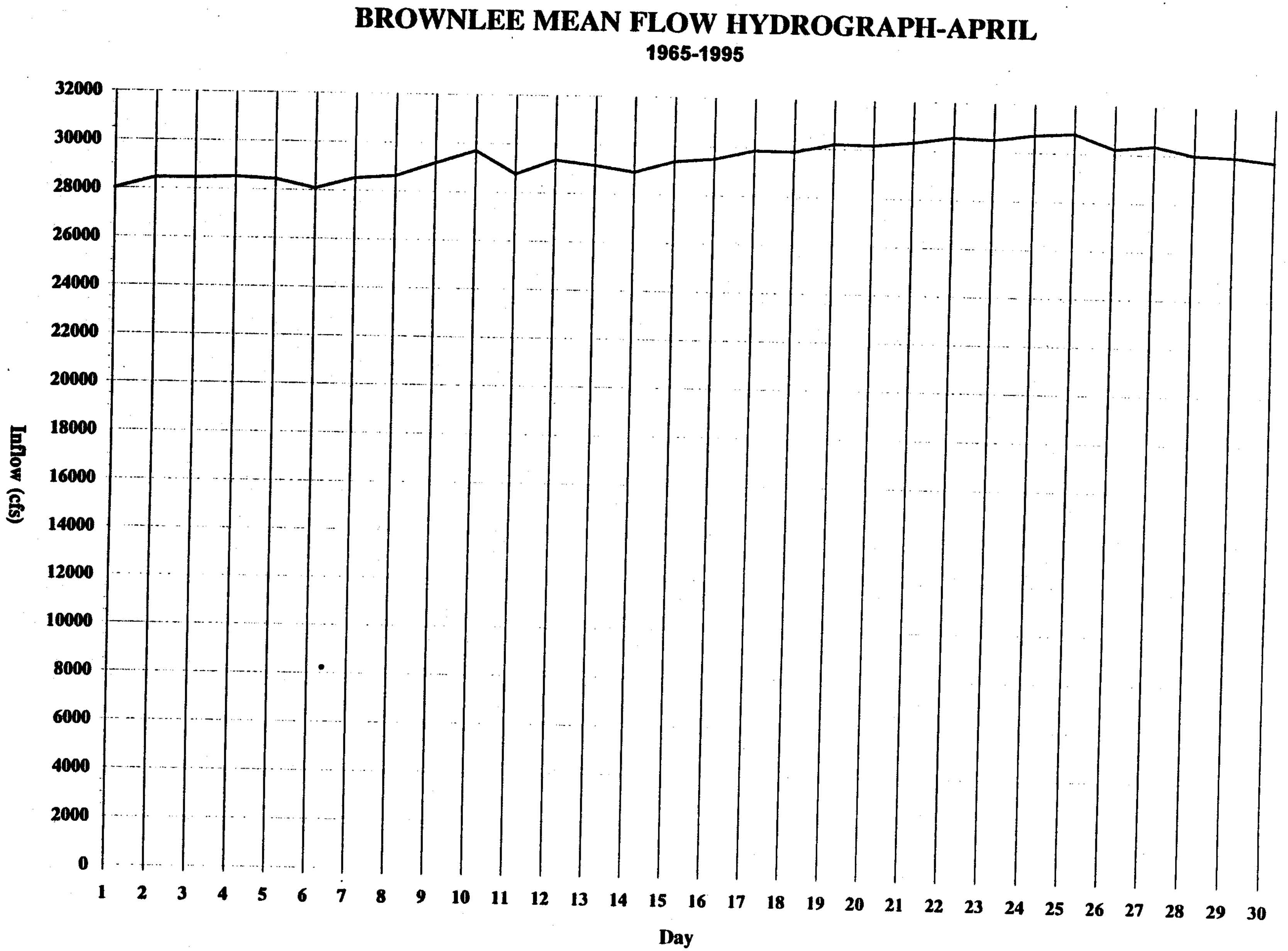


Figure 6-4.3


BROWNLEE MEAN FLOW HYDROGRAPH-APRIL
1965-1995
Inflow (cfs)
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28000
26000
24000
22000
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18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Day

Figure 6-4.4

BROWNLEE MEAN FLOW HYDROGRAPH-MAY

1965-1995

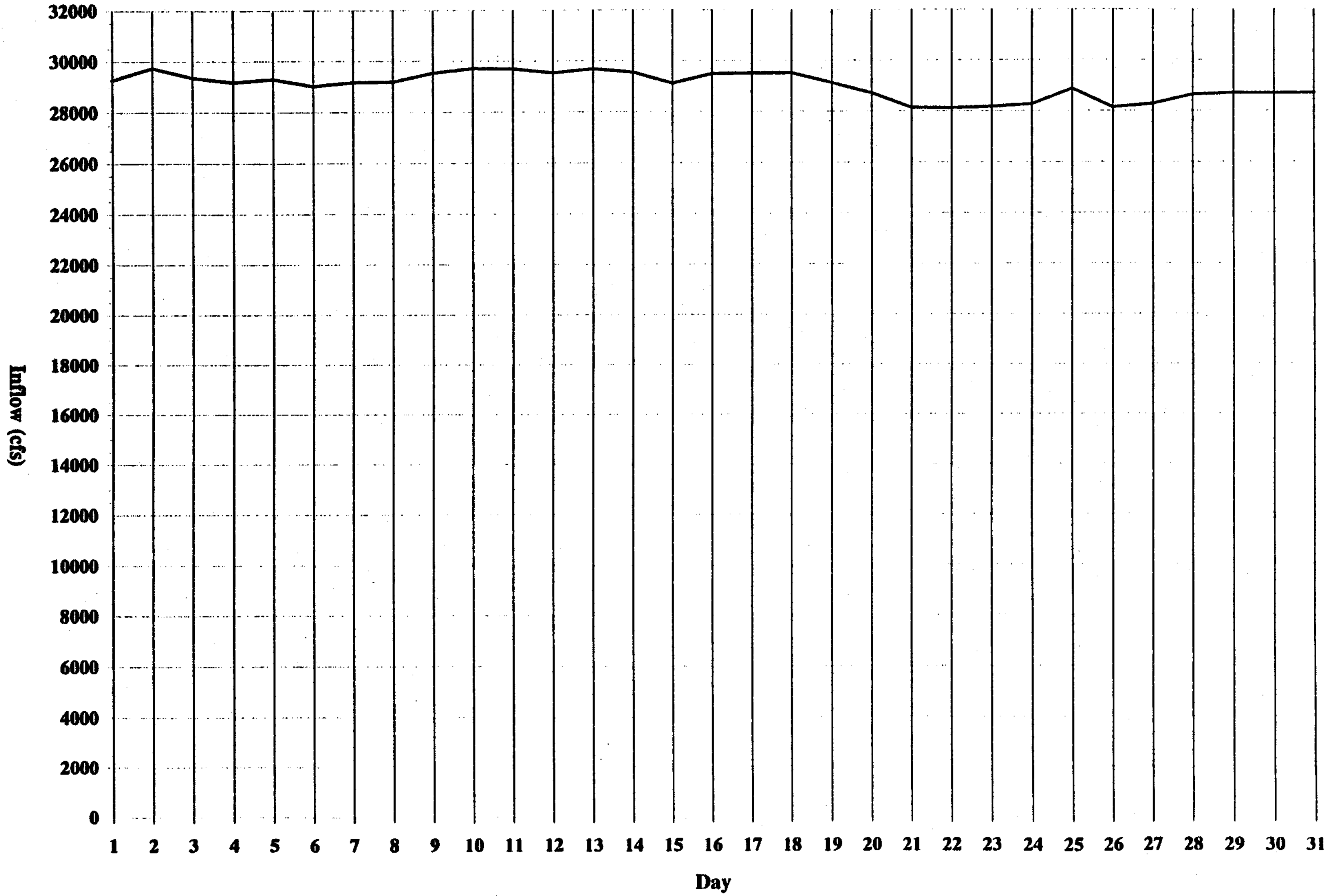
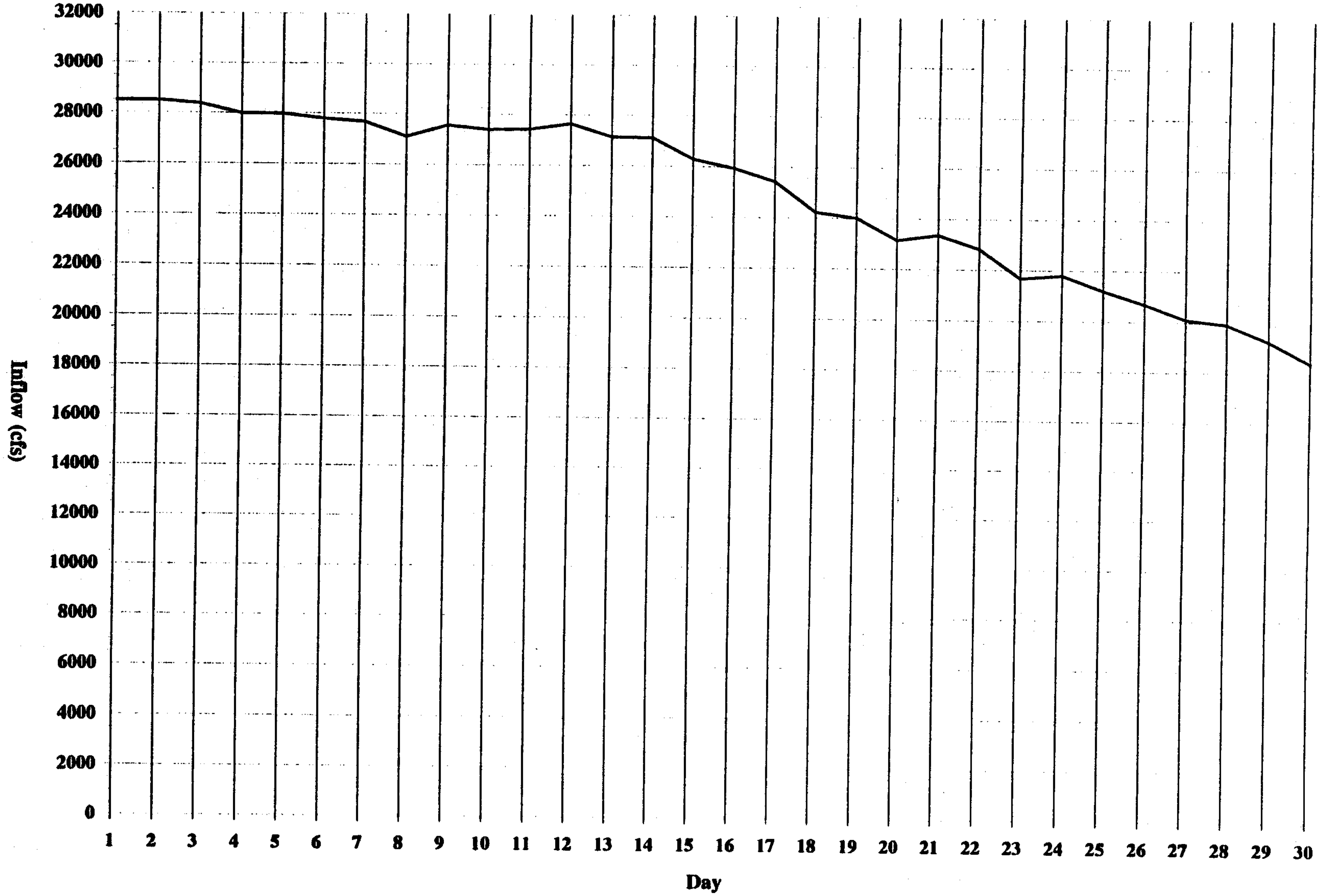


Figure 6-4.5

BROWNLEE MEAN FLOW HYDROGRAPH-JUNE

1965-1995



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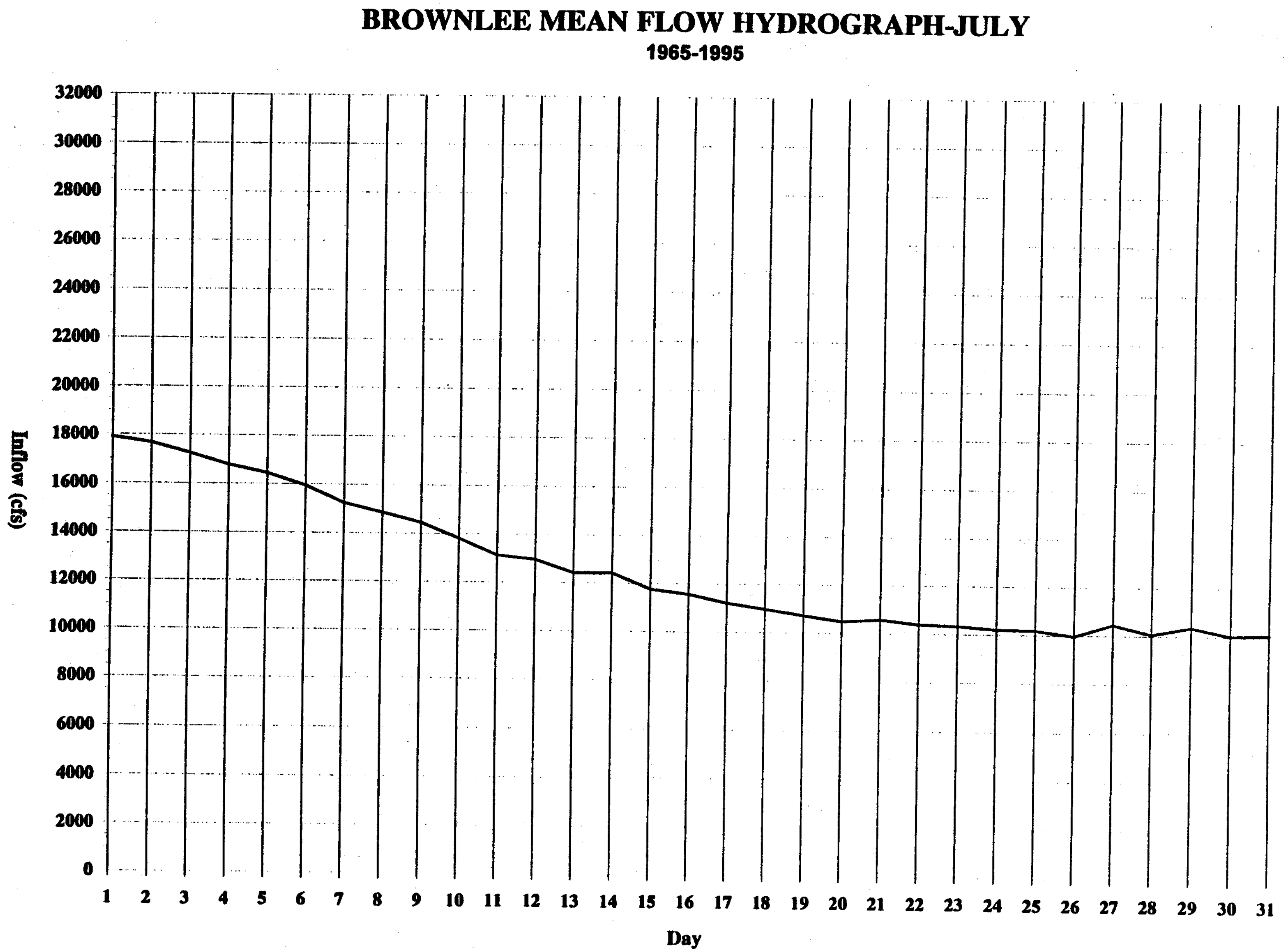

BROWNLEE MEAN FLOW HYDROGRAPH-JULY
1965-1995
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Inflow (cfs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Day

Figure 6-4.7

BROWNLEE MEAN FLOW HYDROGRAPH-AUGUST

1965-1995

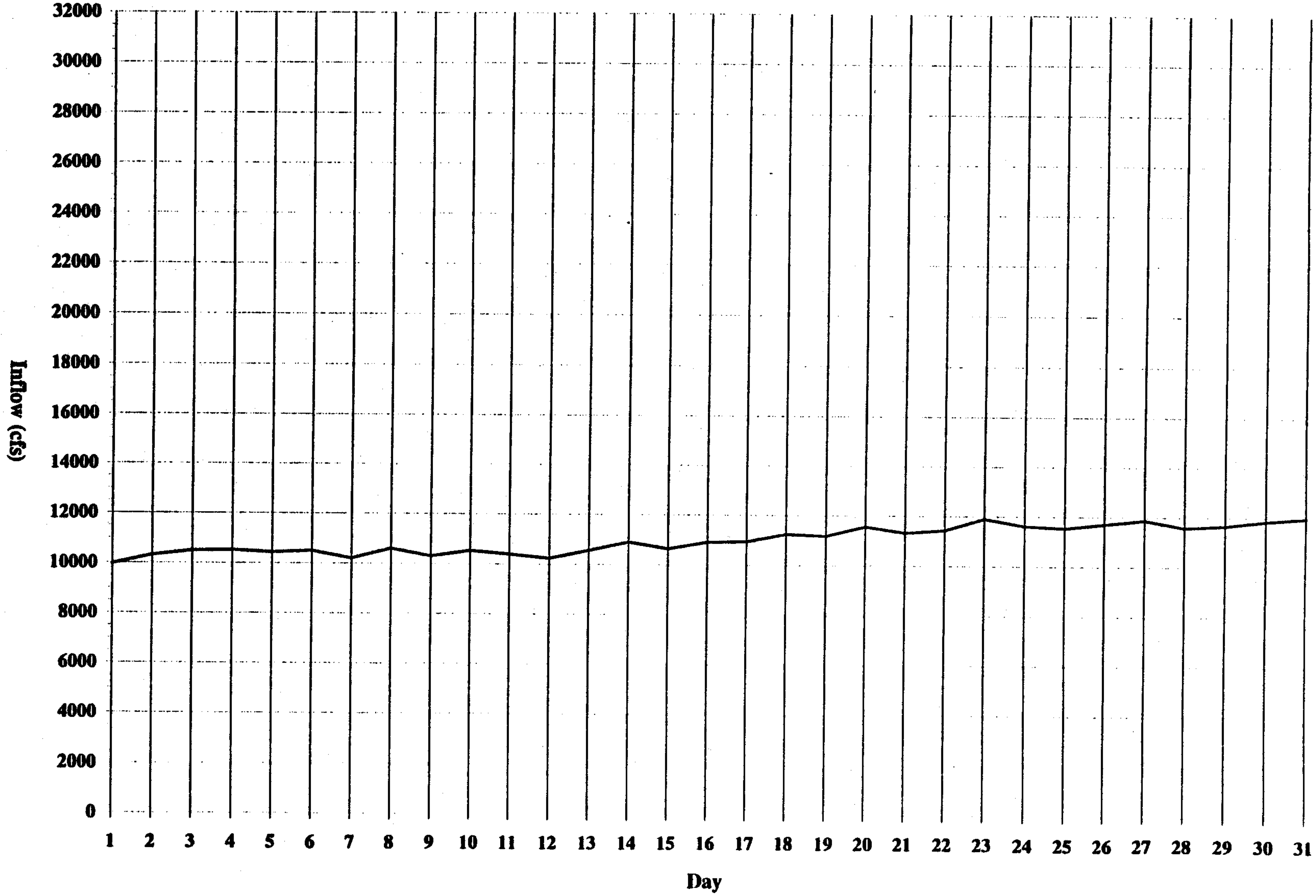
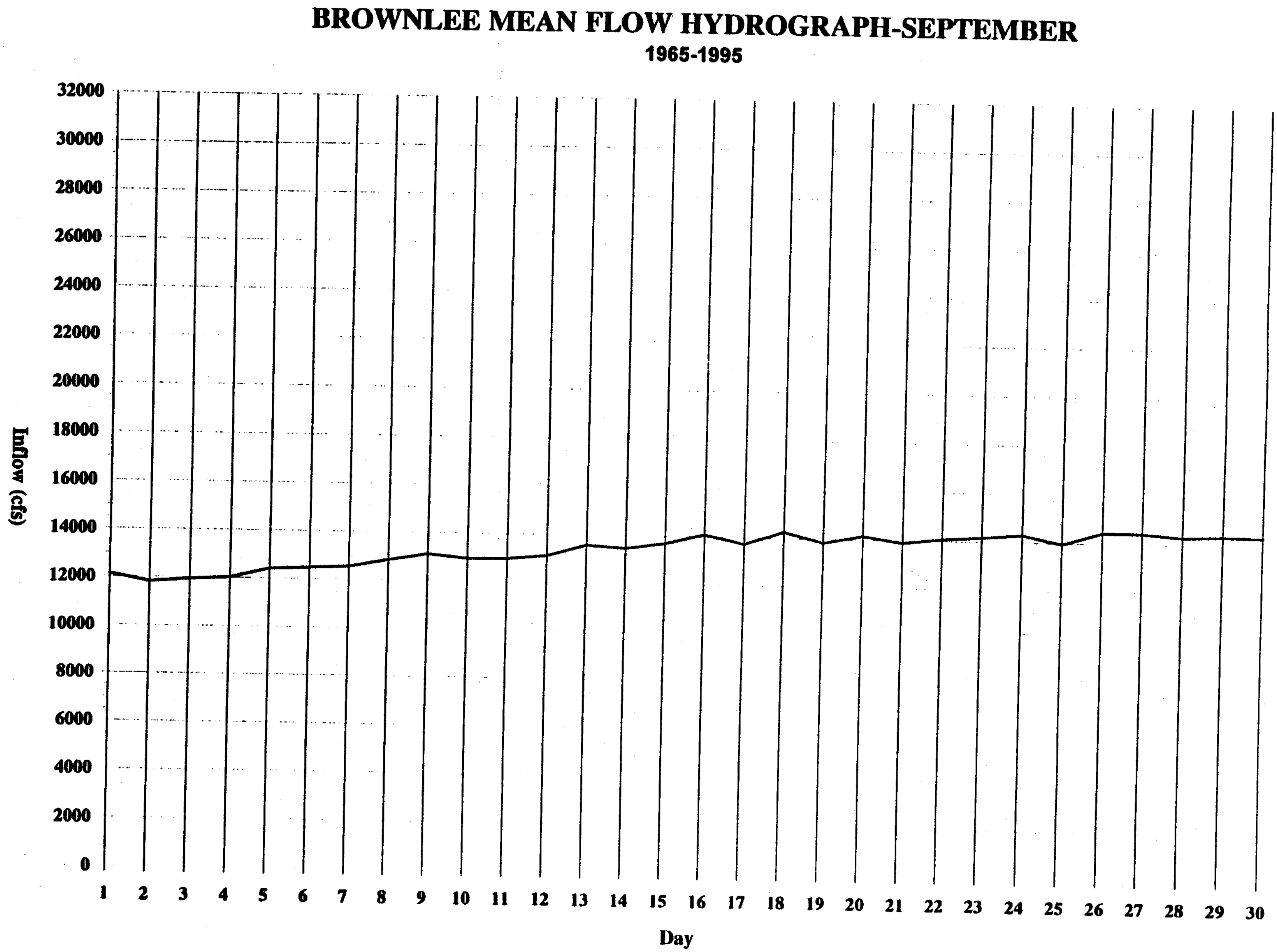


Figure 6-4.8


BROWNLEE MEAN FLOW HYDROGRAPH-SEPTEMBER
1965-1995
Inflow (cfs)
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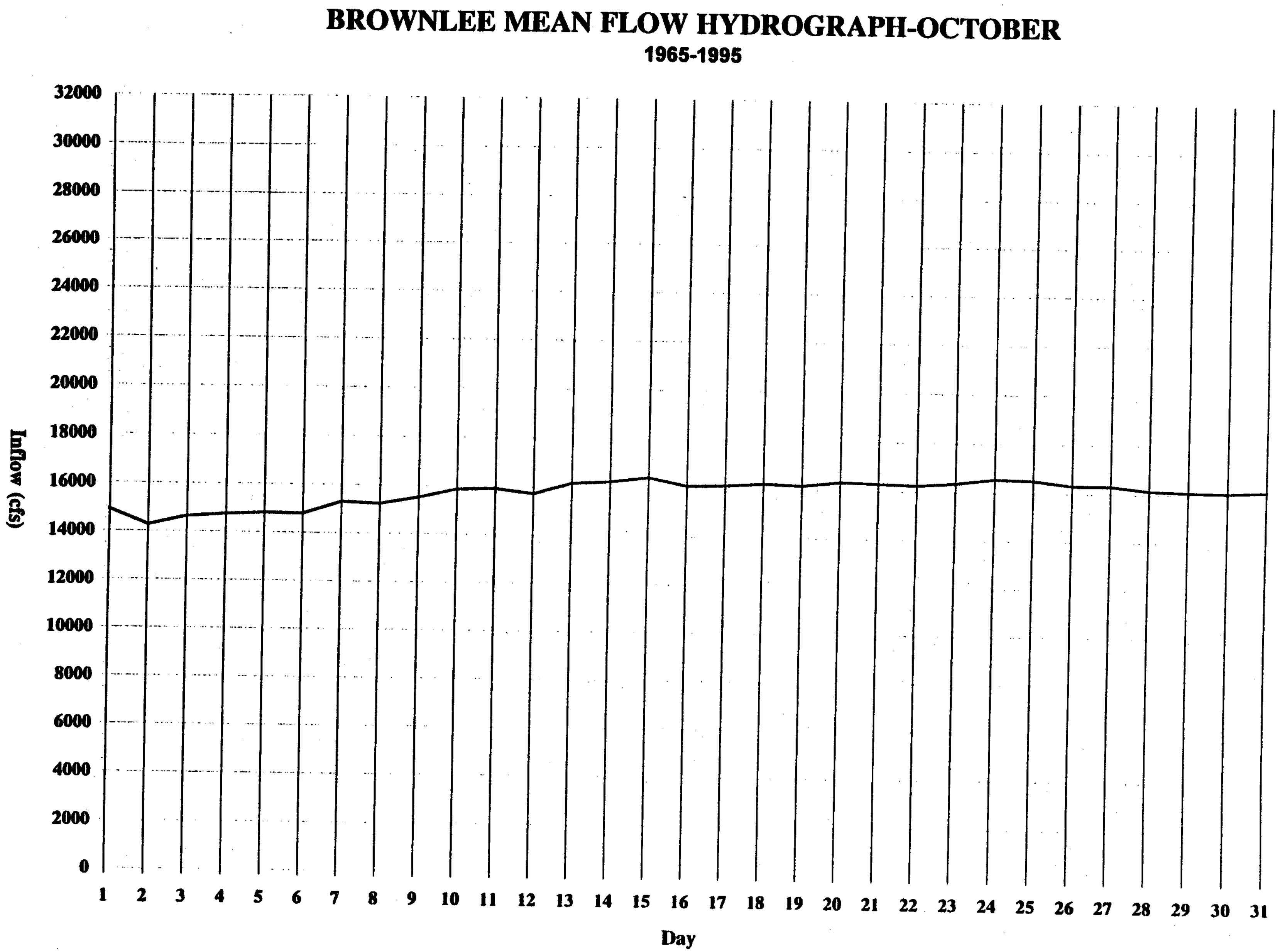
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Day

Figure 6-4.9


BROWNLEE MEAN FLOW HYDROGRAPH-OCTOBER
1965-1995
Inflow (cfs)
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30000
28000
26000
24000
22000
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18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Day

Figure 6-4.10

BROWNLEE MEAN FLOW HYDROGRAPH-NOVEMBER
1965-1995

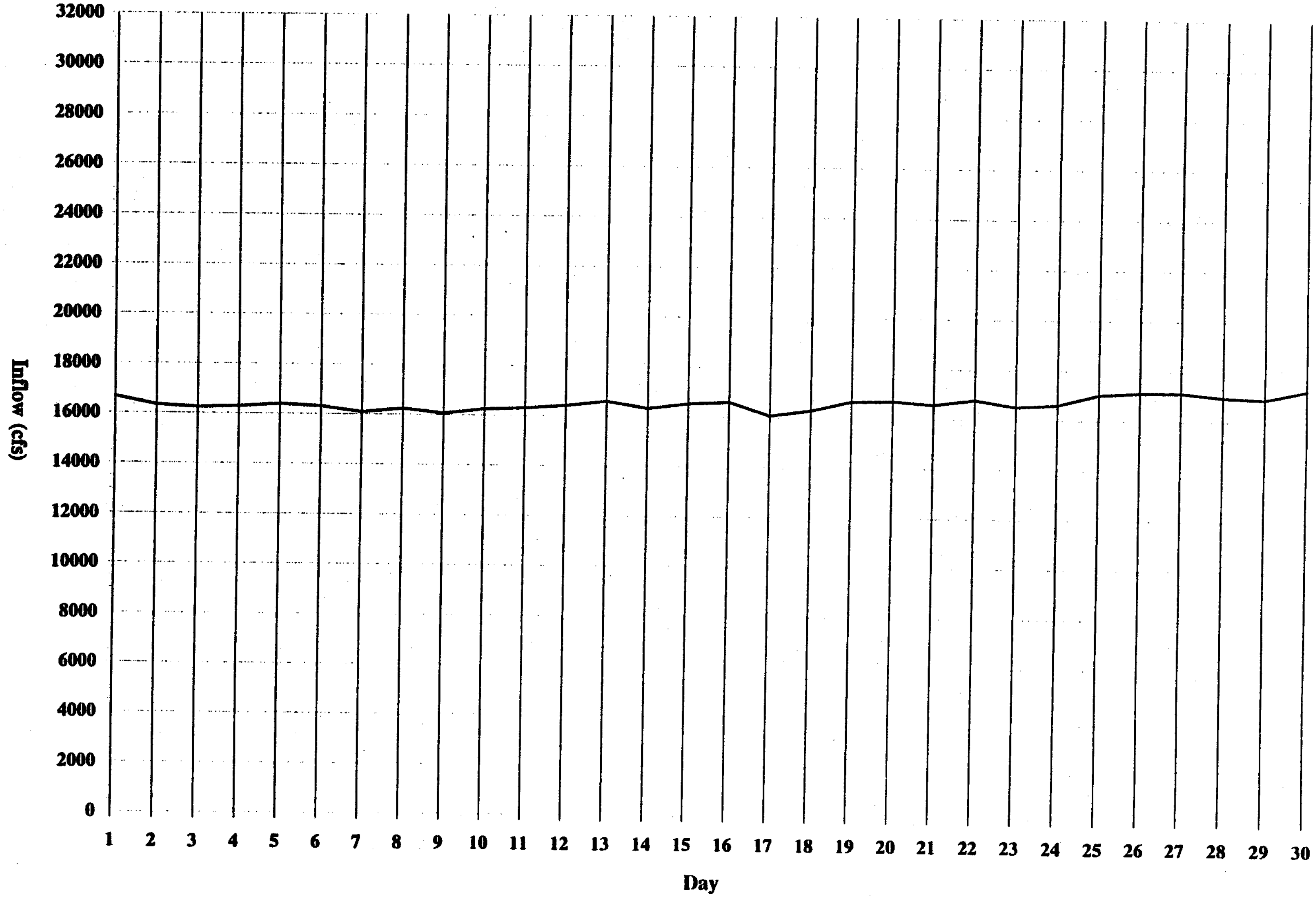


Figure 6-4.11

BROWNLEE MEAN FLOW HYDROGRAPH-DECEMBER

1965-1995

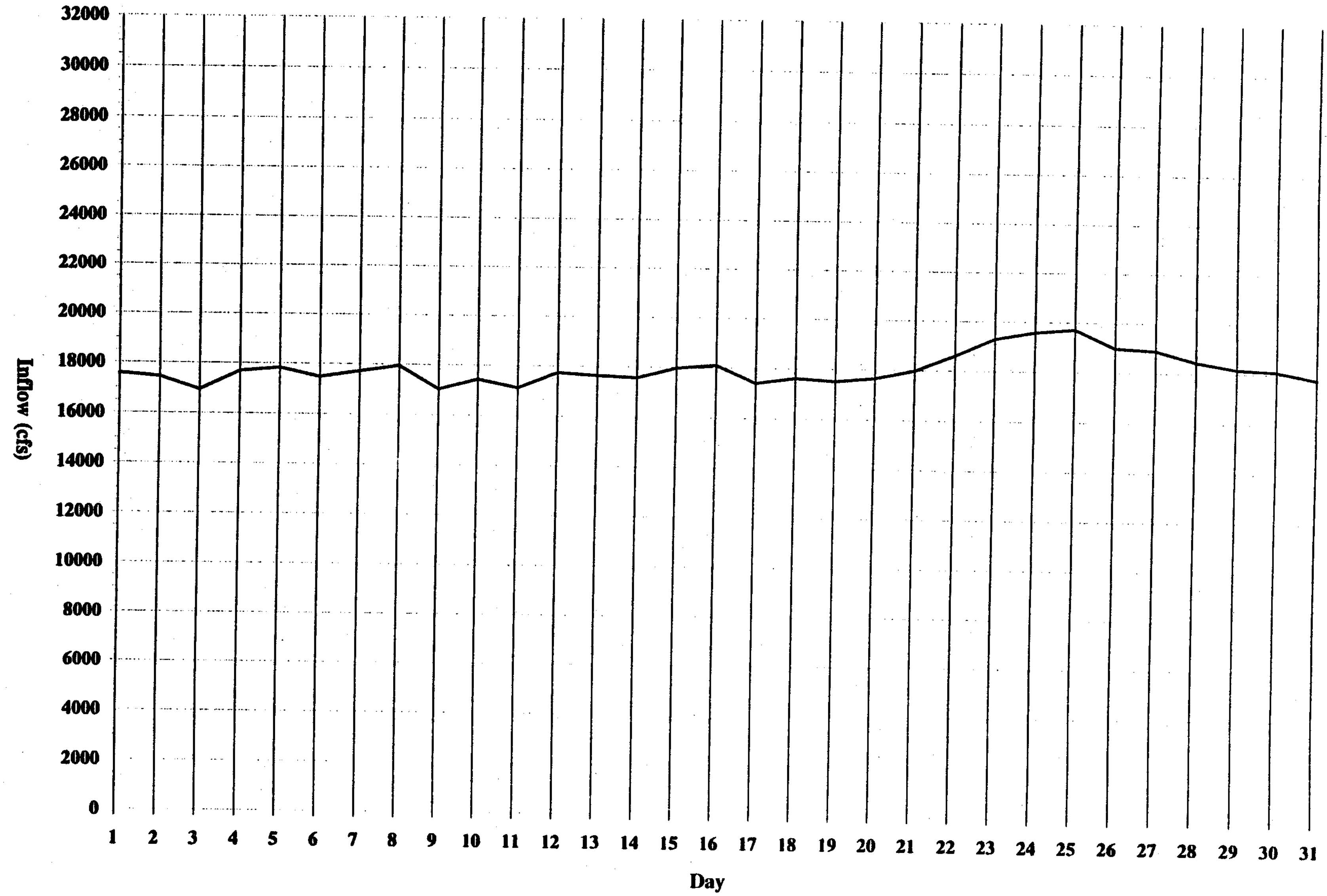
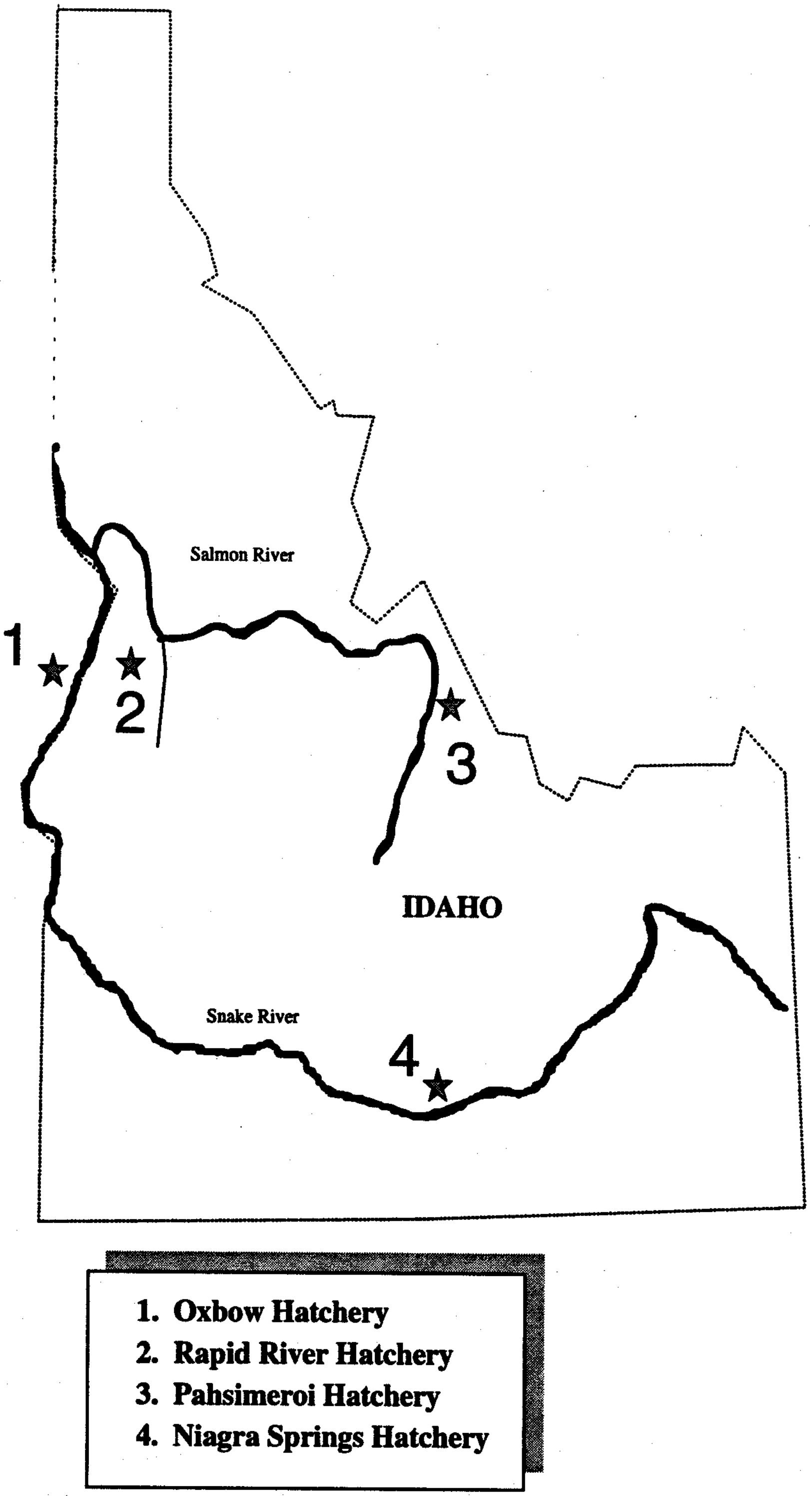


Figure 6-4.12

Figure 7-1 Location of Idaho Power Company's Anadromous Fish Mitigation Hatcheries.



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Formal Consultation Package
for Relicensing

Hells Canyon Project
FERC No. 1971

XIII.
Appendices

LIST OF APPENDICES

A
ABBREVIATIONS AND ACRONYMS

ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act
AF	acre feet
ALE	Arid Land Ecology Reserve
APHA	American Public Health Association
APLIC	Avian Power Line Interaction Committee
ATV	all terrain vehicle
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BP	before present
BPA	Bonneville Power Administration
C	centigrade
CA	Canonical Analysis
CDC	Idaho Conservation Data Center
CEP	Cornell Ecology Program
cfs	cubic feet per second
cm	centimeter
COE	U.S. Army Corps of Engineers
Commission	Federal Energy Regulatory Commission (see also FERC)

CPOM	coarse particular organic matter
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
DEA	Draft Environmental Assessment
DEM	Digital Elevation Map
DEQ	Idaho Division of Environmental Quality
DO	dissolved oxygen
DWOPER	Dynamic Wave Operational Model
EA	environmental assessment
ECPA	Electric Consumers Protection Act
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
FOA	forced oil and air cooling
FPA	Federal Power Act
FPOM	fine particular organic matter
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram
GIS	Geographic Information System
GMA	Game Management Area
GPO	Government Printing Office

GPS	Global Positioning System
gWh	gigawatt hour
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HCNRA	Hells Canyon National Recreation Area
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
hp	horsepower
Hu	Habitat Unit
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDHW-DEQ	IDHW-Division of Environmental Quality
IDPR	Idaho Department of Parks and Recreation
IDWR	Idaho Department of Water Resources
IFIM	Instream Flow Incremental Methodology
IMACS	Intermountain Antiquities Computer System
INEL	Idaho National Engineering Laboratory
INHP	Idaho Natural Heritage Program
Interior	U.S. Department of the Interior
IPC	Idaho Power Company
km	kilometer
kV	kilovolt
kVa	kilovolt amps

kW	kilowatt
kWh	kilowatt hour
m	meter
MAF	millions of acre-feet
MG	megawatt
mg	milligramm
mi	milliliter
min	minute
mm	millimeter
MOU	Memorandum of Understanding
MPH	Miles Per Hour
msl	mean sea level
MUA	Multiple Use Area
MW	megawatt
MWh	megawatt hour
MWh	megawatt hour
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service

NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWPPC	Northwest Power Planning Council
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish and Wildlife
ONHP	Oregon Natural Heritage Program
ORNL	Oak Ridge National Laboratory
PA	programmatic agreement
PCA	Principal Component Analysis
PIT	passive integrated transponder
PU	Planning Unit
RA	Resource Area
RFP	Request for Proposal
RM	River Mile
ROR	run-of-the-river
RV	recreational vehicle
SAS	Statistical Analysis System
SHPO	State Historic Preservation Officer
SRBOPA	Snake River Birds of Prey Area
TDG	total dissolved gas
TMDL	Total Maximum Daily Load
TWINSPAN	Two-way Indicator Species Analysis Program

um	micrometers
USAF	United States Air Force
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USDOE	U.S. Department of Energy
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VQO	Visual Quality Objective
VRM	Visual Resource Management
WDF	Washington Department of Fisheries
WDG	Washington Department of Game
WQC	Water Quality Certificate

IDAHO POWER COMPANY HYDROPOWER FACILITIES
COLLABORATIVE PROCESS FOR RELICENSING CONSULTATION

I. INTRODUCTION

Cooperative approaches to the FERC consultation process are being used more frequently in successful licensing (and relicensing) of hydropower facilities. As noted in a recent issue of the trade journal, HYDRO REVIEW (Kearns, Monahan, and West, 1995), the process offers "a way of identifying the concerns of various water resource stakeholders early in the licensing process, where the issues can be evaluated effectively and balanced with other interests." It also provides stakeholders "a voice before basic decisions about the project license and operation have already been made." In addition, it may reduce "the length and contentiousness of the traditional Federal Energy Regulatory Commission (FERC) licensing process." It also "moves toward taking an ecosystem approach to the watershed rather than just each group considering their own issues."

Between now and 2010, licenses for eight Idaho Power Company (IPC) facilities will expire (date of license expiration is shown in parentheses): Lower Salmon Falls (12/23/97), Bliss (2/28/98), Upper Salmon Falls (1 l/1/98), Shoshone Falls (5/3 l/99), C.J. Strike (1 l/30/00), Malads--Upper and Lower (7/3 l/04), Hells Canyon Complex (7/3 l/OS), and Swan Falls (6/30/10). To comply with FERC regulations, IPC plans to file license applications for the facilities two years before the date of expiration.

Recognizing the significant workload that could be required by the FERC regulations regarding consultation, in October 1989 IPC developed a Memorandum of Understanding for Informal Consultation (MOU) with some state and federal agencies. The MOU was designed to 1) estabiish a procedure for orderly identification and collection of data necessary to meet the requirements for filing an application for the relicensing of a hydroelectric project; and 2) moderate, to the extent possible, the impacts on the parties' personnel and physical resources which would result from the relicensing process of IPC hydroelectric projects. The MOU applied to all the projects listed above except the Malads and Hells Canyon Complex. Although the official signatories of the MOU were limited, IPC expanded the use of the MOU process to include an extensive list of parties concerned or interested in the relicensing process.

Since the process was initiated in 1989, license applications for the Upper and Lower Salmon Falls and Bliss projects have been submitted to FERC (12/20/95), and the license application for Shoshone Falls will be submitted in mid 1997. Other projects are in the earlier stages of the informal process. IPC made some initial efforts to develop an MOU for relicensing of the Hells Canyon Complex, but consensus among the large number of stakeholders with diverse interests was not achieved, and so IPC did not pursue a formal MOU. Instead, IPC has continued to work with the stakeholders in an informal consultation approach for that project.

The participants in the MOU process now have some experience in its workings, and are evaluating what changes are needed to make it more effective. They have focused on the cooperative collaborative process which uses a more structured approach to establish communication and extensive interaction between participants to build trust and understanding, and reach consensus on relicensing issues.

Each involved entity has indicated in writing its acceptance of the approach outlined for this collaborative process.

A. **Mission Statement**

The team will use a collaborative consensus approach to assist and guide IPC in completing license applications which have significant agreement on as many issues as possible, and which outline any areas of disagreement which may still exist. The process is designed to achieve a timely relicensing process and to protect and improve the natural and human environment by considering the interests of the public, regulatory agencies and the applicant.

B. **Scope**

The collaborative approach is built on the framework of the FERC licensing regulations, with enhancements to provide opportunities for more dialogue and agreement throughout the relicensing process. The primary focus is on collaborative consultations in the period prior to filing an application for relicensing This process is expected to provide the participants an opportunity for full and meaningful input on all issues associated with the relicensing process, including development of studies, analyses, and mitigation measures.

C. **Goals**

The participants hope to use the collaborative process to achieve several goals. These include, but are not limited to:

1. Involving resource agencies, affected interests, and the public throughout the relicensing process for IPC hydropower projects;

2. Fostering a frank and open exchange of views among participants;

3. Ensuring well-defined and focused study plans;

4. Encouraging agreements among participants on the contents of applications for relicensing, on protection, mitigation and enhancement plans, and on conditions of new licenses;

5. Ensuring the efficient use of resources and avoiding unnecessary study and process costs;

6. Providing the participants with more control and certainty in the relicensing process through better relationships with the affected interests and the public; and

7. Reducing the likelihood and scope of potential litigation.

II. ORGANIZATIONAL STRUCTURE

A. **Overview**

The basic organizational structure involves the estabiishment of three types of groups. The first group, called the Collaborative Team, is open to entities who have a stake or interest in the management of the hydroelectric projects involved in the FERC relicensing process. The purpose of this group is to make sure that all concerned stakeholders are informed and involved in the relicensing process. The Collaborative Team represents the broad range of interests reflecting the different resource uses and values that are considered in the relicensing process. These resource uses and values include: power generation., flood control, and other developmental objectives, recreation, aesthetics, cultural (including *historical* and archeological factors), water quality, fish, wildlife, botanical, water use, and other aspects of environmental quality. The Collaborative Team provides guidance to the work groups on broad policy issues.

The second type of group is the Resource Work Group. Initially, in the collaborative process, three Resource Work Groups are established: (1) Aquatic Resources; (2) Terrestrial Resources; and (3) Recreation and Aesthetics. The Resource Work Groups focus on the resources identified in 18 CFR Ch. 1 that applicants must address in Exhibit E of the license application. These resources include: water use and quality, fish, wildlife and botanical resources, historical and archeological resources, recreational resources and land management and aesthetics.

The third group is the Economics Work Group, which provides technical economic analysis of developmental and non-developmental values associated with relicensing to the Collaborative Team.

The focus of the work groups is technical and scientific. The work groups are intended to be small and cohesive. They are composed of specialists in a particular resource area and require a substantial commitment of time by those involved. Members of the groups will work together to assist the Collaborative Team in identifying desired future conditions and develop specific proposals for studies, analyses, and mitigation measures in a particular resource subject area.

The relationship between the groups involves essentially a bottom-up approach, where the work groups provide information and recommendations to the Collaborative Team. The Collaborative Team integrates and synthesizes this input and makes it available to IPC for use in developing a cohesive relicensing package. Team and group decisions will be made by consensus. No party can be bound to a decision or be required to expend money without its consent.

The Collaborative Team and the work groups will address all of the IPC projects subject to relicensing. The participants recognize that some parties are only interested in certain projects and that these parties need not attend meetings on projects outside their area of concern. The Collaborative Team and the work groups will use meeting notices and agendas to inform participants of when particular projects will be discussed. All participants should attend sessions dealing with general issues.

The collaborative process described here is intended to be dynamic, not static. The participants anticipate that the process will be adapted to fit changing circumstances and lessons learned from experience. For instance, the Collaborative Team and the work groups may, from time-to-time, create ad hoc groups to address specific issues or to facilitate resolution of disputes.

B. Collaborative Team

1. Description

The Collaborative Team provides an opportunity for key stakeholders to guide the collaborative process. It provides broad representation of stakeholders affected by the relicensing process, including groups such as IPC, federal and state agencies, federally recognized Indian tribes and groups, IPC industrial and residential customers, recreators, sportsmen, water users, environmental interests, the agricultural community, organizations representing affected interests, and local government representatives. Agency participants include the resource agencies that IPC is required to consult with pursuant to FERC consultation requirements (18 CFR § 16.8). The Collaborative Team is a dynamic organization, in the sense that stakeholders may join or may leave the Team as issues and geographic areas change, from FERC project to FERC project. The Rules of Engagement (Section III) describe how the Collaborative Team brings in and orients new participants.

The Collaborative Team is charged with involving the broader public at key points during the relicensing process. To this end, the Collaborative Team will sponsor public meetings at each stage of the consultation process described in 18 CFR § 16.8 and more frequently if necessary. Additionally, public meetings will provide a way to identify stakeholders and their concerns, and will help further define the membership of the Collaborative Team.

Qualifications for involvement in the Collaborative Team are:

1. Members must have interests affected by the relicensing process;

2. Members must be willing to make a positive contribution toward collaborative development of studies, analyses, and mitigation measures needed for relicensing;

3. Members must be willing to abide by the Rules of Engagement, including expectations for participation;

4. Members must provide consistent representation of their interests; and

5. Members must be able to provide decisions in a timely manner.

The Collaborative Team's procedures are designed to balance the need for openness and public involvement with the need to maintain a stable membership that is informed and involved throughout the relicensing process. Several participants have voiced concerns that a loosely constituted Collaborative Team would lead to inconsistent involvement by Team members and undermine the continuity needed to successfully complete the collaborative process. Others felt that the Team should not exclude interested parties that wished to participate.

The Collaborative Team intends to balance these competing concerns by maintaining a policy of open membership for those parties who are affected by the relicensing decisions and who are willing to make a strong commitment to consistent involvement. The Team does not expect to take formal votes on who may join the Team. Instead, the facilitator will explain the terms of the collaborative process to prospective members and will provide any necessary orientation. Prospective members will be asked to discuss their interests and commitment to the process with the Team and to reaffirm in writing their agreement with the collaborative process.

The facilitator will remind existing Team members of their commitment to consistent involvement as needed. Any Team member may raise a concern with the Team if it appears that a member's failure to stay involved may disrupt the collaborative process. The Team may suggest that the member either improve the quality of their involvement or withdraw from the Team. Consistent with the policy of open membership, the decision to withdraw from the Team is left to each member, there is no process for involuntarily removing a member from the Team.

Full membership on the Collaborative Team is not the only means for involvement in the collaborative process. Collaborative Team meetings will be open to the public and meeting agendas will include time for public comment. The work groups will also contact affected landowners, lessees, and local governments in developing work products.

The Collaborative Team will meet as necessary and will make efforts to meet in the areas where the projects are located. Meetings will occur on at least a quarterly basis but may be more frequent depending on the issues under discussion.

The membership of the Collaborative Team is listed in Attachment A, which will be updated periodically to reflect the addition of new members.

2. Responsibilities

Responsibilities of the Collaborative Team are:

1. The Collaborative Team provides a "big-picture" view throughout the process and acts as a sounding board for the work groups. The Team also provides information on related issues or activities in the area of the projects, such as state or local government initiatives. This ensures that the work group activities are consistent with the broader vision.

2. The Collaborative Team provides a forum for economic, resource/environmental, operational and land management discussions and decisions, with the understanding that the work groups also address these issues in the technical or management context of their resource areas throughout the relicensing process.

3. The Collaborative Team discusses policy issues, with the understanding that the Team is not the sole forum on those issues. Some specific issues may be resolved by the work groups, and some may be referred from the work groups to the Collaborative Team.

4. The Collaborative Team formulates issues for the relicensing process and, to the extent possible, identifies desired future conditions for relevant natural resources. The issues and desired future conditions will be addressed at initial work group and Team meetings on any project or group of projects. The issues and desired future conditions provide the framework within which the Team and the work groups develop studies and subsequent, logical mitigation plans.

5. Prior to preparation of applications for relicensing, the Collaborative Team evaluates opportunities and constraints identified through the collaborative process for proposed protection, mitigation, and enhancement measures and considers resource trade-offs.

6. The Collaborative Team sponsors public informational meetings, including time for comment from the public as follows.

a. At the beginning of informal consultation (similar to a National Environmental Policy Act scoping meeting). Meeting topics include the relicensing process, issues, desired future conditions, and other opportunities for public participation. This initial public meeting helps further define who is involved on the Collaborative Team and work groups.

b. After study plans have been finalized and approaches for protection, mitigation, and enhancement measures have been identified. This is an opportunity to inform the public about economic considerations and trade-offs inherent in mitigation alternatives and to receive suggestions from the public on approaches to follow.

c. After draft applications have been prepared.

d. At other times the Collaborative Team deems necessary or appropriate.

7. The Collaborative Team informs FERC of its progress and invites active staff participation in the collaborative process.

8. The Collaborative Team will evaluate the effectiveness of the process on a regular basis. Any member is free to recommend an improvement in the process.

9. The Collaborative Team may form special issue groups on an ad hoc basis.

10. The Collaborative Team may recommend that IPC take advantage of short-term opportunities for beneficial protection, mitigation, and enhancement measures prior to final relicensing – particularly where such opportunities are time sensitive. The Collaborative Team will discuss how IPC will receive "credit'* toward project mitigation obligations for any measures undertaken during the relicensing process.

3. Facilitator

The Collaborative Team will select a facilitator by consensus. The facilitator's general responsibilities are to keep the process moving forward, to act as a process coach, to maintain his or her own neutrality on the issues discussed, and to reinforce the elements of the collaborative process. The facilitator's specific functions are to:

1. Facilitate discussion;

2. Encourage invoivement and help the Team reach consensus when necessary;

3. Assist the Team in evaluating the effectiveness of the collaborative process;

4. Schedule meetings;

5. Coordinate public meetings and public information and education efforts;

6. Ensure that records of meetings and decisions are kept;

7. Ensure that notices, agendas, and records of meetings and decisions are distributed to participants and are accessible to others; and

8. Orient new Team members and continue to reinforce the expectation for consistent involvement.

C. Work Groups

1. Description

The Resource Work Groups and the Economics Work Group are the working arms of the collaborative process organization and require a substantial time commitment from members.

The work groups will select group leaders. This position may rotate within the group. The primary responsibility of the group leader is to keep the process moving forward. The group leader schedules meetings, leads discussion and encourages involvement and consensus. With the assistance of IPC staff, the group leader keeps records of meetings and decisions, and ensures that this information is distributed to members and the Collaborative Team, and is accessible to others.

Qualifications for membership on the work groups are:

1. Members must have a specific interest in relicensing issues;

2. Members must have expertise or special knowledge in the relevant resource subjects;

3. Members must be willing to make a substantial and positive contribution toward collaborative development of studies, analyses, and mitigation measures needed for relicensing;

4. Members must be willing to abide by ground rules, including agreed-upon 'expectations for participation and confidentiality;

5. Members must receive a commitment of funding and resources from their organization to ensure meaningful participation;

6. Members must commit to working toward specific decisions and products;

7. Members must commit to consulting with the Collaborative Team and those on the ground, such as affected land owners, lessees, local government; and

8. Members must be abie to provide decisions in a timely manner.

The membership of the work groups is set out in Attachment B. These attachments will be updated periodically to reflect the addition of any new members.

2. **Resource Work Groups**

The Resource Work Groups guide the studies and development of elements of the license applications, including protection, mitigation and enhancement recommendations consistent with agreed upon issues and desired future conditions. The Resource Work Groups are empowered to resolve issues at their level. They send non-consensus issues to the Collaborative Team for consideration.

The general subject areas for each of the Resource Work Groups are as follows:

1. Aquatic Resources Work Group: water quality, quantity and use; fish and mollusc resources;

2. Terrestrial Resources Group: wildlife, soils and geology, botanical, and cultural resources; and

3. Recreation and Aesthetics Resources Work Group: recreation and aesthetics.

Each Resource Work Group will consider those aspects of operations, economics, and land management relevant to its subject areas.

3. **Economics Work Group**

The Economics Work Group will work with the Collaborative Team and the Resource Work Groups to integrate economic considerations into their discussions. The Economics Work Group is charged with considering the economic values associated with relicensing such as aquatics, fish and wildlife, recreation, cultural and aesthetic values, as well as developmental values such as power generation, irrigation, and flood control. The function of the Economics Work Group is not to constrain discussions by the Team or the Resource Work Groups, but to provide data and expertise on economic issues for consideration in the relicensing process.

4. Responsibilities

Responsibilities of the work groups are:

1. The work groups: (a) assist the Collaborative Team in identifying desired future conditions; (b) develop study plans and protocols under which the studies are performed consistent with the issues and desired future conditions identified by the Collaborative Team and public comments, (C) participate in the selection of contractors and review proposals if the studies are to be performed by contractors, (d) review work products, and (e) assist in identifying issues considered in the license application;

2. The work groups monitor the progress of the studies and make recommendations on any major mid-course corrections, if needed, to the Collaborative Team;

3. The work groups participate in appropriate analyses, such as the GIS resource analysis, and in specific study analyses and interpretation as necessary;

4. When a non-consensus issue is identified, the work group defines the issue, explores options and, if unresolved, makes recommendations for proceeding to the Collaborative Team;

5. The work groups may form special issue groups on an ad hoc basis;

6. The work groups can address economic, resource/environmental, operational, and land management issues relevant to specific resources and in a manner consistent with FERC regulations as needed;

7. The work groups actively consult with landowners, lessees, and local governments in developing work products as needed; and

8. The work groups provide input which leads to significant agreement on the components of the technical studies, draft license applications, and protection, mitigation and enhancement measures.

D. Public

The collaborative process acknowledges the importance of providing opportunities for participation of ail stakeholders, including the public. The collaborative process provides opportunities for public participation at several levels:

1. The views of citizens may be brought to the Collaborative Team through organizations that represent their interests.

2. Citizens with an interest or who can provide expertise may be involved in the activities of the work groups. They may participate in group meetings or via grassroots involvement with group members.

3. Citizens may participate in public meetings organized by the Collaborative Team and submit oral or written comments.

III. RULES OF ENGAGEMENT

A. General Rules of Conduct

1. Everyone participates

2. No complaining/no cheap shots

3. Leave "baggage" at the door

4. Have fun, be creative and solution oriented

B. Specific Rules of Conduct

1. Team members should be on time for meetings. The future meeting schedule and location will be finalized at the end of each meeting, and tentative agenda items will be determined. Tentative meeting dates will be projected two months into the future, if possible.

2. A point person will be identified for each organization as its responsible party. This person will notify the facilitator or group leader of absence or changes in representation prior to the meeting.

3. Collaborative Team and work group actions will be through consensus, defined as a lack of objection. Consensus does not mean that everyone must necessarily be enthusiastic about a decision, only that they will acquiesce to it and that there will be minimal complaints about it later.

4. The Resource Work Groups are empowered to resolve issues at their level. When non-consensus issues are identified, the work groups will define the issue and potential options or recommendations for dealing with them and refer them to the Collaborative Team for further discussion.

5. A meeting agenda and materials will be sent out prior to each meeting. Tie will be allocated on the agenda to discuss other issues. A "parking lot" will be established to collect off-agenda ideas for later discussion. Issues can be tabled for further discussion. Time may be allocated for caucusing or silent reflection. Time will be allocated on the agenda for discussion on how the collaborative process is working.

6. Each member must be a willing, active and responsible contributor and strive for consensus. Each should be open-minded, listen, respect others, provide accurate information, be direct, and be willing to educate other participants on unfamiliar issues.

7. Active involvement means that group members are responsible for providing input and responding to information needs, preferably in writing, in a timely manner.

8. All members must come to meetings prepared. Side discussions should not occur during the meeting. IPC staff will provide logistical support, such as typing mailing, meeting locations, etc.

9. The Collaborative Team and work groups will work within the vision/mission statement. Timely, realistic, and attainable, short and long term goals will be established.

10. All facilitators and group leaders will function in an objective manner while working to keep group discussions focused and moving forward.

11. Meetings will be documented using minutes. Minutes should be reviewed by each Team or work group member prior to meetings and any corrections made at the next meeting of the group, or sooner if possible. A central file will be established at IPC headquarters to hold this information, and an information resource list will be developed and readily available for all who are interested.

12. The collaborative process is intended to be the primary means of communication among the members. However, the need to caucus is recognized. Any outcome of those discussions should be made available to other involved parties within a reasonable time.

Attachment A

Collaborative Team Distribution List - 1120197

Leon Newman, Adams County Commission
Doug Russell, Amalgamated Sugar Co.
Rob Masonis, American Rivers •
Rich Bowers, American Whitewater Affiliation
Clareen Wharry, Andrus Center for Public Policy
Richard W. Lindsay, Argonne National Laboratory
Shirley Atteberry
John Meiser/Barbara Mester, Aura of the Arts
Steve Bogart, Baker County Commission •
Katherine Cheney, Bonneville Power Administration
Bob King, Bonneville Power Administration
Bernie Burnham, Bureau of Indian Affairs
Harold Brown, Bureau of Land Management, Shoshone Office •
Jim Clark, Bureau of Land Management, Boise District •
Terry Costello, Bureau of Land Management, Boise District •
Wallace Evans, Bureau of Land Management, Idaho State Office +
John Fend, Bureau of Land Management, Boise District *
Bill Hagdorn, Bureau of Land Management, Boise District •
John Martin, Bureau of Land Management, Idaho State Office •
Jim May, Bureau of Land Management, Idaho State Office •
Gerry Meyer, Bureau of Land Management, Vale District •
Kathy J. Eaton, Bureau of Land Management, Oregon State Office *
Effie Schultsmeier, Bureau of Land Management, Boise District •
Marty Sharp, Bureau of Land Management, Shoshone Office •
Karl Simonson, Bureau of Land Management, Burley Office +
Bill Weigand, Bureau of Land Management, Idaho State Office *
Elaine Zielinski, Bureau of Land Management, Oregon State Office *
Terry Kent, Bureau of Reclamation
Herbert Hawley, Burns-Paiute Tribes
Haace St. Martin, Burns-Paiute Tribes
Elizabeth Conner, City of Boise, Mayor's Office
Dennis Bowyer, City of Twin Falls
The Honorable Jeff Gooding, City of Twin Falls
Lamar Orton, City of Twin Falls
The Honorable Don Stephens, City of Weiser
John Donalson, Columbia Basin Fish & Wildlife Authority
Clayton Hawkes, Columbia Basin Fish & Wildlife Authority
Rob Heinith, Columbia Basin Fish & Wildlife Authority
Diana McDonald, Columbia Basin Fish & Wildlife Authority
Ted Strong, Columbia River Inter-Tribal Fish Commission
Joseph Pakootas, Confederated Coville Tribes
Jerry Meninick, Confederated Tribes and Bands of the Yakima Indian Nation
Mike Farrow, Confederated Tribes of the Umatila Indian Reservation
Zane Jackson, Confederated Tribes of the Warm Springs Reservation of Oregon
Olivia Confederated Tribes of the Warm Springs Reservation of Oregon
Lawrence Denny
Tony Sullins, Dept. of the Interior, Solicitor's Office, USFWS •

John Eisinger, Eagle-Picher Minerals, Inc.
John Shrum, Elmore County Commission
Robert Hall, Elmore County Wildlife Club
Jim Hastreiter, Federal Energy Regulatory Commission
Ann Miles, Federal Energy Regulatory Commission
Alan Mitchnick Federal Energy Regulatory Commission
Michele DeHart, Fish Passage Center
Gary Findley
Dick Pugh, Friends of the Weiser River Trail
Gooding County Commission
Ned Swisher, Hagerman Valley Citizens Alert
Sandra Mitchell, Hells Canyon Alliance
Terri Carlson, Hells Canyon NRA
Ed Cole, Hells Canyon NRA
Rick Dustin, Hells Canyon NRA
Woody Fine, Hells Canyon NRA
Bruce Womack, Hells Canyon NRA
Ric Bailey, Hells Canyon Preservation Council *
Al McGlinsky, Hells Canyon Preservation Council *
Jack Stern, Hells Canyon Preservation Council •
John White, Hewlett Packard
Jack Spector, Hixon Properties, Inc.
Jim Dessaro, Idaho BASS
Dennis Udlinek, Idaho Bass Federation
Mike Medberry, Idaho Conservation League
Pat Barclay, Idaho Council on Industry and the Environment •
George Enneking, Idaho County Commission
Cal Groen, Idaho Department of Fish & Game *
Jerome Hansen, Idaho Department of Fish & Game •
Carl Nellis, Idaho Department of Fish & Game •
Tom Parker, Idaho Department of Fish & Game *
Dave Parrish, Idaho Department of Fish & Game •
Will Reid, Idaho Department of Fish & Game *
Stacy Stovall, Idaho Department of Fish & Game *
Mike Allen, Idaho Department of Health & Welfare, DEQ *
Wallace Cory, Idaho Department of Health & Welfare, DEQ •
Bob Lupton, Idaho Department of Health & Welfare, DEQ •
Joy Palmer, Idaho Department of Health & Welfare, DEQ *
Jim Johnston, Idaho Department of Health & Welfare, DEQ •
Don McNarie, Idaho Department of Lands
Yvonne Ferrell, Idaho Department of Parks & Recreation *
Mary Lucachick, Idaho Department of Parks & Recreation •
Ellen Berggren, Idaho Department of Water Resources *
Ralph Mellin, Idaho Department of Water Resources •
Ruth Schellbach, Idaho Department of Water Resources •
Tom Dayley, Idaho Farm Bureau Federation •
Bill DeVeney, Idaho Farm Bureau Federation *
Dave Fullmer, Idaho Farm Bureau Federation •
George Lemmon, Idaho Farm Bureau Federation •
Greg Nelson, Idaho Farm Bureau Federation *
Grant Simonds, Idaho Outfitter and Guides Association
Lynn Anderson, Idaho Public Utilities Commission •
Randy Lobb, Idaho Public Utilities Commission •

Brad Purdy, Idaho Public Utilities Commission •
Marti Bridges, Idaho Rivers United *
Mary McGown, Idaho Rivers United •
Suzi Neitzel, Idaho State Historical Society
Robert Yohe, Idaho State Historical Society
Leland L. "Roy" Mink, Idaho Water Resources Research Institute
Harold Nohlman, Idaho Water Users Association
Sandy Thomas, Idaho Whitewater Association
Kent Laverty, Idaho Wildlife Federation
J. Lynn Isaakson
David Hawk, JR Simplot Company •
Art Brown, Jerome County
Roy Prescott, Jerome 'County Commission
Mike Henderson, Lamb-Weston
Laird Lucas, Land & Water Fund of the Rockies
Malheur County Commission
Allan Perman, Micron Technology, Inc.
Steve Stout, Micron Technology, Inc.
Doug VanderBoegh, Micron Technology, Inc.
Bob Muffley, Middle Snake Regional Water Resource Commission *
Rich Fletcher, Mule Deer Foundation
Larry Minkler, Mule Deer Foundation
Scott Carlson, National Marine Fisheries Service
Steve Morris, National Marine Fisheries Service
Mark Eames, National Oceanic & Atmospheric Administration
Dan Haas, National Park Service *
Neil King, National Park Service •
Phil Pearl, National Parks & Conservation Association
Guy Bonnivier, Nature Conservancy
Lee Daniels, Neighbors of Brownlee-Oxbow
Nelson Perry, Nestle Brands
Douglas Nash, Nez Perce Tribe
Richard Raines, Nez Perce Tribe
Rayola Jacobsen, Northwest Power Planning Council
Jim Yost, Northwest Power Planning Council
Peter Paquet, Northwest Power Planning Council
Karl Weist, Northwest Power Planning Council
Ed Chaney, NRIC
John Shram, Ore-Ida Foods, Inc.
Oregon Department of Agriculture •
Oregon Department of Energy •
Greg McMurray, Oregon Department of Environmental Quality •
Stephanie Birchfield, Oregon Department of Fish & Wildlife •
Chris Carter, Oregon Department of Fish & Wildlife •
Errol Claire, Oregon Department of Fish & Wildlife *
Bruce Eddy, Oregon Department of Fish & Wildlife •
Linne Kennedy, Oregon Department of Fish & Wildlife •
Oregon Department of Forestry *
Oregon Department of Geology and Mineral Industries •
Nan Evans, Oregon Department of Parks & Recreation
Martha Pagel, Oregon Department of Water Resources •
Oregon Division of State Lands *
Scott Stouder, Oregon Hunter's Association *

Oregon Natural Resource Council
John Britton, Oregon Public Utilities Commission *
Bill McNamee, Oregon Public Utilities Commission •
James Hammerick, Oregon State Historical Society
Wayne Shuyler, Oregon State Marine Board •
Jim Myron, Oregon Trout
Richard Bass, Owyhee County Commission
John Dyer, OX Ranch
Mike Pepper, Region IV Forum-Middle Snake Recreation Workgroup
Art Talsma, Rocky Mountain Elk Foundation
Rob Ruth
Pat Ford, Save Our Wild Salmon Coalition
David Arthaud, Shoshone-Bannock Tribes •
Delbert Farmer, Shoshone-Bannock Tribes •
Shaun Robertson, Shoshone-Bannock Tribes •
Diane Yupe, Shoshone-Bannock Tribes •
Terry Gibson, Shoshone-Paiute Tribes
Walden Townsend, Shoshone-Paiute,Tribes
Jackie Forsmann, Snake River Preservarion Council
Bill Moore, Southwest Idaho Resource Conservation & Development Council, Inc.
Will Whelan, State of Idaho, Idaho Office of the Attorney General *
The Honorable Phil Batt, State of Idaho, Office of the Governor
Nathan Fisher, State of Idaho, Office of the Governor
The Honorable John Kitzhaber, State of Oregon, Office of the Governor
The Honorable Mike Lowry, State of Washington, Office of the Governor
Ann Beier, Trout Unlimited
N.L.Gates, Trout Unlimited
Kent Just, Twin Falls Chamber of Commerce
Doug Howard, Twin Falls County
Dennis Maughan, Twin Falls County
Brent Reinke, Twin Falls County
Lee Taylor, Twin Falls County
Marvin Hempleman, Twin Falls County
Twin Falls County Parks & Recreation
Rob Brochu, US Army Corps of Engineers
Greg Martinez, US Army Corps of Engineers
Al Bolin, US Bureau of Reclamation
Carolyn Burpee Stone, US Bureau of Reclamation
Regional Environmental Officer, US Department of the Interior •
Barbara Scott Brier, US Department of the Interior •
Steve Tibbetts, US Department of the Interior •
John Olson, US Environmental Protection Agency •
Ted Koch, US Fish & Wildlife Service •
Jim Esch, US Fish & Wildlife Service •
Bryan Kenworthy, US Fish & Wildlife Service •
Susan Martin, US Fish & Wildlife Service •
William Miller, US Fish & Wildlife Service •
Frederick Olney, US Fish & Wildlife Service •
Robert Ruesink, US Fish & Wildlife Service •
Kevin Ryan, US Fish & Wildlife Service *
Michael, Spear, US Fish & Wildlife Service *
Dale Bosworth, US Forest Service *
Pete Johnston, US Forest Service, Council Ranger District •

Cory Jemmett, US Forest Service, Nez Perce National Forest •
David Alexander, US Forest Service, Payette National Forest •
Mike Stayton, US Forest Service, Payette National Forest •
Kevin Martin, US Forest Service, Wallowa Valley Ranger District •
Gretchen Sausen, US Forest Service, Wallowa Valley Ranger District •
John Anderson, US Forest Service, Wallowa-Whitman National Forest •
Elaine Bantam, US Forest Service, Wallowa-Whitman National Forest *
Gay Ernst, US Forest Service, Wallowa-Whitman National Forest •
Sob Richmond, US Forest Service, Wallowa-Whitman National Forest •
Kurt Weidenmann, US Forest Service, Wallowa-Whitman National Forest •
Walton Low, US Geological Survey
Douglas Ott, US Geological Survey
John Lowe, USDA - Forest Service
Wallowa County Commission
Arleigh Isley, Wallowa County Judge
Washington County Commission
Phil Ulmer, Washington County Economic Development Commission
Robert Gerke, Washington Department of Fisheries
Jim Nielsen, Washington Department of Wildlife
Mike Wolverton

‘Agencies that submitted written commitment to participate in the collaborative process

Attachment B

Resource Work Group - Distribution List

Paul Abbott	A	Idaho Power Company
Mike Allen	ARTE	Idaho Dept. of Health & Welfare, Division of Environmental Quality
Lynn Anderson	E	Idaho Public Utilities Commission
Allan Ansell	RT	Idaho Power Company
Jim Arp	R	US Forest Service, Payette National Forest
David Arthaud	AT	Shoshone-Bannock Tribes
Ellen Berggren	R	Idaho Department of Water Resources
Stephanie Birchfield	ARTE	Oregon Department of Fish & Wildlife
Jon Bowling	A	Idaho Power Company
Darren Brandt	A	Idaho Dept. of Health & Welfare, Division of Environmental Quality
Steve Brink	A	Idaho Power Company
Marshall Brown	R	Idaho Power Company
Mike Butler	R	Idaho Power Company
Diane Cazier	A	Idaho Power Company
Jim Chandler	A	Idaho Power Company
John Church	E	Idaho Power Company
Errol Claire	ARTE	Oregon Department of Fish & Wildlife
Greg Clark	A	US Geological Survey
Jim Clark	AT	Bureau of Land Management, Boise District
Nancy Cole	T	Idaho Power Company
Jim Dessaro	E	Idaho BASS
Mark Druss	T	Idaho Power Company
Frank Edelmann	T	Idaho Power Company
Gay Ernst	R	US Forest Service
Jim Esch	AE	US Fish & Wildlife Service
Dave Evans	A	Burns-Paiute Tribes
Jim Fargo	E	Federal Energy Regulatory Commission
Woody Fine	R	U.S. Forest Service Hells Canyon National Recreation Area
Karen Gale	R	Oregon Department of Parks & Recreation
Jack Gantz	AT	Idaho Dept. of Health & Welfare, Division of Environmental Quality
Lisa Grise	R	Idaho Power Company
Phil Groves	A	Idaho Power Company
Scott Grunder	AT	Idaho Department of Fish & Game
Dan Haas	RE	National Park Service
Bill Hagdorn	R	Bureau of Land Management, Boise District
Jerome Hansen	T	Idaho Department of Fish & Game
David Hawk	E	JR Simplot
Gary Holmstead	T	Idaho Power Company
Toni Holthuijzen	T	Idaho Power Company
Chris Huck	R	Idaho Power Company

Jim James	E	Idaho Power Company
Craig Jones	E	Idaho Power Company
Elaine Kleckner	ARTE	Idaho Power Company
Ted Koch	T	US Fish & Wildlife Service
Scott Larrondo	E	Idaho Power Company
George Lemmon	E	Idaho Farm Bureau Federation
Ken Lepla	A	Idaho Power Company
Mary Lucachick	RE	Idaho Department of Parks & Recreation
Doug McLean	E	Micron Technology, Inc.
Al McGlinksy	ARTE	Hells Canyon Preservation Council
Mary McGown	ARTE	Idaho Rivers United
Geoff Maddaugh	R	Bureau of Land Management, Vale District
Kevin Martin	AT	US Forest Service, Wallowa Valley Ranger District
John Martin	E	Bureau of Land Management, Idaho State Office
Dorothy Mason	R	Bureau of Land Management, Vale District
Rob Masonis	ATE	American Rivers
Ralph Mellin	AE	Idaho Department of Water Resource
Gerry Meyer	R	Bureau of Land Management, Vale District
Ralph Myers	A	Idaho Power Company
Mike Newsom	AT	National Marine Fisheries Service
Willie Noll	AT	U.S. Forest Service
John Olson	A	Environmental Protection Agency
Shaun Parkinson	A	Idaho Power Company
Richard Raines	E	Nez Perce Tribe
Chris Randolph	AT	Idaho Power Company
Will Reid	ATE	Idaho Department of Fish & Game
Tracy Richter	A	Idaho Power Company
Haace St. Martin	T	Burns-Paiute Tribes
Craig Shepard	A	Idaho Dept. of Health & Welfare, Division of Environmental Quality
Paul Shinke	A	Idaho Dept. of Health & Welfare, Division of Environmental Quality
Mike Stayton	R	US Forest Service, Payette National Forest
Karl Weist	E	Northwest Power Planning Council (Oregon)
Will Whelan	E	Idaho Attorney General's Office
Bruce Womack	AT	US Forest Service, Hells Canyon National Recreation Area
Dwayne Wood	RE	Idaho Power Company
Paul Woods	A	US Geological Survey
Diane Yupe	RT	Shoshone-Bannock Tribes

Group Designation:

A Aquatics
R Recreation/Aesthetics
T Terrestrial
E Economic

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ISSUES

for

Relicensing Idaho Power Company
Hells Canyon Project

Index

09/13/96

ISSUES

for

Relicensing Idaho Power Company
Hells Canyon Project

INTRODUCTION

The Resource Work Groups established by the Collaborative Team have identified the following resource issues as the basis for proceeding with the Collaborative Process for relicensing the Hells Canyon Project. These and issues identified by the public will be considered as relicensing study plans are developed.

ISSUES IDENTIFICATION

Aquatics

1. Reservoir level effects on resident fish
2. Operational impacts to white sturgeon population
3. Effects of hydro power on anadromous fish above Hells Canyon Project & feasibility of reintroduction
4. Effects of the projects on bull trout
5. Status of white sturgeon population in Brownlee Reservoir, Swan Falls reach (reproductive spawning)
6. Effects of IPC Land Management practices on aquatic resources
7. Effects of hydro power on anadromous fish below Hells Canyon Project
8. Water quality in Brownlee Reservoir
9. Effects of sediment within all the reservoirs
10. Operational effects on downstream beaches
11. Effects of operations on downstream gravels and sediments
12. Impacts of construction operation on native trout population on mainstream and tributaries (i.e. genetic and hatchery interactions
13. Evaluation of existing hatchery mitigation program (anadromous)
14. Impacts of operations on aquatic invertebrates, downstream
15. Effects of operation of the plants on total dissolved gas
16. Assessment of potential anadromous fish habitat in mainstream & tributaries above project
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
18. Evaluation of water fluctuations on warm water fisheries within all reservoirs
19. Loss of anadromous fish in aquatic food chain

20. Effects of operations on water quality below Brownlee Dam
21. Effects of the projects on Mercury (also other heavy metals) within the system (Trans. & processing of Hg)
22. Impacts of projects on downstream water quality
23. Effects of project on sea lamprey
24. Impacts of power house operations on white sturgeon mortality
25. Assessment of biological benefits of a non-resident natural hydrography
26. Effects on aquatic resources due to operation and maintenance of transmission lines
27. Impacts of Hells Canyon Dam--is there a loss of resident game fish during high discharge?
28. Evaluation of fish passage options (upstream &downstream) for residential and anadromous fish
29. Investigate opportunities 84 alternatives for operating projects to improve downstream anadromous fish flows
30. Evaluate the sources of water quality contamination in Brownlee Reservoir
31. Is current angular access adequate for current & future projected demands?
32. Effects on aquatic resources and water quality due to nutrient storage/buildup within all reservoirs
33. Evaluate existing constraints on water management (Brownlee & Oxbow Reservoirs) and downstream
34. Determine changes to macro invertebrate population within reservoirs and determine availability within the food chain
35. Accumulation of agriculturally based chemicals in reservoir sediment and effects on the aquatic species
36. Impacts of construction and operation on aquatic vegetation
37. Impacts of reach fragmentation and flow regulation on white sturgeon
38. Effects of daily and seasonal reservoir fluctuation on large/small mouth bass &crappie (specific to the reservoirs) recruitment (non- spawning success)
39. Evaluate opportunities to acquire water from the basin above the project
40. Are current hatchery rainbow trout strains maximizing angler catch rates?
41. Recreational impacts to water quality and aquatic resources (i.e. petroleum, waste dumping, oils, etc.)
42. Evaluate alternatives for protecting fall chinook salmon spawning habitat below Hells Canyon
43. Determine impacts of reservoir drawdowns on bugs and “creepy crawlies”
44. Nutrient cycling/processing in the impoundments
45. Effects of loss of anadromous fish on cultural and recreational fishery use/values
46. Effects of operations on downstream invertebrates (i.e. mollusks)
47. Water temperature effects, downstream, on aquatic life
48. Determine changes needed in dam operations and fish management programs to sustain a sturgeon fishery in Hells Canyon and Oxbow

49. Evaluation of trophic structure in reservoirs and downstream including redation by squaw fish on resident and anadromous fish
50. Evaluation of dissolved oxygen issues in Brownlee Reservoir when pool is low in the fall (fish kills have occurred)
51. Effects of project operations on connectivity and function of riparian zones and wetlands
52. Study tooplankton as a food resource for fish
53. Evaluate flow requirements for maintaining water quality in Oxbow by-pass reach
54. Determine environmental baseline starting point (point in time)(pre-construction issue)
55. Model the long term probability persistence (how long can they last) of white sturgeon under current operating conditions
56. Storm water impacts to water quality and aquatic resources due to maintenance and new construction
57. That studies be designed to provide a solution to the issue
58. Evaluate historic hydrographs as they relate to present river flow conditions to assist with determination of operational changes needed to sustain sturgeon population
59. Evaluate opportunities to synchronize operations system wide to mimic natural hydrography
60. Determine effects of all land management practices on water quality and aquatics
61. Public awareness of water issues and aquatic resource values
62. impacts of high flow releases below Hells Canyon Dam on small-mouth bass spawning success and recruitment
63. Evaluate present day and historic anadromous fish potential above Hells Canyon Complex
64. Determine factors outside of IPC control that would prevent achieving PM&E Measures
65. Meeting flow objectives at Lower Granite for listed chinook, through operations at Brownlee
66. Meet water quality objectives for listed chinook and habitat in the lower Snake
67. Make sure all ongoing studies are folded into the data base for relicensing (all agencies, not just IPC) to avoid duplication
68. Assess loss of natural river channel, including rapids, on aquatic resources
69. Evaluate any new conflicts or costs for other uses due to changed aquatic conditions (project operations)
70. Assess impacts on IPC ability to meet power demands with the removal of lower four Snake River impoundments for improvement of anadromous passage
71. Evaluate water level fluctuation impacts on drawdown zone riparian vegetation and fish and wildlife micro habitats

72. Economic and engineering feasibility of project removal

Grouping of Aquatic Issues

Fish Resources

Anadromous

3. Effects of hydro power on anadromous fish above Hells Canyon Complex & feasibility of reintroduction
7. Effects of hydro power on anadromous fish below Hells Canyon Complex
13. Evaluation of existing hatchery mitigation program (anadromous)
16. Assessment of potential anadromous fish habitat in mainstream & tributaries above project
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
19. Loss of anadromous fish in aquatic food chain
23. Effects of project on sea lamprey
28. Evaluation of fish passage options (upstream & downstream) for residential and anadromous fish
29. Investigate opportunities & alternatives for operating projects to improve downstream anadromous fish flows
42. Evaluate alternatives for protecting fall chinook salmon spawning habitat below Hells Canyon
45. Effects of loss of anadromous fish on cultural and recreational fishery use/values
49. Evaluation of trophic structure in reservoirs and downstream including predation by squaw fish on resident and anadromous fish
63. Evaluate present day and historic anadromous fish potential above Hells Canyon Complex
65. Meeting flow objectives at Lower Granite for listed chinook, through operations at Brownlee
66. Meet water quality objectives for listed chinook and habitat in the lower Snake
70. Assess impacts on IPC ability to meet power demands with the removal of lower four Snake River impoundments for improvement of anadromous passage

Resident

Reservoir

1. Reservoir level effects on resident fish

4. Effects of the projects on bull trout
12. Impacts of construction operation on native trout population on mainstream and tributaries (i.e. genetic and hatchery interactions
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
18. Evaluation of water fluctuations on warm water fisheries within all reservoirs
27. Impacts of Hells Canyon Dam - is there a loss of resident game fish during high discharge?
28. Evaluation of fish passage options (upstream & downstream) for residential and anadromous fish
35. Accumulation, of agriculturally based chemicals in reservoir sediment and effects on the aquatic species
38. Effects of daily and seasonal reservoir fluctuation on large/small mouth bass & crappie (specific to the reservoirs) recruitment (non- spawning success)Effects of daily and seasonal reservoir fluctuation on large/small mouth bass & crappie (specific to the reservoirs) recruitment (non- spawning success)
40. Are current hatchery rainbow trout strains maximizing angler catch rates?
49. Evaluation of trophic structure in reservoirs and downstream including predation by squaw fish on resident and anadromous fish

River

4. Effects of the projects on bull trout
12. Impacts of construction operation on native trout population on mainstream and tributaries (i.e. genetic and hatchery interactions
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
28. Evaluation of fish passage options (upstream & downstream) for residential and anadromous fish
40. Are current hatchery rainbow trout strains maximizing angler catch rates?
49. Evaluation of trophic structure in reservoirs and downstream including predation by squaw fish on resident and anadromous fish
57. That studies be designed to provide a solution to the issue
62. Impacts of high flow releases below Hells Canyon Dam on small-mouth bass spawning success and recruitment

Sturgeon

2. Operational impacts to white sturgeon population
5. Status of white sturgeon population in Brownlee Reservoir, Swan Falls reach (reproductive spawning)
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
24. Impacts of power house operations on white sturgeon mortality
28. Evaluation of fish passage options (upstream & downstream) for residential and anadromous fish
37. Impacts of reach fragmentation and flow regulation on white sturgeon
48. Determine changes needed in dam operations and fish management programs to sustain a sturgeon fishery in Hells Canyon and Oxbow
55. Model the long term probability persistence (how long can they last) of white sturgeon under current operating conditions
58. Evaluate historic hydrographies as they relate to present river flow conditions to assist with determination of operational changes needed to sustain sturgeon population

<u>Other Aquatic Biota</u>

14. Impacts of operations on aquatic invertebrates, downstream
17. Effects of introducing non-native species resident fish on native species (effects of exotic fish on native species)
34. Determine changes to macro invertebrate population within reservoirs and determine availability within the food chain
35. Accumulation of agriculturally based chemicals in reservoir sediment and effects on the aquatic species
36. Impacts of construction and operation on aquatic vegetation
43. Determine impacts of reservoir drawdowns on bugs and "creepy crawlies"
46. Effects of operations on downstream invertebrates (i.e. mollusks)
52. Study zooplankton as a food resource for fish

Water Quality

8. Water quality in Brownlee Reservoir
9. Effects of sediment within all the reservoirs
15. Effects of operation of the plants on total dissolved gas
20. Effects of operations on water quality below Brownlee Dam

21. Effects of the projects on Mercury (also other heavy metals) within the system (transfer & processing of Hg)
22. Impacts of projects on downstream water quality
30. Evaluate the sources of water quality contamination in Brownlee Reservoir
32. Effects on aquatic resources and water quality due to nutrient storage/buildup within all reservoirs
35. Accumulation of agriculturally based chemicals in reservoir sediment and effects on the aquatic species
41. Recreational impacts to water quality and aquatic resources (i.e. petroleum, waste dumping, oils, etc.)
44. Nutrient cycling/processing in the impoundments
47. Water temperature effects, downstream, on aquatic life
50. Evaluation of dissolved oxygen issues in Brownlee Reservoir when pool is low in the fall (fish kills have occurred)
53. Evaluate flow requirements for maintaining water quality in Oxbow by-pass reach
56. Storm water impacts to water quality and aquatic resources due to maintenance and new construction
60. Determine effects of all land management practices on water quality and aquatics
66. Meet water quality objectives for listed chinook and habitat in the lower Snake

Physical

9. Effects of sediment within all the reservoirs
10. Operational effects on downstream beaches
11. Effects of operations on downstream gravels and sediments
68. Assess loss of natural river channel, including rapids, on aquatic resources

Flow

20. Effects of operations on water quality below Brownlee Dam

25. Assessment of biological benefits of a non-resident natural hydrography
29. Investigate opportunities & alternatives for operating projects to improve
39. Evaluate opportunities to acquire water from the basin above the project
53. Evaluate flow requirements for maintaining water quality in Oxbow by-pass reach

58. Evaluate historic hydrographics as they relate to present river flow conditions to assist with determination of operational changes needed to sustain sturgeon population
59. Evaluate opportunities to synchronize operations system wide to mimic natural hydrography
62. Impacts of high flow releases below Hells Canyon Dam on small-mouth bass spawning success and recruitment
65. Meeting flow objectives at Lower Granite for listed chinook, through operations at Brownlee
71. Evaluate water level fluctuation impacts on drawdown zone riparian vegetation and fish and wildlife micro habitats

Legal/Economic/Management

6. Effects of IPC Land Management practices on aquatic resources
26. Effects on aquatic resources due to operation and maintenance of transmission lines
31. Is current anglar access adequate for current & future projected demands?
33. Evaluate existing constraints on water management (Brownlee & Oxbow Reservoirs) and downstream
39. Evaluate opportunities to acquire water from the basin above the project
54. Determine environmental baseline starting point (point in time)(pre-construction issue)
57. That studies be designed to provide a solution to the issue
59. Evaluate opportunities to synchronize operations system wide to mimic natural hydrography
60. Determine effects of all land management practices on water quality and aquatics
61. Public awareness of water issues and aquatic resource values
64. Determine factors outside of IPC control that would prevent achieving PM&E Measures
72. Economic and engineering feasibility of project removal

Eco-Systems

25. Assessment of biological benefits of a non-resident natural hydrography
49. Evaluation of trophic structure in reservoirs and downstream including predation by squaw fish on resident and anadromous fish
51. Effects of project operations on connectivity and function of riparian zones and wetlands

68. Assess loss of natural river channel, including rapids, on aquatic resources

System Wide Accumulation

30. Evaluate the sources of water quality contamination in Brownlee Reservoir
32. Effects on aquatic resources and water quality due to nutrient storage/buildup within all reservoirs
39. Evaluate opportunities to acquire water from the basin above the project
67. Make sure all ongoing studies are folded into the data base for relicensing (all agencies, not just IPC) to avoid duplication
70. Assess impacts on IPC ability to meet power demands with the removal of lower four Snake River impoundments for improvement of anadromous passage

<u>Terrestrial</u>

1. Impacts of water level on reservoir habitats
2. Impacts of water level on riparian habitat downstream
3. Cultural and natural resource inventories (FERC requirements)
4. Effects of flow changes below dams
5. Impacts to T.E. & S. species from flow changes and flooding of original habitat from construction
6. Former candidate species--how are they treated since their status has changed, should they be studied
7. Terrestrial Species Habitat impacts in units/acres by habitat type (both sides of the river, all known species)
8. Direct species impacts due to reservoir operational changes during the winter (i.e. winter loss of deer, elk, Big horn--that become stranded on winter ice (operational)
9. Operational effects on both reservoir and downstream areas
10. Post-construction loss of habitat
11. Cumulative impacts to discovered and undiscovered archaeological properties from construction and operation/maintenance of power line corridors.
12. Studies focus on Hells Canyon project impacts on wildlife vs. focus on current conditions (impacts vs data only)
13. Changes in quality of upland and riparian habitat on lands currently or formerly under IPC control
14. Study design and quality? - How do we know what we know??
15. Dont forget the bugs
16. Size of study area
17. Impact Identification (actual)

18. Mitigation plans
19. Impacts associated with transmission line operation (R/W)
20. Potential impacts downstream to listed archaeological properties from flow regulation activities
21. Potential impacts to discover previously undiscovered archaeological properties due to fluctuation of reservoir levels and wave action
22. LOSS of wildlife habitat due to project construction
23. Current impacts of project operations on wildlife habitat-- altered migration routes
24. Blank
25. LOSS of anadromous link in the wildlife food chain,
26. Effect of operations on the quantity and quality of riparian habitat (reservoir & free flowing reaches)
27. Wildlife habitat fragmentation caused by project construction and operation
28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off)
29. Cumulative impacts on the overall function of the system - b/u natural river & reservoir
30. Long term availability of base line data collected, how it will be used
31. Flooding/dewatering of Terrestrial Species - micro habitat.
32. Public access/recreational use impact of new roads, public, wildlife species terrestrial habitat, winter ranges, etc., people use in former wildlife habitat
33. IPC Land Management practices effects on terrestrial resources
34. Potential effect of recreation on cultural, botanical, and wildlife resources (i.e. bald eagles, cultural sites T&E plant species)
35. Potential impacts of project construction/maintenance activities on American Indian traditional use of sites and/or activities
36. Foregone opportunities: i.e. turkey habitat, protecting and restoring riparian systems.
37. Miles/acres of free flowing river riparian habitat impacted by original construction
38. Migration routes impacted (especially Big Horn Sheep) by original construction
39. Climatic changes that have occurred particularly - summer & winter - thermal cover for big game
40. Livestock grazing impacts in relation to current management plans. (Intermingled land in project areas)
41. Do noxious weeds limit mitigation opportunity
42. Native Terrestrial Species composition change due to original construction
43. Secondary Terrestrial Species impacts associated with construction/maintenance of power line corridors
44. Water level fluctuation versus migrations, home ranges, territories, etc
45. Water lever fluctuations pm shoreline riparian conditions

46. Flooding/dewatering impacts on micro habitats of certain small mammal and amphibians
47. Foregone opportunities for some species, i.e. forest grouse, big horn sheep
48, How to prioritize species and habitats to be studies
49. Hydro vs. other uses (Impacts)

Grouping of Terrestrial Issues

Construction (original)

5. Impacts to T.E. & S. species from flow changes and flooding of original habitat from construction
7. Terrestrial Species Habitat impacts in units/acres by habitat type (both sides of the river, all known species
10. Post-construction loss of habitat
11. Cumulative impacts to discovered and undiscovered archaeological properties from construction and operation/maintenance of power line corridors.
22. Loss of Wild Life habitat due to project construction
23. Current impacts of project operation on wildlife habitat altered migration routes
25. Loss of anadromous link in the wildlife food chain.
27. Wildlife habitat fragmentation caused by project construction and operation
28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off)
29. Cumulative impacts on the overall function of the system - b/u natural river & reservoir
32. Public access/recreational vs impact of new roads/public/wildlife species on terrestrial habitat, winter ranges, etc. (people use in former wildlife habitat
36. Foregone opportunities: i.e. turkey habitat, protecting and restoring riparian systems.
37. Miles/acres of free flowing river riparian habitat impacted by original construction
38. Migration routes impacted (especially Big Horn Sheep) by original construction
39. Climatic changes that have occurred particularly - summer & winter - thermal cover for big game
42. Native Terrestrial Species composition change due to originai construction
43. Secondary Terrestrial Species impacts associated with construction/maintenance of power line corridors

47. For gone opportunities for some species i.e. forest grouse, big horn sheep

New Construction

7. Terrestrial Species Habitat impacts in units/acres by habitat type (both sides of the river, all known species.
10. Post-construction loss of habitat
11. Cumulative impacts to discovered and undiscovered archaeological properties from construction and operation/maintenance of power line corridors.
22. Loss of Wild Life habitat due to project construction
23. Current impacts of project operations on wildlife habitat-- altered migration routes
27. Wildlife habitat fragmentation caused by project construction and operation
28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off)
29. Cumulative impacts on the overall function of the system - b/u natural river & reservoir
32. Public access/recreational vs impact of new roads/public/wildlife species on terrestrial habitat, winter ranges, etc. (people use in former wildlife habitat
43. Secondary Terrestrial Species impacts associated with construction/maintenance of power line corridors?

Operational

1. impacts of water level on reservoir habitats
2. Impacts of water level on riparian habitats downstream
4, Potential effects of flow changes below dams
5. Impacts to T.E. & S. species from flow changes and flooding of original habitat from construction
8. Direct species impacts due to reservoir operational changes during the winter (i.e. winter loss of deer, elk, Big horn - that become stranded on winter ice (operational)
9. Operational effects on both reservoir and downstream are
19. Impacts associated with transmission line operation (R/W)
23. Current impacts of project operation on wildlife habitat--altered migration routes
26. Effect of operations on the quantity and quality of riparian habitat (reservoir & free flowing reaches)
27. Wild Life habitat fragmentation caused by project construction and operation

28. Effect on water quality from terrestrial resource impacts (inCreaSe in sediment, etc.) (nutrients that may come off)
31. Flooding/dewatering of Terrestrial Species - micro habitat.
32. Public access/recreational vs impact of new roads, public, wildlife species terrestrial habitat, winter ranges, etc., people use in former, wildlife habitat
33. IPC Land Management practices effects on terrestrial resources
34. Potential effect of recreation on cultural, botanical, and wild life resources (i.e. bald eagles, cultural sites T&E plant species)
40. Livestock grazing impacts in relation to current management plans. (Intermingled land in project areas)
41. Do noxious weeds limit mitigation opportunity
43. Secondary Terrestrial Species impacts associated with construction/maintenance of power line corridors
44. Water level fluctuation versus migrations, home ranges, territories, etc
45. Water lever fluctuations on shoreline riparian conditions
46. Flooding/dewatering impacts on micro habitats of certain small mammal and amphib. Flooding/dewatering impacts on micro habitats of certain small mammal and amphib

Maintenance

11. Cumulative impacts to discovered and undiscovered archaeological properties from construction and operation/maintenance of power line corridors.
19. Impacts associated with transmission line operation (R/W)
28. Effect on water quality from terrestrial resource impacts (increase in sediment, etc.) (nutrients that may come off)
33. IPC Land Management practices effects on terrestrial resources
43. Secondary Terrestrial Species impacts associated with construction/maintenance of power line corridors

Process

1. Impacts of water level on riparian habitats
2. Impacts of water level on reservoir habitat downstream.
3. Cultural and natural resource inventories (FERC requirements)
4. Potential effects of flow changes below dams
6. Former candidate species--how are they treated since their status has changed, should they be studied
12. Studies focus on Hells Canyon project impacts on wildlife vs. focus on current conditions (Impacts vs Data Only)
14. Study design and quality? - How do we know what we know?

15. Don't forget the bugs
16. Size of study area
17. Impact Identification (actual)
18. Mitigation plans
30. Long term availability of base line data collected (How will it be used?)
48. How to prioritize species and habitats to be studies
49. Hydro vs. other uses (Impacts)

Recreation & Aesthetics

Recreation (By issue group)

Use

Type and level of acceptable use

- R1. Identification of current and potential users
- R2. Monitoring of use trends
- R3. Effects of attracting more use
- R4. Management of increasing use
- R5. Limits of acceptable change (LAC)

Other use-related issues

- R6. Law enforcement
- R7. Traffic associated with use
- R8. Multiple-use conflicts
- R9. Local socio-economic impacts

Access

Type and level of access needed for people accessing area by foot, vehicle, boat and livestock

- R10. Identification of existing and potential access sites
- R11. User expectations and desires relating to access
- R12. Fishing turnouts for bank angling
- R13. Upland access for hunting and other uses
- R14. Wildlife viewing sites
- R15. Seasonal closures of access areas
- R16. Protection from loss of public access
- R17. Providing access during changing reservoir levels

Other access-related issues

- R18. Improved property ownership identification
- R19. Impacts of recreation use on adjacent lands

R20. Depletion of beaches below HC dam

Facilities

Type and level of development needed to accommodate use

R21. Identification of existing and potential facilities
R22. User expectations and desires relating to facilities
R23. “Improved” facilities vs. dispersed sites
R24. Boat mooring facilities
R25. Sanitation
R26. Commercial recreation service providers (i.e. conncessionaires)
R27. Historic interpretation

Other facility-related issues

R28. Type and level of marketing used
R29. Displacement of users due to changing fee structures
R30. Cooperative opportunities among concerned entities
R31. Operation and maintenance costs of facilities

Study logistics

R32. Scope of study area
R33. Use of instream flow data
R34. Recommendations to other managing entities

Aesthetics (By issue group)

R35. Appearance of project facilities
R36. Views from recreation facilities, heavily used dispersed sites, travel routes and scenic overlooks
R37. Effects of project operations on aesthetic quality
R38. Effects of land management practices on aesthetic quality
R39. Effects of transportation facilities on aesthetic quality (dust, proposed facilities)
R40. Costs and other constraints related to PM&E measures

Economics (For all resource work groups)

33. Evaluate existing constraints on water management (Brownlee and Oxbow Reservoirs) and downstream **(Aquatic)**
70. Assess impacts on IPC ability to meet power demands with the removal of lower four Snake River impoundments for improvement of anadromous passage **(Aquatic)**

72. Economic and engineering feasibility of project removal **(Aquatic)**
49. Hydro vs. other uses (impacts) **(Terrestrial)**
R9. Local socio-economic impacts **(Recreation & Aesthetics, Use)**
R19. Impacts of recreation use on adjacent lands **(Recreation & Aesthetics, Access)**
R31. Operation and maintenance costs of facilities **(Recreation & Aesthetics, Facilities)**
R40. Costs and other constraints related to PM&E measures **(Recreation & Aesthetics, Aesthetics)**

10/29/96

HC Project, IPC
Issues Presented at Public meting
Boise, Idaho (g-25-96)
Halfway, Oregon (9-26-96)
Lewiston, Idaho (10-2-96)

<u>Aquatic</u>

P1A Water level fluctuations and impacts on fish, insects, crayfish and recreation (floating). (Witnessed stranded crayfish and rampant fluctuation during fish flush)

P2A Want to see on-the-ground habitat enhancement measures

P3A "Normative" flows in river system to include more natural hydrography and adequate instream flows. (PM&E)

P4A Fish passage for anadromous species at all HCC dams

P5A Assess feasibility of anadromous sport fishery above HCC dams

P6A Water quality.

P7A Anadromous fish.

P8A Restoration of anadromous fish - may trade off support of anadromous fish or salmon for restoration on Snake above Hells Canyon. (PM&E)

P9A Establishing minimum reservoir levels at Brownlee and maximumwater fluctuation guidelines during fish spawning periods. Recommendations:
-Water levels are not to fall below 20 feet of full pool (elevation of 2057) at any time throughout the year.
-Water fluctuations are not to exceed two (2) feet in any ten (10) day period from April 15th through June 15th of any year.

P1OA Spawning conditions are preserved.
-Rapidly falling and raising water levels that cause fish to abort spawning.
-Rapidly raising water that covers eggs at depths that reduce light penetration and causes failure for eggs to hatch.
-Rapidly falling water that leaves eggs high and dry.
-High water flows going over the Brownlee spillways washed juvenile fish downstream.

P11A Fishing opportunities for anadromous species ~~above~~ HCC.
-Passage up and down (Aquatic)
-Supplementing stocks (Aquatic)
-More natural hydrography to enhance all resident & anadromous fisheries (Terrestrial)
-Predictable annual hydrography to fish, wildlife and recreation in river and reservoirs. (ramp rates) (Terrestrial)

P12A New technology.

P13A Manage rivers and reservoirs to mimic a natural hydrograph.
-Minimize reservoir water fluctuations.
-Provide flows for salmon.

P14A Oil loss at turbines. (New Issue)

P15A Fisheries below HCC. (New Issue)
-Survey outfitters/users at Pittsburgh landing.

P16A Lack of water in Brownlee Reservoir.

P17A Fecal coliform levels immediately adjacent to dispersed recreation sites. (LMP, New Issue)

P18A Flow levels on river below Hells Canyon adversely affecting fishing. (New Issue)

P19A Fish runs need to be restored before the projects are relicensed. (PM&E)

P20A Do what they (IPC?) promised in '55. (Mark Gress)
-Greatest recreation area in Huntington. (R)
-Paved road from Huntington to Richland. (LMP)
-Keep anadromous fish runs alive. (A)

P21A Warm water fishery is almost gone.
-Bass die-off from lowering reservoir when fish are on beds.

P22A Concentration of pollutants from reservoir drawdown from irrigation ditches.

P23A Algae in river is really bad.

P24A Get warm water fish back to where they were five 'years ago.

P25A Killing of three species, bass, crappie and trout, for salmon spawn.

P26A Nitrogen supersaturation.

P27A Bass and crappie nest de-watering as a result of flow fluctuations, ie. 8,000 to 25,000 cfs/24 hrs.

P28A Catch rate affected by flow fluctuations. (New Issue)

P29A Use Oxbow and Hells Canyon Reservoirs as re-regulatory for flow fluctuation from Brownlee Reservoir. (PM&E)

P30A Beach erosion from flow fluctuation.

P31A Flow impacts on biotic co-aunities.

P32A Salmon run restoration.

P33A Dam removal.

P34A Flow regulation to mimic natural flows. (PM&E)

P35A Don't forget about the bugs, (invertebrates).
-Salmon flies (regulating water flows).

P36A Hells Canyon Dam was supposed to be a re-regulating dam for other two dams.

P37A Effects of NO, saturation on crappie, et. al. (New Issue)

P38A Impacts of dam removal (HC Dam). (New Issue)

P39A Whitewater recreation gain if dams removed (2-3 class V drops!). (New Issue)

<u>Terrestrial</u>

P1T Protect wildlife habitat on islands in the Snake River

P2T Secure key goose brooding areas along the Snake. (PM&E)

P3T Protect Snake River island integrity through protecting instream flows above and in project area

P4T Restoration of wildlife habitat in riparian areas lost due to inundation due to HCC. (PM&E)

PST Operation so as to provide more normal river flows so wildlife habitat and beaches are maintained.

P6T Restoration of wildlife habitat (winter range) lost due to.inundation by the dams. Wildlife need improved winter range to replace what was lost. Its something we can improve through planting and restoration that will pay long term dividends. (PM&E)

P7T Water level fluctuations and impacts on fish, insects, crayfish and recreation (floating). (Witnessed stranded crayfish and rampant fluctuation during fish flush)

P8T Want to see on-the-ground habitat enhancement measures

P9T "Normative" flows in river system to include more natural hydrography and adequate instream flows. (PM&E)

P10T Reservoir levels too low, Brownlee in particular

P11T Fishing opportunities for anadromous species above HCC.
-Passage up and down (Aquatic)
-Supplementing stocks (Aquatic)
-More natural hydrography to enhance all resident & anadromous fisheries (Terrestrial)
-Predictable annual hydrography to fish, wildlife and recreation in river and reservoirs. (ramp rates) (Terrestrial)

P12T Effects on beaches from jet boats.

P13T Loss of big game winter range in Hells Canyon.
-Supplemental feeding.

P14T Big game trapped on reservoir ice.

P15T Manage rivers and reservoirs to mimic a natural hydrograph.
-Minimize reservoir water fluctuations.
-Provide flows for salmon.

P16T Oil loss at turbines. (New Issue)

P17T Economic loss of big game hunting opportunities to the community of Halfway. (New Issue)

P18T Geologic activity-who is monitoring seismic activity? One fault passes through Brownlee Dam. (New Issue, recommend to IPC for consideration as part of the application.)
-What is the safety of Brownlee Dam?

P19T Big slip above Brownlee Reservoir. What if it goes into the reservoir? Big floods. (New Issue, recommend to IPC for consideration as part of the application.)

P20T Dam removal effects on wildlife and other resources.

P21T Dam removal.

P22T Beach erosion from flow fluctuation.

P23T Flow impacts on biotic communities.

P24T Impacts of dam removal (HC Dam). (New Issue)

P25T Beach erosion.

P26T Flow regulation to mimic natural flows. (New Issue)

<u>Recreation/Aesthetics</u>

P1R Reservoir levels too low, Brownlee in particular

P2R Hazards to jet boats from low flows

P3R What are the economic impacts from bass tournaments?

P4R Right of jet boats to access the Snake below Hells Canyon Dam. (Outside scope of project)

P5R Reduced recreational opportunities due to river fluctuations effecting camp access.

P6R Concern about recreational flows below Hells Canyon Dam. Will this be addressed? (Flow fluctuations over 24 hours in particular.)

P7R Aesthetics.

P8R Operation so as to provide more normal river flows so wildlife habitat and beaches are maintained.

P9R Boat ramps at all major access points remain usable, therefore allowing for maximum recreation use.

P10R Hotel needs to be built at Brownlee Reservoir for bass tournaments. (New issue, verbal comment)

P11R Water level fluctuations and impacts on fish, insects, crayfish and recreation (floating). (Witnessed stranded crayfish and rampant fluctuation during fish flush)

P12R IPC camping rates are way too high for retired people.

P13R Do what they (IPC?) promised in '55. (Mark Gress)
-Greatest recreation area in Huntington. (R)
-Paved road from Huntington to Richland. (LMP)
-Keep anadromous fish runs alive. (A)

P14R Algae in river is really bad.

P15R Keep the reservoir levels up. (PM&E)

P16R Camping fees keep going up. Prices are higher than anyone else ($300/mo. if you could stay a full month).

P17R Need more primitive campgrounds--not fond of camping on asphalt. Don't like having the water shut off in CG's on 10/15. Feel parks are too manicured, concrete curbs, dead spots, difficult to park the big rigs because of design of CG's.

P18R Primitive CG's should be developed/provided. Cost should be free, based on the promises IPC made when the dam Was built. Free sewer, power, water, etc.

P19R Facilities near Richland aren't available because of drawdowns. Hurts the economy.

P20R Would like to know the economic benefits of fish before the dams started to fluctuate so much. Relates to killing off the crappies. Above the dams vs. below the dams (natural flow).

P21R Large fluctuation of reservoir effects ability of getting into Brownlee--when it's low, can't get in from the Oregon side.

P22R Increasing recreational use fees (IPC Parks).

P23R Sites of future meetings. (Present to C.T.)

P24R Impacts of reservoir fluctuations on boating and local economies.

P25R Reservoir level extreme drawdowns on Brownlee making it next to impossible to launch boats at flow levels.

P26R Maintain the same level of recreation and power as in the past.

P27R Fisheries below HCC. (New Issue)
-Survey outfitters/users at Pittsburgh landing.

P28R Effect of fluctuating water levels (especially access to boat ramps) on guides (on reservoirs) and other small businesses.

P29R Lack of water in Brownlee Reservoir.

P30R Fecal coliform levels immediately adjacent to dispersed recreation sites. (LMP, New Issue)

P31R Flow levels on river below Hells Canyon adversely affecting fishing. (New Issue)

P32R Economic loss of big game hunting opportunities to the community of Halfway. (New Issue)

P33R Flow fluctuations (severe) affecting boat access and beaches.

P34R Positive notification to downstream users (outfitters and private property owners) of expected flow operations and changes. Keep doing it!

P35R Unsafe below 7,000 cfs.

P36R Ramp problems for boaters because of daily fluctuation volumes.

P37R Boat ramp at Heller's Bar needs renovation to accommodate more use. (PM&E)

P38R Impacts of dam removal (HC Dam). (New Issue)

P39R Impacts of flow changes (daily) on recreation.

P40R Whitewater recreation gain if dams removed (2-3 class V drops!). (New Issue)

P41R Impacts of flow fluctuations on recreational boating including safety, camping and fishing.

P42R Beach erosion.

P43R Dam removal.

P44R Flow regulation to mimic natural flows. (New Issue)

P45R Catch rate affected by flow fluctuations. (New Issue)

P46R Beach erosion from flow fluctuation.

P47R Recorded flow information inaccurate or not timely. (PM&E)

<u>Economic</u>

P1E Recreation impacts on local economies.

P2E Affordable electricity.

P3E Richland boat ramp.

P4E Huntington and other cities businesses as affected by loss of fishermen. Feel there is a 75% loss of business in Richland. Feel Richland will be a ghost town within a year, due to the process used to do flushing.

P5E Spread "flush" flows through all dams.

P6E Quantify **all** relicensing costs.

P7E Economic loss of big game hunting opportunities to the community of Halfway. (New Issue)

P8E Effect of fluctuating water levels (especially access to boat ramps) on guides (on reservoirs) and other small businesses.

P9E Willing to pay much higher power rates to restore the fish runs (anadromous).

P10E Concerned about the effects of deregulation on power price--that our rates are going up before these projects are relicensed.

P11E Feel that IPC will be bought out as soon as the complex is relicensed, rates will go up.

P12E Would like to know the economic benefits of fish before the dams started to fluctuate so much. Relates to killing off the crappies. Above the dams vs. below the dams (natural flow).

P13E Cost/benefit of dam removals vs. fisheries, biologic and recreation gains.

P14E Impact of de-regulation of power generation.
-Will more power be generated here where it is cheap and be exported?
-Will we, as a result, suffer the threatening negative effects? (externalities)

P15E Possible IPC land acquisition downstream of the project to preserve open space. (New Issue, LMP)

P16E Dam removal.

P17E Flow regulation to mimic natural flows.

P18E Impacts of dam removal (HC Dam). (New Issue))

(11/19/96) ISSUES REQUIRING AN ECONOMIC RESPONSE

A. *Work* group brainstorming sessions:

6. Costs and other constraints related to PM&E measures.

33. Evaluate existing constraints on water management (Brownlee and Oxbow Reservoirs) and downstream.

49. Hydro vs. other uses (impacts).

70. Assess impacts on IPC ability to meet power demands with the removal of lower four Snake River impoundments for improvement of anadromous passage.

72. Economic and engineering feasibility of project removal.

B.2. Impacts of recreation use on adjacent lands.

B.4. Local socio-economic impacts.

B.4. Operation and maintenance costs of facilities.

B. Public Meetings:

P1E Recreation impacts on Local economics.

P2E Affordable electricity.

P3E Richland boat ramp.

P4E Huntington and other cities businesses as affected by loss of fishermen. Feel there is a 75% loss of business in Richland. Feel Richland will be a ghost town within a year, due to the process used to do flushing.

P5E Spread "flush" flows through all dams.

P6E Quantify all relicensing costs.

P7E Economic loss of big game bunting opportunities to the community of Halfway.

P8E Effect of fluctuating water levels (especially access to boat ramps) on guides (on reservoirs) and other small businesses.

P9E Willing to pay much higher power rates to restore the fish runs (anadromous).

P1OE Concerned about the effects of deregulation on power price--that our rates are going up before these projects are relicensed.

P11E Feel that IPC will be bought out as soon as the complex is relicensed, rates will go up.

P12E Would like to know the economic benefits of fish before the dams started to fluctuate so much. Relates to killing off the crappies. Above the dams vs. below the dams (natural flow).

P13E Cost/Benefit of dam removals vs. fisheries, biologic and recreation gains.

P14E Impact of de-regulation of power generation.

a. Will more power be generated here where it is cheap and then be exported?
b. Will we, as a result, suffer the threatening negative effects? (Externalities)

P15E Possible IPC land acquisition downstream of the project to preserve open space.

P16E Dam removal.

P17E Flow regulation to mimic natural flows.

P18E Impacts of dam removal (HC Dam).

C. Additional Public Issues:

X5. Believe the dam in Hells Canyon should be retro-fitted with a fish ladder that can let returning fish get past the dam and smolts get down the river.

X16. Removing the Snake River dams be included in options discussed and considered.

X18. Improve the sturgeon's habitat and modify dam operating procedures to improve sturgeon habitat as well.

X20. Remove or discontinue operation of the dams.

X24. Want IPC to stop fluctuating water levels of reservoirs for power peaking.

X25. Manage dams for power output first, resident fish populations second and migrating fish third.

X35. Alternative energy sources.

X37. Solve fish passage problems.

X42. The idea of removing the dams at first seems unthinkable. But since they are doing so much damage and their life-span is limited anyway, perhaps their removal would be the best course of action.

X46. Economics. (Under no circumstances should Brownlee water be used for summer salmon flushing.)

D. Additional Issues from the Recreation/Aesthetics Work Group (11/12/96 Meeting):

1. Determine economic impacts of recreation on the HCRC on local economics. "Loca1" is defined as: all counties that are contiguous to the HCRC.

2. Determine economic impacts on local communities from reservoir water fluctuations.

3. Determine economic impacts on local communities from river flow fluctuations and/or beach erosion.

4. Determine willingness of public to pay for dispersed recreation sites. Note : May need to be a tradeoff analysis, i.e. at what price would public not use dispersed recreation sites.

E. Aquatic *Work* Group, Sub-group (Legal/Economic/Management):

1. Identify land ownership and uses associated with the HCC, including direct tributaries. (6,60), (what are land use effects on WQ?)

2. What legal/regulatory factors effect the ability to alter flow regimes (33,64,39,59).

   a. operational constraints at HCC
   b. opportunities to acquire additional water
   c. opportunities to synchronize dam operation in the Basin

3. What management actions have been taken by agencies to address project impacts and what costs have been incurred? (69)

4. What are the impacts on IPC of removing one or more of the HCC dams, including availability and cost of replacement power? (Benefits?) (72)

5. What are the potential effects on Hcc operations of the listing of Snake River Salmon? (Steelhead) (New)

11/11/96, KW

Additional Issues
Received after the Public Meetings

The following issues were received via mail, telephone, personal contact, etc. after the public involvement meeting that were held in Boise, Halfway and Lewiston:

Xl. Sandbars below Hells Canyon Dam have been lost. The dams are virtual silt traps.

x2. Bring consistency to the regulation of flows.

x3. It is imperative that a recovery plan for these salmon be developed. It would involve passage for both juvenile and adult fish by these dams, and the restoration of genetic stock that as closely as possible resemble the native fish in these drainages.

x4. Want to have a fish ladder put on Hells Canyon Dam before it is relicensed.

x5. Believe the dam in Hells Canyon should be retro-fitted with a fish ladder that can let returning fish get past the dam and smolts get down the river.

X6. Change system of operation to include more "normative" natural hydrograph with appropriate season variation; fall/winter minimal flows increased.

x7. Relicensing contingent upon establishment of anadromous fish passage in Hells Canyon. (Consider all options including flip-up spillway for smolts and ladders/trap and haul for adults.)

X8. Supplement/ out-plant steelhead and chinook above HCC.

x9. Please address fish passage.

X10. Primary emphasis in Hells Canyon and along the Snake River should be restoration of native plants and wildlife. No additional commercial development or road building should occur.

X11. Stop all cattle and sheep grazing on public lands.

X12. Restore salmon and steelhead stocks.

X13. No more dams or other water diversion projects.

X14. Want to see the salmon return.

x15. Would like the Snake River to run clear again.

X16. Removing the Snake River dams be included in options discussed and considered.

x17. Restoring salmon runs should be one of the conditions for a new license.

X18. Improve the sturgeon's habitat and modify dam operating procedures to improve sturgeon habitat as well.

x19. Fluctuating water level in pool area. There are numerous archaeological sites in these pools.

x20. Remove or discontinue operation of the dams.

x21. Shape flows to more natural flows below Hells Canyon Dam.

x22. Solve fish passage problems.

X23. Want IPC to do a better job providing salmon flows in a timely & cooperative manner.

X24. Want IPC to stop fluctuating water levels of reservoirs for power peaking.

X25. Manage dams for power output first, resident fish populations second and migrating fish third.

X26. Try to settle water level problems.

X27. Continue the parks.

X28. Manage dams fore people, then fish; not the reverse.

x29. Stop fluctuating Brownlee Reservoir so much, so fast.

x30. Streamline this relicensing process to reduce costs.

x31. Fish passage.

X32. Beach erosion.

x33. Recreational flows.

x34. Winter range.

x35. Alternative energy sources.

X36. Shape flows to more natural flows below Hells Canyon Dam.

x37. Solve fish passage problems.

X38. Any Hells Canyon hydropower management plan that doesn't have restoration of the Snake River wild salmon and steelhead runs as its centerpiece is fundamentally flawed.

X39. Ways to permit anadromous fish to be successful.

X40. No new recreational facilities. Adequate maintenance of present facilities.

X41. Greater clarification to river users on respect between uses, (canoes = jet skies).

X42. The idea of removing the dams at first seems unthinkable. But since they are doing so much damage and their life-span is limited anyway, perhaps their removal would be the best course of action.

X43. Fish passage facilities should be required before the Hells Canyon, Oxbow and Brownlee Dams are relicensed.

X44. Flood Control

X45. Recreation & aesthetics.

X46. Economics. (Under no circumstances should Brownlee water be used for summer salmon flushing.)

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Idaho Power Company Relicensing - Terrestrial Resource Issues

Joint Proposal for Study of Wildlife Habitat
Inundated by the Hells Canyon Complex By:

United States Fish and Wildlife Service
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife

December 6, 1996

INTRODUCTION

The Federal Power Act charges the Federal Energy Regulatory Commission with developing measures to protect, mitigate, and enhance fish and wildlife. These measures include enhancements needed to reduce the negative impacts attributable to the project since its construction. One of the key issues associated with the relicensing of the Hells Canyon Complex is the need to enhance wildlife habitat affected by hydropower development.

The state and federal agencies charged with managing wildlife in the area of the Hells Canyon Complex request that Idaho Power Company fund a study to quantify and characterize the wildlife habitat inundated by the Hells Canyon Complex. This study will provide an essential context in which to address actions necessary to meet today's wildlife needs. The purpose of the study is not to produce a "museum view" of the area prior to dam construction. Instead, the study is based on the premise that an understanding of the natural habitat that once supported the area's wildlife species is an important building block for any future-looking program to protect and enhance those species. In other words, knowing what was lost in the past is a key to determining what might be needed in the future.

The agencies believe that this study is of utmost importance to the success of the collaborative effort on wildlife habitat issues. Without the common information base provided by the study, it will be difficult for the parties to find a common approach to wildlife habitat protection.

It is important to note that this proposal only deals with one of the many wildlife studies discussed by the Terrestrial Resources Work Group. A number of study plans are nearly complete; on others, the agencies will seek additional information from Work Group members. In particular, the agencies wish to verify that existing study plans will provide adequate information on vegetative cover, habitat type and quality, land ownership, and other elements needed to design habitat protection, mitigation, and enhancement measures.

BACKGROUND

A. The Wildlife Habitat Problem

It is well documented that the wildlife habitat types found in the Hells Canyon area have been greatly affected by human development in southern Idaho and northeastern Oregon. Extensive areas of native upland shrublands and perennial bunch grasslands have been destroyed over the last century. For example. The National Biological Service identified the sagebrush-steppe ecosystem of the Snake River Plain to be one of the most threatened ecosystems in the United States. In addition, most riparian habitat in Hells Canyon has been lost this century due to various human developments, including hydropower development. Much of the most critical large ungulate winter range along the main Snake River in western Idaho and northeastern Oregon has been lost due to construction and operation of the Hells Canyon Complex.

B. Resource Goals

The agencies' desired future condition for upland and riparian habitats (e.g. terrestrial resource communities) in southern Idaho-independent of relicensing-is to protect and restore native upland and riparian habitat. These habitats have become so degraded at lower elevations in southern Idaho and northeast Oregon over the last century (losses of 70-90%) that years of focused, extensive and intensive work will only just begin to restore them. By protecting native upland and riparian habitats and associated terrestrial resource communities, we may help avoid imperiling individual species by protecting the ecosystems upon which these species depend. State agencies, including Idaho Department of Fish and Game (IDFG) and Oregon Department of Fish and Wildlife (ODFW), have identified in long-term planning documents the need to protect, mitigate, and enhance terrestrial resources near the Snake River as well. For example. the IDFG's mule deer plan identifies the need to protect and enhance winter range habitat in southwest Idaho, which includes low elevation perennial bunch grass communities, shrublands, and riparian habitats. Other management plans exist for other species vvhich further support the need for protecting and restoring native upland and riparian habitats along the Snake River.

STUDY DESCRIPTION

A. Purpose: dentify Opportunities for Protection, Mitigation, and Enhancement of Wildlife Habitat.

We do not expect Idaho Power to shoulder all responsibility for achieving these resource goals. However, through the FERC relicensing effort, we see an opportunity for Idaho Power to contribute to achieving these desired future conditions. This includes protecting, restoring and enhancing native upland and riparian habitats, and improving conditions for terrestrial wildlife species that depend on those habitats.

We believe restoring native upland and riparian habitats through the relicensing process is consistent with FERC directives to meet identified resource needs. This includes FERC's directive to look at pre-existing conditions in the project area to identify adequate and equitable fish and wildlife protection, mitigation. and enhancement measures, and to evaluate cumulative impacts to terrestrial resources through the NEPA process.

Without these studies, FERC will not be able to give "equal consideration" to terrestrial resources, as required by the Federal Power Act. Nor will parties involved be able to accurately assess adequate and equitable terrestrial resource protection. mitigation, and enhancement measures, including: (1) whether the chosen measures will be effective, and (2) whether the quantity of gains that would be obtained is commensurate with project impacts.

General concepts regarding studies that will contribute to our understanding of the habitat resources that were available in the past and that might be targeted for protection. mitigation, and enhancement in the future were outlined by the Terrestrial Resources Working Group at its September 1996 meeting. These concepts have been identified as study questions listed under each of five problem statements in the notes for that meeting. We propose the following methods be considered as a more detailed approach for addressing these study questions. Please keep in mind that this is simply one recommended approach, and further integration of ideas from Idaho Power Company technical staff would surely enhance this study proposal.

B ,Methods

The proposed study consists of the following elements:

- Using pre-construction aerial photographs, estimate the acres of each cover type inundated by the Hells Canyon Complex reservoirs, including riparian habitats, upland habitats, islands, etc.;
- In coordination with the collaborative team, select target wildlife species;
- Develop estimates of the habitat quality of cover types inundated by measuring important target species habitat variables in surrounding representative upland and riparian habitats, and casting the results to the cover types inundated;

- Multiply the habitat quantity inundated by the habitat quality. to provide an estimate of the continuing impact hydroelectric development is having on upland and riparian habitats and associated wildlife species in the Hells Canyon ecosystem; and

- Conduct a similar evaluation on the impact of the construction of transmission corridors and roads associated with the project.

Based on this information, the Idaho Power Company should overlay land management and wildlife habitat information, including the pre-construction cover map. in order to: (1) identify landscape features and important habitats now absent from the Hells Canyon ecosystem, (2) assist in the identification of high quality native upland and riparian sites in need of protection, (3) identify degraded habitats that need restored. and (4) identify key corridors needed to maintain habitat connectivity. The agencies expect that items 2 through 4 will already be completed under existing study proposals. Company and agency staff should work together to ensure that these items are adequately addressed. Based on this understanding, only the five bulleted items represent an additional undertaking,

C. Cost Estimates

Agency staff estimate that the study would cost $100.000 to 5200.000 depending on the level of detail of the analyses. Further discussion of the study needs could define and potentially reduce these costs.

The Terrestrial Work Group developed the following list of Problem Statements and associated Study Questions that deal with the issue of impacts of the construction of the Hells Canyon Complex on terrestrial resources. The group was not able to reach consensus on how to move forward with these issues.

Staff from the U.S. Fish and Wildlife Service, Idaho Department of Fish and Game and the Oregon Department of Fish and Wildlife have developed the proposal dated December 6, 1996 as one approach to address this issue. The proposal has been submitted to Idaho Power Company for their consideration. It is hoped that this issue can be resolved, and decisions made on how or whether to proceed with these studies.

PROBLEM STATEMENTS

Construction

Problem Statement #l: Terrestrial wildlife and plant species have been affectedd through construction and inundation of habitat in the HCC.

Study Questions:

a. What were the quantity and quality of habitat types impacted as a result of project construction and inundation:

- -game
- -non-game (include T&ES)
- -botanical (include T&ES)

b. How did project construction and inudation of habitat affect:

- -big game winter range
- -riparian ecosystems
- -aquatic furbearers
- -waterfowl
- -small mammals
- -herptiles
- -upland game (native and exotic)
- -T&ES (plant and animals
- -Deep Qeek disjunct species/communities
- -neotropical migrants
- -insects
- -lower plants (fungi)

c. what are lost opportunities for development and establishment of certain terrestrial wildlife species?

d. How are results linked to PM&E planning and implementation?

Problem Statement #2: Erosion associated with construction can affect the quality of terrestrial habitat.

Study Questions:

a. Where are erodible areas within HCC study area?
b. Which erodible areas resulted from construction?
c. How have these sites affected cultural and wildlife resources?
d. How are results linked to PM&e planning and implementation?

Problem Statement #3: Construction of HCC has affected terrestrial resources that reach beyond original inundation of habitat.

Study Questions:

a. How were wildlife movements affected by consequence of construction?
b. How was wildlife food chain affected by the loss of anadromous species plus other consequences of construction?
c. How have wildlife and botanical resources been affected by changes in public use that art consequences of construction?
d. How has biological diversity of native plant and animal communities been affected by consequences of construction? (biological diversity = genetic, species and community level)
e. How are results linked to PM&E planning and implementation?

Problem Statement #4: Construction of HCC and transmission lines affected cultural resources.

Study Questions:

a. What are the cultural resources?
b. What are the effects of projectf construction on cultural resources?
c. What are the effects of project inundation on cultural resources below the high water line?
d. How have changes in public use resulting from consequences of constmction affected cultural resources?
e. How are results linked to PM&E planning and implementation?

Problem Statement #5: Construction of power lines and related facilities affected terrestrial plant and animal species.

Study Questions:

a. How has construction of power lines affected wildlife habitat use and distribution?

b. How has construction of power lines affected big girds through electrocution or collision?

c. How has power line construction led to human impacts on vegetation and wildlife resources?

d. How has construction of transmission lines affected botanical habitats?

e. How are the results linked to PM&E planning and implementation?