US Army Corps of Engineers ®
Portland District

Salmon Recovery through John Day Reservoir

John Day Drawdown Phase I Study

September 2000

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ABBREVIATION AND ACRONYMS

AGC	Automatic Generation Control
aMW	Average megawatt
AWS	auxiliary water supply
BiOp	Biological Opinion
BNSF	Burlington Northern & Santa Fe Railway
BPA	Bonneville Power Administration
CENWD	U.S. Army Corps of Engineers, Northwestern Division
CENWP	U.S. Army Corps of Engineers, Portland District
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfs	cubic feet per second
CSCS	Confirmed and Suspected Contaminated Sites
DM	Design Memorandum
DPS	Distinct Population Segment
DTM	Design Technical Memorandum [also Digital Terrain Model]
ECSI	Environment Cleanup Site Inventory
EM	Engineering Manual
EPCRA	Emergency Preparedness and Community Right to Know Act
ESA	Endangered Species Act
ESU	Evolutionary Significant Units
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
fps	feet per second
FTC	fish transportation conduit
ft/s	feet per second
GDM	General Design Memorandum
gpm	gallons per minute
hp	horsepower
HMU	Habitat Management Unit
HTRW	Hazardous, Toxic, and Radioactive Waste
JBS	juvenile bypass system

kw	kilowatt
m	meter
mm	millimeter
MCACES	Microcomputer Aided Cost Engineering System
MOP*	minimum operating pool
MW	megawatt
NED	National Economic Development
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NSFL	North Shore Fish Ladder
NTU	Neophelometric Turbidity Units
NWR	National Wildlife Refuge
NWI	National Wetlands Inventory
O&M	operations and maintenance
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OMB	Office of Management and Budget
OWRD	Oregon Water Rights Department
PAHs	polynuclear aromatic hydrocarbons
PAT	Planning Aid team
PCBs	polychlorinated byphenyls
pH	measure of acidity
PMF	Probable Maximum Flood
PNW	Pacific Northwest
RCRA	Resource Conservation and Recovery Act
RM	River Mile
RPA	Reasonable and Prudent
SHPO	State Historic Preservation Office
SOR	System Operation Review
SPF	Standard Project Flood
STS	Submersible Traveling Screens
SSFL	South Shore Fish Ladder

TCM	Travel Cost Method
TOC	total organic carbon
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
WDOE	Washington Department of Energy
WMA	Wildlife Management Area
WPT	Wildlife Planning Team
WTP	Willingness to Pay
WSCC	Western Systems Coordinating Council
WSDOT	Washington State Department of Transportation

Section 1. Study Authority

In the 1998 Senate Energy and Water Development Appropriation Bill, the Subcommittee on Energy and Water Development approved the U.S. Army Corps of Engineers (USACE) February 25, 1997, reprogramming request, related to a study of the biological, social and economic impacts of a drawdown, consistent with the terms and conditions specified in its' June 6, 1997 letter. The John Day Drawdown Phase I Scope of Study was subsequently prepared, approved and authorized in the September 25, 1998, Conference Report.

The Subcommittee directed that USACE limit the study to drawdown of the John Day Reservoir to only spillway crest and natural river levels and that the study include "the social and economic impacts of each proposed drawdown, including effects on irrigation operations, hydraulics and hydrology, fisheries, flood control, hydropower production, navigation, transportation, structural changes to federal projects, and other impacts related to cultural resources, recreational activities, and municipal water supply." (U.S. Senate Subcommittee on Energy and Water Development, 1998.)

Section 2. Study Purpose and Scope

The purpose of this study is to evaluate the social, economic, and biological impacts of drawing down the John Day Reservoir. The current conditions and the impacts of the proposed alternatives will be discussed. The primary drawdown alternatives will reduce the current John Day Reservoir forebay elevations from 265 feet National Geodetic Vertical Datum[1] (NGVD) to (1) a pool elevation that will vary from about 217 to 230 for spillway drawdown, and (2) about elevation 165 for natural river drawdown.

The regional goals for a drawdown of John Day Reservoir, as identified in the National Marine Fisheries Service's (NMFS) draft Recovery Plan for Snake River salmon, the Tribal Restoration Plan, and the Northwest Power Planning Council's Fish and Wildlife Program are to:

- Improve migration and rearing conditions for juvenile spring, summer, and fall chinook salmon, sockeye salmon, and winter and summer steelhead
- Reduce water temperature and total dissolved gas to comply with Clean Water Act criteria and standards
- Improve spawning conditions for fall chinook salmon

The USACE Scope of Study (December 1997) detailed a two-phased approach. The objectives of this Phase 1 Study are as follows:

1. Evaluate the potential of a John Day Reservoir drawdown to protect, mitigate, and enhance fish (particularly anadromous fish) and wildlife populations and habitat of the

[1] All elevations referred to in this Phase I Study are referenced in feet to the National Geodetic Vertical Datum.

Columbia River and its tributaries, and evaluate how drawdown might contribute to an increase in the number of harvestable anadromous fish.

2. Evaluate the social, economic, and biological benefits and costs of a drawdown of the John Day Reservoir water surface elevation 265 to spillway crest elevation 215 or natural river elevation 165. As part of the Phase I Study, a preliminary evaluation was done based on direct economic costs and available information on the survival of anadromous fish.
3. Make information available that may be useful to the USACE *Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement* (December 1999).
4. Develop information that may be used to determine whether it is appropriate to continue further studies to draw down the John Day Reservoir.

This Phase I report was developed primarily from existing documents and from information developed as part of the *Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement*.

In accordance with the scope, the Phase I Study includes the social and economic impacts of each drawdown alternative specifically pertaining to irrigation operations, hydraulics and hydrology, fisheries, flood control, hydropower production, navigation, transportation, structural changes to federal projects, and other impacts related to cultural resources, recreational activities, and municipal water supply.

If found feasible, the John Day Drawdown would have regional implications. The Senate Subcommittee on Energy and Water Development, in its June 6, 1997, letter to the Assistant Secretary of the Army for Civil Works, stated that "The Corps should actively involve the public in the process by which it designs and implements these studies, with particular attention to communities adjacent to the John Day Project and reservoir that would be most directly affected, and to other communities affected, including Washington, Oregon, and southeast Alaska salmon fishing communities." During USACE's coordination with regional interests, a request was made to expand public involvement coordination to include communities in Montana and Idaho. The public involvement effort was therefore expanded to include them also.

As part of this Phase I Study, USACE has coordinated its efforts with regional policy and technical workgroups; has considered and incorporated, as appropriate all comments received.

Section 3. Existing Studies and Reports

3.1 Background of the Project

In 1991, NMFS proposed Snake River wild sockeye, spring/summer chinook, and fall chinook salmon for endangered or threatened status under provisions of the Endangered Species Act (ESA). Natural resource agencies believe that the drawdown of the 76-mile John Day Reservoir may provide substantial improvements in migration and rearing

conditions for juveniles by increasing river velocity, reducing water temperature and dissolved gas, and restoring riverine habitat. It is also speculated that drawdown may improve spawning conditions for adult fall chinook by restoring spawning habitat and the natural flow regimes needed for successful incubation and emergence.

As a result, the NMFS Reasonable and Prudent Alternative Action #5 of its' Biological Opinion on Operation of the Federal Columbia River Power System (FCRPS), and subsequent reports recommended that USACE investigate the feasibility of lowering John Day Reservoir.

In compliance with appropriation conditions, only two alternatives were to be evaluated: operation at spillway crest resulting in a reservoir elevation that would vary from about 217 to 230, or reduction to natural river level elevation 165. Both alternatives were proposed by NMFS. These two alternatives were then expanded to consider each alternative with 500,000 acre-feet of flood storage and without such storage.

- Alternative 1: Drawdown to spillway crest without flood control
- Alternative 2: Drawdown to spillway crest with flood control
- Alternative 3: Drawdown to natural river without flood control
- Alternative 4: Drawdown to natural river with flood control

3.2 Description of the Study Area

The Columbia River originates in Canada and flows for 300 miles through eastern Washington to Oregon and continues west to the Pacific Ocean, as shown in Figure 1. The adjoining region is mostly open country, with widely scattered population centers. The climate of the region is semiarid. Agriculture, open space, and large farms are prevalent. Lands adjacent to the reservoir are used to grow grains and other crops. The reach of the Columbia River under consideration in this report extends from John Day Lock and Dam at river mile (RM) 215.6, to McNary Lock and Dam RM 291. The body of water impounded by John Day Dam, Lake Umatilla, is referred to as the John Day Reservoir throughout this report. It is the second longest reservoir on the Columbia River, extending 76 miles upstream to McNary Dam.

John Day Dam and Reservoir are part of the Columbia-Snake Inland Waterway. This shallow-draft navigation channel extends 465 miles from the Pacific Ocean at the mouth of the Columbia River to Lewiston, Idaho. The entire channel consists of three segments. The first is the 40-foot-deep water channel for ocean-going vessels that extends for 106 miles from the ocean to Vancouver, Washington. The second is a shallow-draft barge channel that extends from Vancouver to The Dalles, Oregon. Although this section is authorized for dredging to a depth of 27 feet, it is currently maintained at 17 feet. The third section of the channel is authorized and maintained at a depth of 14 feet and extends from The Dalles to Lewiston. In addition to the main navigation channel, channels are dredged to numerous ports and harbors along the river.

The middle Columbia River area is served by a well-developed regional transportation system consisting of highways, railroads, and navigation channels. Railroads and highways parallel the northern and southern shores of Lake Umatilla. Interstate 84 (I-84), a divided

multilane highway, runs parallel on the south shore with the Columbia River from Portland, Oregon, to points east. It is a major freight corridor. Washington State Route 14 (SR-14) also parallels the Columbia River from Vancouver to McNary Dam on the north shore. Umatilla Bridge at RM 290.5, downstream from McNary Dam, is the only highway bridge linking Oregon and Washington across the Columbia River in the John Day Reservoir.

Two major railroad lines run next to John Day Reservoir: Burlington Northern and Santa Fe Railway (BNSF) and Union Pacific Railroad (UPRR). BNSF lines run east and west along the Columbia River on the Washington shore, from Longview past McNary Dam. On the Oregon shore, the UPRR also parallels the Columbia River, from Portland to Hermiston and points east.

3.3 Authorization for the John Day Project

The John Day Lock and Dam Project was originally authorized in the May 17, 1950, Flood Control Act, Public Law 516. The general plan, presented in House Document No. 531 (81st Congress, 2nd Session), provided for a dam, power plant, navigation lock, and slack-water lake extending to McNary Lock and Dam. Flood control storage of 2 million acre-feet was provided between elevations 255 and 292 at the dam. Due to the adverse effects of fluctuating water levels on waterside properties and installations, the Committee on Public Works of the U.S. Senate requested a review of authorized flood control features of the project on April 22, 1953. In response, a review report was submitted to the Congress on August 9, 1956 (Senate Document No. 10, 84th Congress, 2nd Session), which recommended revision of flood storage capacity to about 500,000 acre-feet. Reduced surcharge and drawdown from normal lake level at approximate elevation 262 would achieve this revision.

The Public Works Committees of the Senate and House adopted this recommendation as a change from the original 1950 authorization in review reports dated April 22, 1956, and December 12, 1956, respectively. USACE's General Design Memorandum (GDM) June 1958 indicated that the most beneficial plan would be to fluctuate the reservoir elevation between elevations 265 and 262 feet for power generation, and provide for 500,000 acre-feet of flood control storage between elevations 257 and 268.

The John Day Project authorization was later modified by Public Law 89-298 (March 24, 1965) to provide additional authority for the acquisition of land to be used for waterfowl habitat management. This authorization was substantially in accordance with the recommendations of the USACE'S Chief of Engineers report contained in Senate Document No. 28 (89th Congress, 1st Session) in 1965. The Chief's recommendations cited both mitigation for the construction of the project and resource enhancement as justification for acquiring additional lands and for developing a national wildlife refuge within the project area.

The authorized project purposes for the John Day Project are currently flood control, hydropower and navigation. The John Day Project provides numerous other benefits to the study area that are not included in the congressional authorization.

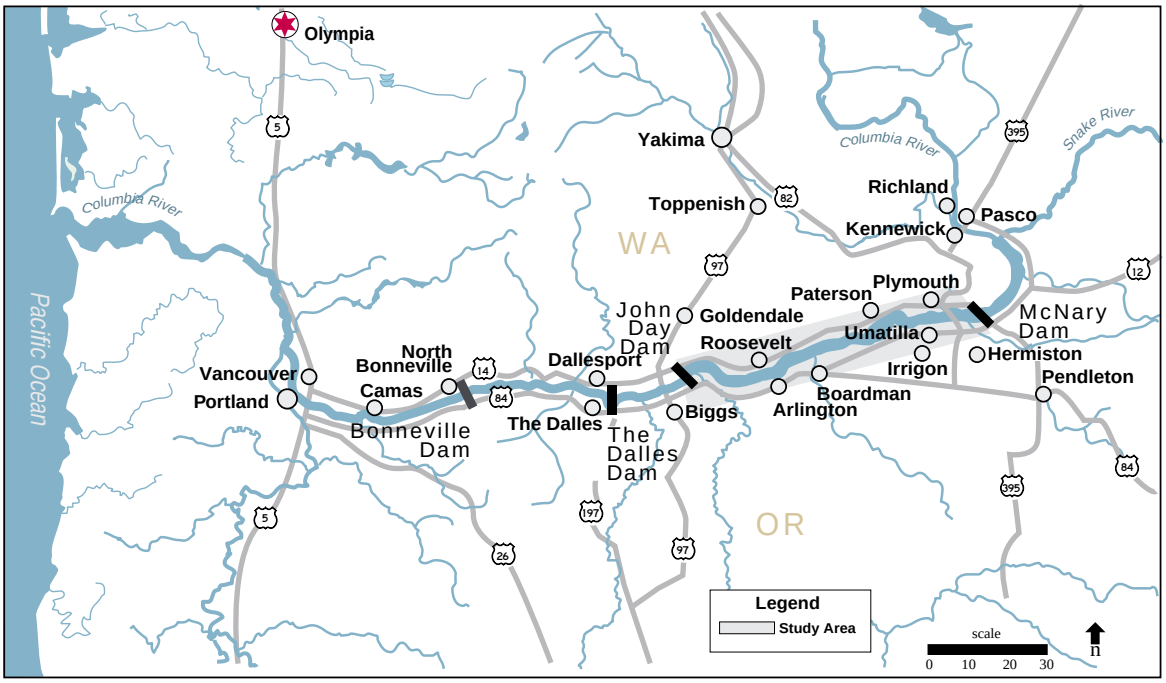

Figure 1. John Day Drawdown Phase 1 Study Area

3.4 Existing Project Information

John Day Lock and Dam is one unit in the comprehensive development for multiple-purpose uses of the water resources of the Columbia River and its tributaries. The general layout of the project is shown in Plates 1 and 2.[2] The dam provides approximately 76 miles of slack-water navigation from the head of The Dalles reservoir to McNary Dam, completing the slack-water navigation improvements from the Pacific Ocean to the Pasco-Kennewick area of Washington and to the Ice Harbor Lock and Dam in the lower Snake River in Idaho.

The project provides a maximum generating capacity of 2,484,000 kilowatts (kw). The John Day Reservoir is the farthest downstream reservoir on the Columbia River with authorized flood control storage. The approximately 500,000 acre-feet of flood control storage provides an opportunity for final regulation of peak flood flows for the Portland-Vancouver area, identified as the primary damage control point of the Columbia River Basin.

3.5 General Approach and Related Studies

To the maximum extent possible, existing and readily available data have been used, including similar Juvenile Salmon Migration Feasibility studies undertaken for the Lower Snake River projects. The study team also compiled information from technical reports for other fish passage improvement measures, including flow deflectors, extended length screens, surface collection, and smolt monitoring. Much of the information developed in these evaluations is directly or indirectly relevant to drawdown below minimum operating levels (257). Products and analyses from the Columbia River System Operation Review, conducted by the Bonneville Power Administration (BPA), USACE, and Bureau of Reclamation, were also used.

A list of the reports and studies used in the compilation of this report is located in the References Section at the end of this report. Consequently, reference citations are not included in this report. Specific reference citations can be found in the technical appendices.

3.6 Phase I Report Format

The Phase I Report consists of two main components: Study Report and five Technical Appendices. The Summary is intended to provide a brief overview of the study purpose and alternatives, existing resources, potential results of project implementation, and cost estimates. The Report expands on the Summary by providing a greater level of detail for each component. The information presented in the Summary and Report is gathered from several technical appendices.

The technical appendices are grouped into five categories: engineering, biological/environmental, economics, tribal/cultural resources, and public involvement/agency coordination. These appendices contain one or more technical memoranda that focus on a specific facet within the broader grouping. These Technical

[2] Plates referred to in this report are grouped at the end of this document.

Appendices are separate and independent documents that provide detailed analysis of the components summarized in the Report. The appendices are categorized as follows:

Engineering Technical Appendix

- Structural Analysis Section
- Navigation Analysis Section
- Flood Control Evaluation Section
- Tributary Sedimentation Evaluation Section
- Water Quality Section
- Sediment Quality Section
- Hazardous, Toxic and Radioactive Waste Section
- Irrigation Impacts and Modifications Section
- Utilities Section
- Public Recreation Section
- Hydropower Operation and Regulations Section
- Slope Stability, Shoreline Erosion and Shoreline Infrastructure Section
- Engineering Cost Estimate Section

Biological/ Environmental Technical Appendix

- Aquatic Resources Section
- Wildlife Resources Section

Economic Analysis Technical Appendix

- Flood Control Section
- Hydropower Operation and Regulations Section
- Recreation Section
- Navigation Section
- Water Supply Section
- Commercial Fishing Section
- Regional Section
- Social Section

Cultural/Tribal Resources Appendix

Public Involvement/Agency Coordination Appendix

Section 4. Existing Project Resources

The project area resources and characteristics evaluated in this Phase I Study include the structural features, hydrology, hydraulics, geology of the reservoir, shoreline conditions, sedimentation, sediment quality, water quality, transportation, navigation, hydropower operation, flood control, irrigation, water supply, utilities, and hazardous, toxic and radioactive waste, recreation, aquatic resources, wildlife resources, cultural/tribal resources.

The existing environmental and economic resources that may be affected by drawdown of the John Day Reservoir are described in the following subsections. The existing condition will be the baseline condition for evaluating the impacts and benefits of each of the drawdown alternatives, both with and without the 500,000 acre-feet of allocated flood control storage.

4.1 Project Location

The Columbia River flows for 300 miles between the states of Washington and Oregon, and drains most of the Pacific Northwest. The reach of the Columbia River under consideration in this report extends from John Day Lock and Dam at RM 215.6 to McNary Lock and Dam (RM 291). The John Day Reservoir, is the second longest reservoir on the Columbia River.

The project study focal point is the 76-mile John Day Reservoir (figure 1) which is located between John Day and McNary Dams. However, the impacts of any drawdown alternative will have regional implications. Consequently, this study will evaluate direct impacts to the reservoir and surrounding communities as well as indirect effects to other regional communities, including those in the states of Washington, Oregon, Montana, Idaho, and Alaska.

4.2 Project Features

4.2.1 John Day

The John Day Project consists of a south embankment dam, powerhouse, spillway, navigation lock, and north embankment dam, with a total project length of approximately 5,900 feet. The normal gross hydraulic head of the dam from headwater to tailwater is 105 feet. The powerhouse consists of 16 generating units with a maximum capacity of 2,484,000 kw, and it includes space for an additional four units.

The spillway consists of twenty 50-foot-wide spillway bays, which are controlled by radial gates for passing flow in excess of powerhouse capacity. The navigation lock has a 15-foot minimum depth over the lower sill, and includes dimensions of 86 feet inside clear width and about 670 feet inside clear length. Hence, the navigation lock can pass a modern barge tow configuration with dimensions of about 650 feet long and 85 feet wide. John Day Reservoir has approximately 500,00 acre-feet of allocated flood control storage space. Two fish ladders (north shore and south shore fish ladders) allow upstream migrating adults to pass the project. Downstream migrating juvenile fish are currently redirected from the turbines with submersible traveling screens to a juvenile bypass system, which directs them either to the tailrace or through an existing juvenile fish monitoring facility.

4.2.2 McNary

McNary Dam fish passage facilities were in operation prior to the completion of the John Day Dam and the filling of the John Day Reservoir. The original upstream passage facilities included the Washington north shore fish ladder, a pressure fish lock, and the Oregon south shore fish ladder. The Oregon shore ladder collects Oregon shore fish as well as fish collected at entryways along the downstream face of the powerhouse. There were no downstream passage facilities prior to the construction of John Day Dam.

Fish ladders operated over a pre-John Day tailwater range from minimum tailwater elevation 248 at a river discharge of 30,000 cubic feet per second (cfs), to a tailwater elevation of 278.2 at a river discharge of 700,000 cfs. With the construction of the John Day Project, the McNary facilities were modified to accommodate an increase in tailwater elevations. Construction of the John Day Project raised the McNary minimum tailwater to elevation 262 and the maximum tailwater to elevation 280.5. These modifications are described in *USACE John Day Design Memorandum No. 30*.

4.3 Hydrologic and Hydraulic Characteristics

The existing condition and the conditions that would prevail in the future in the absence of any new federal action at John Day Dam (referred to as the "baseline condition") were used as a basis by which to evaluate the proposed alternatives. During a flood event, the spillway gates for John Day Dam will be controlled to reduce downstream flood flows based on using 500,000 acre-feet of allocated project storage space.

The existing condition model of the John Day Reservoir was developed using the USACE model HEC-RAS (HEC, 1998). Input data to the model were provided by USACE, as detailed in the Flood Control Evaluation Section of the Engineering Technical Appendix. The model was run for 22 flows to simulate conditions under low, normal, high, and flood flows.

Figure 2 graphically depicts the existing water surface elevations behind the John Day Dam and throughout the John Day Reservoir using flows denoted on the legend. The graph was created by plotting water surface elevations from the HEC-RAS output model.

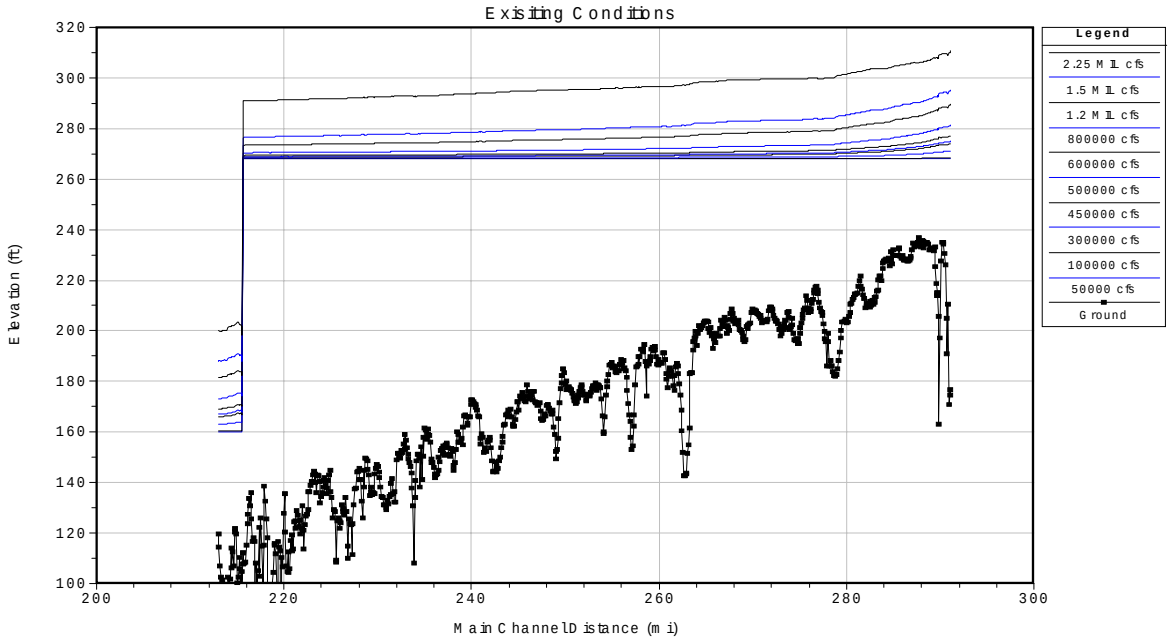

Figure 2. Existing Conditions - Water Surface Profiles

Figure 3 details the average channel velocities throughout the John Day Reservoir for existing conditions. By using this data and comparing it with data from alternative designs, conclusions can be drawn on how time-of-travel estimates through John Day Reservoir will change upon drawdown. This study assumes that there is a direct correlation between reduced time-of-travel estimates and improved survival of juvenile salmon.

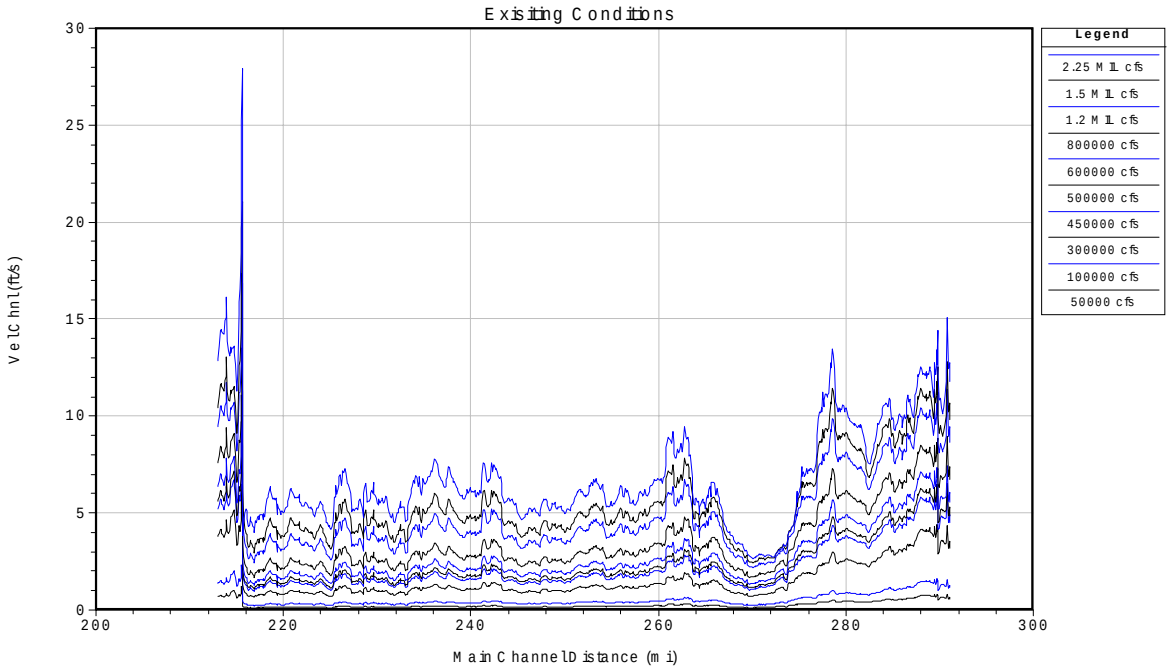

Figure 3. Existing Condition Channel Velocity Profiles

4.4 Geology of the Reservoir Area

The John Day Project spans the upper reach of the Lower Columbia and, to a great extent, marks the geomorphic and geo-historical boundary between the middle and lower sections of the river.

The geology of the John Day Reservoir consist of basalt flows with an apparent dip of 1/2 to 1 degree eastward from a northwest/southeast anticlinal axis parallel and near the lower John Day River. In addition, the basalt flows have a slight apparent dip to the north and meet the Columbia Hills anticline abruptly just north of the Columbia River. Most of the reservoir area is in the Umatilla Basin portion of the Columbia Plateau. Bedrock units appear flat-lying, from a practical standpoint, in a given local area. Contact zones between basalt flows often contain thin soil horizons and flow breccia material. The Umatilla Basin flow layering also contains two thick beds of claystone (derived from ash deposits), commonly referred to as the upper and lower claystones. The natural dip of bedrock units and landslides off the canyon edge have brought this claystone and slide debris down to construction elevations on both sides of the Columbia River. Construction of I-84 and railroad relocations had to deal with old slide planes within the slide debris, and some slide areas were reactivated. Other types of soil materials involved in the construction work were silt, sand, gravel, and talus. Most of the fills were constructed of talus, shot rock, and gravel.

4.5 Shoreline Conditions

The shoreline within the John Day Reservoir (Plates 3 and 4) can generally be divided into four categories:

- Benches cut in bedrock with the water against bedrock
- Embankments with the water against riprap
- Natural soil with sufficient distance for beach formation
- Placed material with gravel protection or self-armoring characteristics

Table 1 is a generalized description of the reservoir shoreline and variations within these reaches are present.

Table 1.
Shoreline Description

River Reach	Shore Material
Oregon	
John Day Dam to Arlington	Embankment fill and riprap protection
Arlington to Willow Creek	Riprap-protected fills and natural or placed material
Willow Creek to McNary Dam	Gently sloping natural materials
Washington	
John Day Dam to Roosevelt	Alternating fill protected by riprap and bedrock
Roosevelt to Crow Butte	Riprap-protected fill and natural or placed material
Crow Butte to McNary Dam	Alternating protected fills and gently sloping natural materials

4.6 Sedimentation

4.6.1 Reservoir Sedimentation

Sediment transported into the reservoir since the construction of John Day Dam was quantified by using computer models to compare pre-project and post-project surfaces. The difference between the two surfaces roughly approximates the amount of sediment in-fill or sedimentation. Results of the analysis are shown on Plates 5-10. The majority of erosion appears to have come from around the islands and reservoir slopes in the upper third of the reservoir, while sedimentation was concentrated in the natural river channel with minor amounts of sediment deposition on the side slopes. There appears to be an overall loss of material or net erosion, but these results are not completely accurate due to accuracy limitations of the data used (see the Slope Stability, Shoreline Erosion, and Sedimentation Section of the Engineering Appendix). Erosion of the previously dry areas was probably the result of wind-generated waves during and after reservoir operation. The upper third of the reservoir contains alluvial sands and silts and sand dune islands that are easily eroded.

4.6.2 Tributary Sedimentation

Sediment transport characteristics of the tributaries to the John Day Reservoir were evaluated to obtain a better understanding of how the tributaries would be impacted by the proposed drawdown alternatives and to determine the implications that these effects might have on the John Day authorized project purposes such as navigation in the main John Day Reservoir. The sediment transport characteristics of the four major tributaries - John Day River, Umatilla River, Willow Creek, and Rock Creek (were analyzed in order to understand the impacts of sedimentation on fish passage and the implications for maintaining fish passage.

The sediment transport conditions of the major tributaries and other significant tributaries (>1 square mile) to the John Day Reservoir were investigated. A total of 35 tributaries to the John Day Pool were identified. The five largest tributaries (John Day River, Umatilla River, Willow Creek, Rock Creek, and Glade Creek) were found to encompass 91.3 percent of the total drainage area for all 35 tributaries. Of these five, all except Glade Creek are considered for fish passage. Glade Creek is not known to support anadromous fish. Although Wood Gulch is not one of the five largest tributaries, it does support anadromous fisheries and is therefore considered a stream of concern in terms of fish passage.

A qualitative evaluation of sediment inputs from tributaries to the John Day Reservoir was conducted. A field inspection of the 31 minor tributaries revealed the relative contribution of sediment expected from these basins. In addition, an evaluation of the pre-dam (1955) topographic maps revealed the relative impact of tributary sediment inputs to the confluence with the river prior to the formation of the reservoir.

Of the 31 minor tributaries, 20 showed evidence of sediment contribution to the Columbia River prior to the formation of the reservoir. Current field conditions indicate that the majority of these tributaries, with hydraulic structures such as culverts, block most of the sediment from entering the reservoir. Current contributors of sediment to the John Day Reservoir are typically those streams with bridges at their confluence, such as Glade Creek, Alder Creek, Dead Canyon, Wood Gulch, and Chapman Creek. Of these, Glade Creek

appears to be the largest contributor. Some of the smaller tributaries with culverts, including Sand Spring Canyon and Ju Canyon, appear to contribute relatively minor amounts of sediment to the John Day Reservoir.

Suspended sediment data and changes in channel topography were used to estimate the amount of sediment that is contributed by the four major tributaries to the John Day Reservoir. Sediment input values from these tributaries were used to estimate sediment inputs from the smaller nearby tributaries that were deemed significant in the qualitative evaluation. The average annual sediment load for major tributary streams is shown in Table 2.

Table 2.
Average Annual Tributary Sediment Loads

Tributary	Average Annual Suspended Sediment Load Rating Curve (tons/year)	Measured Average Annual Accumulation[a] 1955 and 1994 Surveys (tons/year)	Measured Average Annual Accumulation[a] 1955 and 1994 Surveys (% of suspended load)
John Day River	720,444	76,729	11%
Willow Creek	748,745	132,363	18%
Umatilla River	608,291	6,670	1.1%
Rock Creek	28,004	23,872[b]	85%

a. Measured accumulation assumes a sediment density of 93 pounds per cubic foot.

b. No digital terrain model output was available for 1955. Annual accumulation was estimated using the thalweg elevation from the 1955 topographic map, assuming triangular cross sections and top widths measured from the 1994 topographic map.

4.7 Sediment Characteristics and Quality

NMFS collected sediment samples from six stations and submitted them for physical analyses. Each of the stations was sampled at three depths: 1 meter (m), 3 meters, and 5 meters. A total of 93 samples were analyzed in 1994 and 1995. With few exceptions, the samples were graded "poorly graded sand with silt" or "silty sand." The average of the samples was 72.2 percent sand, 20.8 percent silt/clay, and 1.4 percent volatile solids, with a median grain size of 0.14 millimeter (mm). The data are summarized in Table 3.

Table 3.
Sediment Physical Analysis

Site Location Description	Depth (m)	Mean Grain size (mm)	Gravel (%)	Sand (%)	Silt/clay (%)	Total Fines (%)	Volatile solids (%)
Big Blalock Island	1.00	0.17	0.00	83.77	10.68	16.23	0.82
Big Blalock Island	3.00	0.16	0.02	80.12	17.03	19.85	0.87
Big Blalock Island	5.00	0.17	0.00	83.10	13.03	16.90	0.75
Crow Butte	1.00	0.07	0.00	33.40	59.65	66.60	2.20
Crow Butte	3.00	0.10	4.70	46.95	40.35	48.35	1.60
Crow Butte	5.00	0.06	0.00	50.80	63.45	74.60	3.00
Long Walk Island (downstream site)	1.00	0.17	0.23	91.00	6.32	8.77	1.72
Long Walk Island (downstream site)	3.00	0.08	0.00	54.42	34.62	45.57	2.08
Long Walk Island (downstream site)	5.00	0.08	0.00	55.68	31.58	44.32	2.28
Long Walk Island (upstream site)	1.00	0.09	0.00	60.77	30.03	39.23	1.67
Long Walk Island (upstream site)	3.00	0.08	0.00	56.37	31.92	43.63	2.08
Long Walk Island (upstream site)	5.00	0.15	5.15	74.63	16.23	20.22	1.35
Paterson Slough	1.00	0.12	0.00	67.42	26.68	32.58	0.70
Paterson Slough	3.00	0.13	1.72	79.32	12.38	18.95	0.82
Paterson Slough	5.00	0.12	0.17	74.90	16.80	24.97	0.87
Sand Island	1.00	0.19	0.00	90.10	7.38	9.90	0.62
Sand Island	3.00	0.20	0.00	90.94	7.36	9.06	0.68
Sand Island	5.00	0.23	0.00	92.90	5.80	7.10	2.42

Note: Each entry is an average of the samples taken at that location and depth.

Eleven sediment samples were collected at Messner Cove, Port of Morrow, Boardman, Oregon (RM 270), in March 1999 and tested for chemical composition. Chemical analyses included metals, total organic carbon (TOC), pesticides/polychlorinated biphenyls (PCBs), phenols, phthalates, miscellaneous extractables, and polynuclear aromatic hydrocarbons (PAHs).

This sediment analysis indicates that dredged material from the John Day Reservoir would be considered acceptable for both unconfined in-water and upland disposal.

4.7.1 Potential Sources of Sediment Contamination

There are a number of specific (point) and dispersed (non-point) sources that could contribute to sediment contamination within the study area. These include the following:

4.7.1.1 Hanford

The Hanford Facility is located just upstream from McNary Dam. Nuclear reactor releases of radioactive material occurred from January 1944 to January 1971. A variety of reactive materials were released, including sodium-24, arsenic-76, neptunium-239, phosphorus-32, and zinc-65.

4.7.1.2 Goldendale Aluminum Reduction Plant

Primary concerns are heavy metals, including nickel, chromium, and cadmium. Other concerns include fluoride, sulfide, cyanide, and PAHs (in soot from carbon anode).

4.7.1.3 Tributaries and Commercial Fishing

Primary concerns are ammonia, pesticides, phosphorus, and herbicides.

4.7.1.4 Ports, Boat Basins, and Barging

Primary concerns are low- and high-density PAHs cadmium, chromium, copper, mercury, selenium, tin, oil and grease, organotin, and PCBs.

4.7.1.5 Recreation Facilities

Primary concerns are related to boat refueling—oil and grease and PAHs (breakdown products of oil).

4.7.1.6 Wood Products Industry

Primary concerns are mercury, PAHs, and dioxin/furan.

4.7.1.7 Municipal Waste Water Discharge

Primary concerns are ammonia and pesticides.

4.7.1.8 Radioactivity

A 1994 report by the Washington State Department of Health on radioactivity in Columbia River sediments concluded that the human-caused radionuclide concentrations found in Columbia River sediments do not pose a significant risk to human health. Also, most radioactive discharges occurred prior to filling the reservoir and any more resent discharges are captured behind McNary. The Bi-State program that investigated radionuclides in fish measured eight radionuclides in a small number of carp and large-scale sucker samples. This level of radioactivity poses negligible risk to human consumers.

4.8 Water Quality

Several sources were used to obtain water quality data in order to assess current conditions in the John Day Reservoir. These sources include the USGS, ODEQ, WDOE, NMFS, and the National Park Service. Water quality characteristics of the John Day Reservoir and state and federal standards are also shown in Table 4. For comparison, pre-John Day Reservoir and Hanford Reach data are also included.

Water quality in the John Day Reservoir is generally good (Table 4). Dissolved oxygen levels are usually above 6 mg/L; and, for most of the year, temperatures are below the standard except in summer and fall. Nutrient concentrations are below drinking water standards but can be high enough to promote aquatic plant growth. For example, threshold nitrogen and phosphorus concentrations associated with accelerated growth of aquatic plants are 0.30mg/L and 0.05 mg/L respectively. Phosphate concentrations range from 0.001 to 0.39 mg/L and nitrogen as NO_2-NO_3 from 0.01 to 1.9 mg/L. These nutrient concentrations are not much different than pre-dam concentrations but are worse than in the Hanford Reach, a stretch of the river considered to be representative of a more pristine state of the river.

Concentrations of the heavy metals cadmium, lead, mercury, and zinc sometimes exceed standards.

Two parameters of concern because of their impacts to fish are water temperature and total dissolved gas (TDG). As Table 4 shows, temperatures in the John Day Reservoir exceed the standards for both Oregon and Washington. Oregon has three temperature standards, 64 degrees F (17.8 degrees C) for most streams, 55 degrees F (12.8 degrees C) for parts of streams where salmon spawning occurs, and 50 degrees F (10 degrees C) for streams with cold water species. Washington's standard is 64.4 degrees F (18 degrees C). Because John Day is operated as a run-of –river project the 64 degree F standard should apply within the reservoir. However, salmon spawning may occur in a small section of the upper part of the reservoir just below McNary Dam where the 55 degree F standard could apply.

Data from the 1998 TDG fixed monitoring station, located at the dam forebay, indicates that, from late June through fall, temperatures exceed the 64 degree standard. These data are taken from a depth of 15 feet so it is likely surface temperatures are higher. Probably, temperatures in shallow embayments along the edge of the reservoir are higher yet. Historically, the current 64 degree F standard was violated during the same period, June through September, at Rufus, Oregon, a site near John Day pool (USGS, 1964).

Since John Day is a run of river project, travel time for water is short and varies from 1 to 23 days depending on flows. Consequently, at least at the 15 foot depth, very little heating occurs between the tailwaters of McNary Dam and the forebay at John Day Dam (about 1.8 degrees F, see Pages P-36 and P-37 of the 1998 Total Dissolved Gas Annual Report, prepared by USACE Northwestern Division). This would indicate that much of the heating of water occurs upstream of McNary dam. One of the consequences of the Columbia River dams is that the volume of heated water delays the fall cooling that would normally occur. Because the John Day project is run-of river, it probably contributes little to the heating of water but merely passes it on in summer and fall.

Total dissolved gas concentrations in tailwaters from John Day are of concern. High TDG concentrations are associated with gas bubble disease in fish. This is potentially troublesome during the spring migration of both adults and juveniles in the Columbia and Snake Rivers. During periods of high spill especially in the spring and summer, when salmon are migrating, TDG levels below John Day Dam exceed the standards of both Oregon and Washington (110 % TDG). Concentrations have even exceeded 140 % TDG. At the request of the U. S. Fish and Wildlife Service, the states of Oregon and Washington have granted waivers to the standard to allow up to 120 % TDG concentrations from March through August. The data from TDG monitoring stations above and below John Day Dam are carefully scrutinized to adjust flows to insure as much as possible that the 120 % concentration is not exceeded. After 1997, gas concentrations in the river below John Day Dam were decreased because of structural improvements to the dam. In 1998 "flip lips" were installed on the dam and since then it has been easier to increase flows for fish passage and still keep TDG concentrations below 120 %. Naturally, the breaching of the dam or operating under drawdown conditions will have an impact on TDG concentrations. This will be discussed in the Section 7.

Table 4.

Water Quality Summary

Parameter	Pre John Day Dam before 1968	Post John Day Dam after 1968	Hanford Reach	Oregon DEQ Standard	Washington DOE Standard	EPA Recommended Criteria
Turbidity	NA	1.3 - 41.8[h]	0.7 - 2.9[c]	< 10% increase over background	< 5 NTU increase if background < 50 NTU or < 10% increase if > 50 NTU	< 5 NTU increase if background < 50 NTU or < 10% increase if > 50 NTU
Temperature	-0.6 - 27.2 °C[a]	0 - 24.7 °C[b]	0.9 - 21 °C[c]	13 °C[o] (maximum)	18 °C[q] (maximum)	SPECIES DEPENDENT
pH	7.2 - 8.2[d]	7.5 - 8.9[e]	6.4 - 8.7[c]	7.0 - 8.5[bb]	6.5 - 8.5[q]	6.5 - 9.0[u]
Dissolved Oxygen	10.2 - 10. 3 mg/L[l]	8.3 - 14.8 mg/L[g] 8.5 - 13.8 mg/L[i] 8.9 - 16.1 mg/L[f] 4.6 - 13.9 mg/L[m]	9.8 - 14.8 mg/L[c] 8.1 - 12.2 mg/L[h]	6 mg/L[p] (minimum)	8 mg/L[q] (minimum)	8 mg/L[aa] (minimum)
Phosphate	0.2 - .28 mg/L[d]	.0001 - .038 mg/L[e] .005 - .199 mg/L[f] .11 - .39 mg/L[g]	.0005 - .016 mg/L[h]	.05 mg/L[z]	r	Narrative Statement
Nitrates	.1 - 2.1 mg/L NO3[d]	0.0 - .84 mg/L NO2-NO3[l] 0.0 - 0.67 mg/L NO2-NO3[e] .01 - .84 mg/L NO2-NO3[f] .2 - 1.9 mg/L NO3[g]	.05 - .33 mg/L NO2-NO3[h]	10 mg/L[x]	NA	10 mg/L Nitrates[u]
Heavy Metals	NA	Arsenic <1 - 3 ug/L[i] 1.44 - 30 ug/L[j] Cadmium ND - 9 ug/L[i] .1 - .39 ug/L[k] Chromium ND - 20 ug/L[i] 02 - 5 ug/L[k] Lead ND - 44 ug/L[i] 1 - 1 ug/L[k] Mercury <.10 - .60 ug/L[i] .001 - .3 ug/L[k] Zinc ND - 170 ug/L[i] 4 - 12 ug/L[k]	Chromium <1 - 1[n]	Arsenic 190 ug/L[w] Cadmium 1.1ug/L[w] Chromium III210 ug/L[w] Chromium IV 11 ug/L[w] Lead 3.2 ug/L[w] Mercury .012 ug/L[w] Zinc 110 ug/L[w]	Arsenic 190 ug/L[t] Cadmium s,t Chromium III s,t Chromium IV 15 ug/L[t] Lead s,t Mercury 0.012 ug/[Lt] Zinc s,t	Arsenic 150 ug/L[v] Cadmium 2.2 ug/L[v] Chromium III 74 ug/L[v] Chromium IV 11 ug/L[v] Lead 2.5 ug/L[v] Mercury 0.77 ug/L[v] Zinc 120 ug/L[v]
Chlorophyll A	NA	0.3 - 42.1 ug/L[e]	1.6 - 13.4 ug/L[h]	15 ug/L[y]	NA	NA
Pollutants	NA	NA	NA	VARIOUS	VARIOUS	VARIOUS

a. Once-daily observations from December 1950 to September 1958 at Maryhill Ferry, near Rufus. Taken from USGS Open-file Report Compilation of Water-Temperature Data for Oregon Streams, 1964.

b. Hourly observations from John Day forebay total dissolved gas fixed monitoring station, 1994 - 1998. Taken from total dissolved gas abatement database.

c. 1985 data taken from Hanford Reach of the Columbia River, National Park Service, 1994.

d. Once monthly USGS data recorded at gage 14019200, McNary Dam in 1960, 1962, 1963, 1966 and 1967.

e. Taken from NMFS database accompanying Limnological Investigation in John Day Reservoir, Including Selected Shallow-Water Habitats: April to December 1994.

f. Once monthly Washington Department of Energy (WDOE) data recorded at gage 31A070, Columbia River at Umatilla from 10/1991 - 12/1998.

g. Once monthly USGS data recorded at gage 14019200, McNary Dam in 1969.

h. Taken from database provided by NWW. Bi-monthly observations from 6/1997-10/1997.

i. Once monthly USGS data recorded at gage 14019250, Columbia River at Umatilla from 1975 - 1980.

j. Six observations of Total Recoverable Arsenic from WDOE gage 31A070, Columbia River at Umatilla from 1994 - 1995.

k. Observations from WDOE gage 31A070, Columbia River at Umatilla from 1991 - 1998.

l. Two readings from USGS gage 14049200, McNary Dam from 10/1967 and 11/1967.

m. Taken from NMFS database accompanying Limnological Investigation in John Day Reservoir, Including Selected Shallow-Water Habitats: April to December 1994. Note that readings taken at depth may account for lower values.

n. Taken from Hanford Reach of the Columbia River, National Park Service, 1994. Data are listed as dissolved chromium.

o. Temperature, which must not be exceeded within salmonid habitat during spawning and rearing seasons.

p. Absolute minimum for cold water species habitat water bodies.

q. For waters designated Class A (excellent).

r. Criteria for an oligotrophic lake within the Columbia Basin Ecoregion is .01 mg/L. John Day pool is not representative of an oligiotrophic lake, however. No other standards found.

s. Calculation dependent upon hardness.

t. Chronic values as listed in "Water Quality Standards for Surface Waters of the State of Washington." This document should be consulted for specific details of each standard.

u. Human health for consumption of water plus organism value as listed in "National Recommended Water Quality Criteria - Correction" EPA, April 1999.

v. Criterion Continuous Concentration as listed in "National Recommended Water Quality Criteria - Correction" EPA, April 1999.

w. Fresh chronic criteria for protection of aquatic life as listed at http://waterquality.deq.state.or.us/wq/wqrules/340Div41Tbl20.pdf

x. Concentration for the protection of human health for water and fish ingestion as listed at http://waterquality.deq.state.or.us/wq/wqrules/340Div41Tbl20.pdf

y. Oregon Administrative Rules 340-41-015.

z. Standard for primary and secondary contact recreation in the state of Utah. No applicable standard for Oregon found.

aa. Coldwater criteria one-day minimum, early life stages.

bb. Oregon Administrative Rules 340-41-0642.

ND = Not detected.

NA = No available data found.

mg/L = milligram per liter.

ug/L = microgram per liter.

Mg/L = microgram per liter.

4.9 Transportation and Shoreline Infrastructure

4.9.1 Transportation

The middle Columbia River area is served by a well-developed regional transportation system consisting of highways, railroads, and navigation channels. Railroads and highways parallel the northern and southern shores of the John Day Reservoir. Highway I-84, is a major freight corridor is a divided multilane highway that runs parallel to the Columbia River on the south shore from Portland, to points east. Washington SR-14 also parallels the Columbia River from Vancouver, Washington, to McNary Dam on the north shore. Umatilla Bridge at RM 290.5 downstream of McNary Dam is the only highway bridge linking Oregon and Washington across the Columbia River in the John Day Reservoir.

Two major railroad lines run adjacent to the reservoir: BNSF and UPRR. BNSF lines run east and west along the Columbia River on the Washington shore, from Longview past McNary Dam. On the Oregon shore, UPRR also parallels the Columbia River, from Portland to Hermiston and points east.

4.9.2 Shoreline Infrastructure

For all four drawdown alternatives, structural impacts may occur to both culverts and bridges along the John Day Reservoir. There are more than 20 bridges and hundreds of culverts that border the reservoir. Due to the much lower pool elevation, scouring may occur to road and railroad embankments located below culvert outfalls. There is also the potential for failure of bridge piers due to scour. The objectives of the shoreline impact analysis are to first identify what bridges and culverts could potentially be impacted by drawdown, then determine the type and extent of impact, and finally develop mitigation measures.

To develop an inventory of bridges and culverts, the roads and railroads that could be affected by drawdown of the reservoir were first determined. Two Interstate 82 (I-82) bridges cross the reservoir near McNary Dam. Track profiles for both railways and bridge logs were obtained from the Oregon and Washington Departments of Transportation. An inventory was then compiled from these track profiles and bridge logs. In addition, bridge plans for nearly all the bridges were acquired from the railroads and state highway departments. An abbreviated list of the gathered information follows:

4.9.2.1 Washington Department of Transportation (WSDOT) Structures

SR-14 parallels the John Day Reservoir on the northern side. In some areas, especially in the lower pool, the highway is near the river. In other areas, the highway is set back from the river and is several hundred feet higher than the pool elevation. The WSDOT bridge list shows only five bridges and one set of culverts for the reach of highway along the reservoir.

4.9.2.2 Burlington Northern Santa Fe Railway

The BNSF railway line borders the reservoir on the northern side. The rail line is sandwiched between the reservoir and SR-14. In many locations the railway embankment is set right against the reservoir. The track profile for the BNSF line lists more than 300 culverts and bridges between John Day and McNary Dams.

4.9.2.3 Oregon Department of Transportation (ODOT) Structures

I-84 parallels the south side of the John Day Reservoir on the southern side. This four-lane interstate freeway follows the shoreline from John Day Dam to about Boardman, before veering south and away from the reservoir. The ODOT bridge log lists 17 bridges or culverts along the reservoir.

Oregon State Highway 730 only parallels a small portion of the reservoir from Irrigon to Umatilla. The ODOT bridge log lists two bridges and one culvert for the highway. Bridge plans for the Umatilla River Bridge were also obtained from ODOT.

I-82 does not parallel the John Day Reservoir; however it does cross the reservoir about a mile and a half downstream from McNary Dam. The crossing consists of two 2-lane bridges—an original one as well as a newer one that was constructed when the highway was upgraded to an interstate. ODOT provided plans for the original bridge.

4.9.2.4 Union Pacific Railroad

Similar to the BNSF line on the Washington side of the reservoir, the UPRR line is sandwiched between a freeway (I-84) and the reservoir. The UPRR line also breaks away from the reservoir. The UPRR track profile lists 34 bridges and culverts and seems to be far less comprehensive than the BNSF track profile. UPRR also provided plans for the bridges at the John Day River, Arlington, and Willow Creek.

4.10 Navigation

Currently, navigation through the John Day Reservoir is achieved by means of a lock at the dam and a navigation channel throughout the length of the reservoir. The lock provides a maximum lift of 113 feet. The authorized federal navigation channel through the 76-mile length of the John Day Reservoir is 250 feet wide by 14 feet minimum depth and allows for two-way barge traffic along the entire length of the reservoir. This arrangement facilitates the transport of modern barge tow configurations of one tug and four barges (i.e., lengths up to 650 feet and widths up to 85 feet). About nine million tons of commodities move through the John Day Lock each year.

Operation for navigation, a major project function, consists of making the necessary lockages and observing pondage and release limitations. The lock facilities are operable for a full range of flow conditions. At the minimum operational pool of 257 feet, the upstream sill of the navigation lock will have 15 feet of water depth. The project was originally design for barges with nine feet of draft, but some of the larger barges have up to 14 feet of draft. Information to date indicates that entrance and exit velocities at the lock do not cause safety problems.

Emergency dredging operations in 1992 removed areas of rock (at about elevation 242) in and adjacent to the navigation channel in the upstream portions of the reservoir. These rock outcrops were a major concern for navigation if the forebay of John Day Dam dropped below elevation 261.0, in combination with low releases from McNary Dam.

John Day Reservoir has numerous local port and dock facilities. Most of these facilities require local access channels and were originally designed and dredged by local sponsors. These channels are not considered to be a part of the "federal channel" and are normally not

within USACE authority to be maintained. In 1992, however, Congress provided special authorization and funds to perform limited dredging in anticipation of special drawdown operations at John Day Dam. Currently, all local access channels are operable at the minimum pool elevation of 257.

4.11 Hydropower Operation

Columbia River Basin hydropower projects (hereafter referred to as the hydropower system) serve as the major element in the Pacific Northwest (PNW) electrical system. On average, they provide about 60 percent of the total energy generation and 70 percent of the total generating capacity in the region. However, the hydrologic nature of hydropower generation makes it variable from year to year depending on streamflow conditions. In high streamflow years, the amount of hydropower generated can be significantly greater than in the average year. This additional power serves as a major part of the electricity exports from the PNW. In low streamflow years, or in high demand periods, power is often imported into the PNW to meet the local power demands (also referred to as loads). Consequently, any long-term or permanent changes in the level PNW hydropower production could impact the amount of power bought and sold from the PNW and also the amount of new power generating facilities built throughout the West. For these reasons, the geographic scope of this analysis spanned the entire western United States and parts of Canada and Mexico as defined by the boundaries of the Western Systems Coordinating Council (WSCC). The WSCC is one of nine self-governed regional electric power reliability councils that form the North American Electric Reliability council (NERC). The WSCC comprises all or part of the 14 western states as well as two provinces in Canada and a small portion of northern Mexico. It totals over 1.8 million square miles.

The primary source of generating capacity and energy in the WSCC is hydropower, but to a significantly less extent than in the PNW. Coal and natural-gas-driven thermal plants provide a much larger share of capacity and energy in the WSCC than in the PNW. However, hydropower makes up the vast majority of system capacity and generation in the PNW, and it is the largest contributor for the entire WSCC.

Table 5 describes some of the hydropower characteristics of John Day and each Lower Snake hydropower project. The overload capacity represents the maximum output that can be achieved. The average annual energy is presented in two different units: the *average megawatt* (aMW), which is the amount of generation averaged over all the hours of the year, and the *annual MWh*, which is the sum of all generation over the entire year. These energy data were taken from the average of 60 years modeled with a hydro-regulation model.

Table 5. Hydropower Plant Characteristics						
	Ice Harbor	**Lower Monumental**	**Little Goose**	**Lower Granite**	**Lower Snake Total**	**John Day**
Number of Hydroturbine Units	6	6	6	6	24	16
Overload Capacity (MW)	693	931	931	931	3,486	2,484
Average Annual Energy (aMW) Existing Condition	219	335	317	329	1,200	1,146
Average Annual Energy (1,000 MWh) Existing Condition	1,918	2,935	2,777	2,882	10,512	10,039

Figure 4 shows an estimate of the average monthly generation of John Day Dam by month based on a system hydro-regulation model for the existing condition. The amount of generation from this plant can change significantly in different water years and seasons. Figure 4 compares the monthly generation for a 60-year average simulation (from 1929 to 1988), a low water year (1944-45), and a high water year (1955-56).

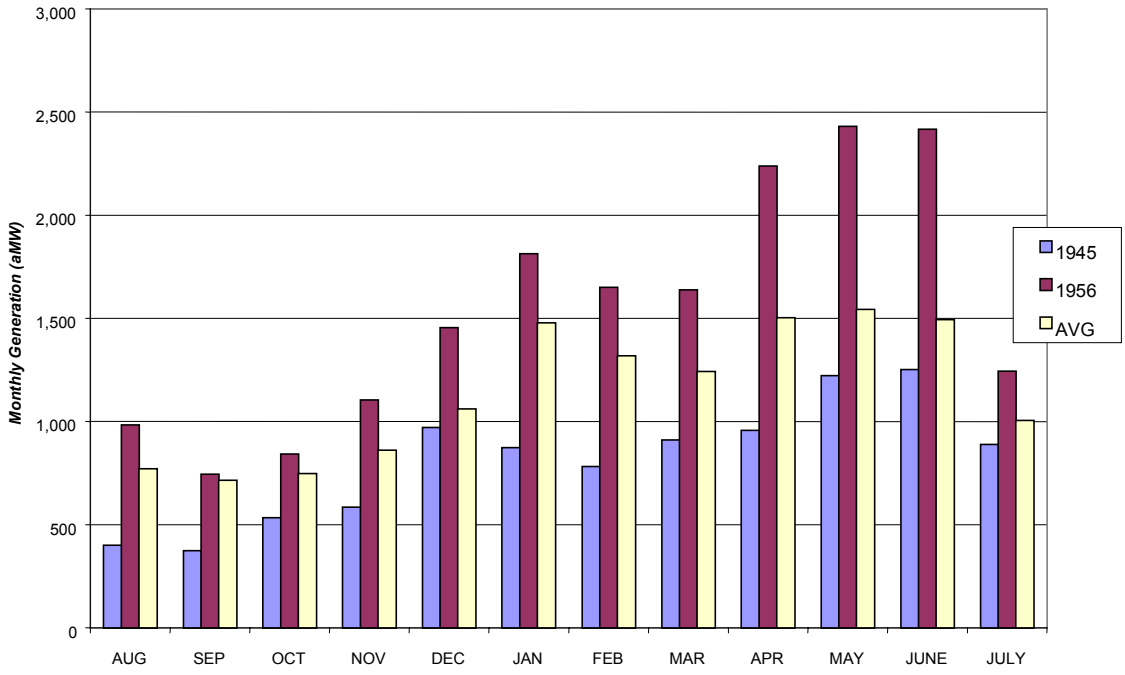

Figure 4. John Day Monthly Generation for the Existing Project Condition

The hourly operation of the John Day plant is determined primarily by the amount of Columbia River water passed by McNary Dam and by the system's power demand (load). John Day serves an important role in the power system by providing a considerable amount of flexibility in response to load fluctuations throughout the day.

John Day, and other hydropower projects, contribute greatly to system reliability through the Automatic Generation Control (AGC) system that adjusts the system generations, second by second, to match changes in power demand. John Day also contributes to the WSCC capacity reserve requirements and provides backup generation in the event of an unexpected outage of another generating power plant. In addition, John Day can provide extra energy during extreme and/or prolonged weather periods (if enough water from storage is available) and help maintain transmission stability during system disturbances. For all of these reasons, the power operations of John Day Dam play an important role in maintaining the flexibility, reliability, and transfer capacity of the PNW generation and transmission systems, which ultimately saves the region money.

The amount of energy generated annually from John Day Dam makes up about 5 percent of all energy generated in the PNW and about 11 percent of the energy sold annually by the Bonneville Power Administration (BPA). The peaking capacity of John Day represents about 5 percent of the total electricity peaking capacity of the PNW and about 10 percent of BPA's total peaking capacity.

4.12 Flood Control System and Operation

John Day Dam is the largest of the lower Columbia River dam and reservoir projects, and it is the only one with allocated flood control space. It provides final regulation of flood peak flows for downstream control points. In addition, the project is operated to provide optimum conditions for navigation and hydroelectric power without creating unnecessary adverse effects on fish passage, recreation, and other project uses. The study only analyzed impacts to flood control operations for points along John Day Reservoir, and thus did not study impacts for downstream locations.

The primary damage control point for the lower Columbia River, and indeed for the entire Columbia River Basin, is the Portland-Vancouver area. Grand Coulee Dam and other large upstream projects are the primary components of Columbia River flood regulation. However, their remoteness from the Portland-Vancouver area makes it difficult to achieve the target regulation. Uncertainties in weather and timing of runoff also complicate flood control operations. The approximately 500,000 acre-feet of flood control space in John Day Reservoir, between elevations 257 and 268, provide an opportunity for final regulation to the target discharges for the downstream control points. The flood control space will be evacuated during the pre-flood period, generally no farther in advance than is necessary for assured operation based on forecasts of seasonal runoff volumes, short-term inflow forecasts, weather outlook, power demands, and current conditions along the river. Because winter floods can develop rapidly, it is necessary to reserve the space between elevation 265 and 268 exclusively for control of sudden winter floods. When the potential of heavy runoff is evident, additional space below elevation 265 can be provided.

4.13 Irrigation

Twelve irrigation pump stations have been identified along the Washington side of the reservoir, and 18 irrigation pump stations are located along the Oregon side (Plates 11-16). Existing information for each of the pump stations is shown in Table 6 (Oregon) and Table 7 (Washington), respectively. There are approximately 180,000 acres of irrigated lands along the John Day Reservoir. Existing stations in Washington pump approximately 575,000 gallons per minute (gpm), using approximately 92,200 horsepower (hp) to irrigate approximately 92,000 acres. Existing stations in Oregon pump approximately 700,000 gpm, using approximately 50,000 hp to irrigate approximately 90,000 acres.

Table 6.
Oregon Pump Stations

Name	Location (RM)	Number of Pumps and Power (hp)	Volume per Pump (gpm)	Available Reports	Available Information	Current Intake Elev.	Impacted Pool Elev.
Boeing	252.8	12 @ 600 each 1 @ 400 1 @ 200	82,000 total	(a)	Vertical Turbine, Pier	Unknown	262
Taggares Farm	252.8	12 @ 1,250 each	144,000 total	(a)	Vertical Turbine, Pier	Unknown	262
Sullivan Farm	252.8	2@ 125 each	4,000 total	(b)	Vertical Turbine	Unknown	262
Harris Farm (Trafton)	252.8	1 @ 50	800	(b)	None	Unknown	263.5
Boardman Rest Area (Westbound lanes)	265.4	1 @ 25 (estimated)	150	None	None	Unknown	260
Circle C Farm	267.8	2 @ 200 each	2 @ 2,100 ea 4,200 total	(a) & (b)	Vertical Turbine, Shore	263 u/s 260.7 d/s	263.5
Port of Morrow	270.6	5 @ 300 each 4@ 200 each	18,900 total	(b)	Vertical Turbine,	Unknown	260
Columbia Improvement District	271.4	6 @ 500 each	144,000 total	(b)	Vertical Turbine, Shore	Unknown	259
Potlatch Corporation	271.4	1 @ 300 3 @ 250 each 2 @ 150 each	1 @ 26,000 3 @ 23,000 ea 2 @ 13,750 ea (122,500 total)	(b)	Vertical Turbine, Shore	Unknown	257
Western Empire #2	271.5	5 @ 800 each	31,000 total	(a) & (b)	Vertical Turbine, Shore	255	260
Western Empire #1	280.7	5 @ 300 each	25,000 total	(b)	Vertical Turbine, Shore	Unknown	259
West Extension Irrigation District #2	280.7	1 @ 300 2 @ 100 each	12,200 total	(b)	Vertical Turbine, Shore	Unknown	259
Strebin Farms	285.2	4 @ 200 each	13,300 total	(a) & (b)	Centrifugal	251 d/s 257 u/s	262
Perkins Farms	287.3	5 @ 600 each 1 @ 700	6 @ 3,250 19,500 total	(a) & (b)	Vertical Turbine, Shore	251	263
C & B Livestock	287.3	2 @ 1,000 each 4 @ 800 each 1 @ 600 1 @ 300	33,200 total	(a) & (b)	Vertical Turbine, Shore	248	263
Leonard Farm (d)	0.4	2 @ 500 each 1 @ 200	8,100 total	(b)	Inlet Channel	Unknown	263
West Extension Irrigation District #1	0.4	3 @ 600 each	35,000 total	(b)	Vertical Turbine, Shore	Unknown	263
Umatilla High School Athletic Field Irrigation Pump (d)	0.8	1 @ 25 (estimated)	200 (estimated)	None	None	Unknown	Unknown

See Table 7 for table reference

Table 7.

Washington Pump Stations

Name	Location (RM)	Number of Pumps and Power (hp)	Volume per Pump (gpm)	Available Reports	Available Information	Current Intake Elev.	Impacted Pool Elev.
Goldendale Aluminum	216.9	6 @ 600 each	21,000 total	None	Shore	Unknown	Unknown
Harris Farms	240.8	2 @ 300 each	4,000 (estimated)	None	None	Unknown	Unknown
Mercer Ranches	261	1 @ 1,500 1 @ 1,250 1 @ 1,000 2 @ 800 each 3 @ 600 each	1 @ 8,000 1 @ 7,000 1 @ 5,500 1 @ 4,100 1 @ 4,000 3 @ 3,000 each (37,100 total)	(b)	Vertical Turbine, Pier	262	262
100 Circles Farm	264	8 @ 1,500 each 2 @ 1,000 each	8 @ 10,000 each 2 @ 6,500 each (93,000 total)	(b)	Vertical Turbine, Pier	261	261
USFWS/Whitcomb Island	266.6	6 @ 410 (total)	5,000 total	(a)	Vertical Turbine, Pier	259	260.5
Sandpiper Farms	271.5	5 @ 7,500 (total)	45,000 total	(a)	Vertical Turbine, Pier	250.7	257
Milliman Farms	272.3	1 @ 30	250	(a)	Cent, shore	260	260
Sunheaven Farms	276.4	6 @ 12,000 (total)	66,000 total	(a)	Vertical Turbine, Shore	257	257.5
Stimson Lane	276.4	4 @ 1,500 each 5 @ 1,000 each 1 @ 800 6 @ 700 each 2 @ 250 each	4 @ 8,300 each 5 @ 5,600 each 1 @ 4,300 6 @ 3,700 each 2 @ 1,300 each (90,300 total)	(b)	Vertical Turbine, Shore	4 @ 250 14 @ 255 (sump)	260
South Slope Irrigation District	277	8 @ 4,400 (total)	36,000 total	(a)	Vertical Turbine, Shore	253	257.5
Berg Brothers	(277)	4,000 (estimated)	31,900 total	None	None	Unknown	Unknown
U & I/Agril Northwest	285.1	20 @ 22,000 (total)	145,000 total	(a)	Vertical Turbine, Pier	251	257

EXISTING REPORTS:

a. Existing pump station information and proposed modifications for drawdown to minimum operating pool (MOP) included in "Washington Shore, Irrigation Pumping Stations Evaluations, Feb. 1993", prepared by Bovay Northwest, Inc.

b. Existing pump station information and proposed modifications for drawdown to MOP included in "Effects of JDPD on Selected Pumping Stations In Washington, Aug. 1991", prepared by PACAM Engineering and IRZ Consulting.

c. Preliminary design information developed during MOP study, April 1994, Appendix B, Technical report

d. Located on the Umatilla River

4.14 Water Supply

Most residents in the developing John Day Reservoir area rely directly or indirectly on the reservoir at its present operating levels for their water supply. Historically, water rights have been claimed under permits for domestic, commercial and public use. The total number of water supply systems in the region, exclusive of pumping plants for large-scale irrigation purposes, was recently estimated at about 2,200; the majority of these were private water wells for domestic use. Publicly owned and operated facilities consist of federal, state, municipal, and other local public systems (as listed in Table 8); many of these users operate multiple systems. There are approximately 15 public water supply users in the region whose systems have a total capacity of roughly 77,500 gpm. Approximately 300 alluvial wells, used primarily for domestic water, are located adjacent to the reservoir. Their well screens are located in the alluvial aquifer that is recharged directly by the reservoir. Approximately 320 other shallow wells are located away from the reservoir and may not be affected by reservoir drawdown levels.

Although some water supply systems draw water directly from the reservoir, most systems consist of one or more wells that draw water from groundwater aquifers, either in overburden or bedrock. Next to the John Day Reservoir, however, much of the recharge of the ground water aquifers comes from the river. This is particularly true for the alluvial aquifer consisting of river-deposited sediments overlying the bedrock in the area. Thus any significant change in the operating level of the reservoir will affect the efficiency of well systems involving river recharge. Changes in operating levels of the reservoir will affect some well systems dramatically or render them unusable in their current configuration.

Table 8.

Municipal Water Supplies

Identification Number[g]	Current Well Owner	Common Well Name or Designation	State	Aquifer	Ground Surface Elevation (ft)	Elevation Top Open Interval (ft)	Elevation Bottom Open Interval (ft)	Elevation, Static Water Level (SWL)	Elevation Bottom of Well (ft)	Water Right (gpm)	Target Yield (gpm)
See Note[f]	City of Boardman	Ranney Collector (# 1)[a]	OR	Aluv	272	230	230	264	223.5	6030[b]	6000
See Note[f]	City of Boardman	Ranney Collector (# 2)[c]	OR	Aluv	272	--	--	--	--	--	--
1	USACE	LaPage Park Well	OR	Aluv	280	137	122	268	122	67	67
3	USACE	Albert Philippi Park Well	OR	Bslt	290	184	17	258	17	148	148
5	City of Arlington	Main City Well	OR	Bslt	291	227	-328	250	-328	987	600
7	City of Arlington	Arlington Park Well[d]	OR	Bslt	290	239	40	258	40	13.5	155
11	WA Dept Parks and Rec	Crow Bte St Pk Dom Well	WA	--	300	--	--	--	210	40	40
12	Port of Morrow	Redi-Mix Well	OR	Bslt	297	196	62	249	62	--	--
18	Boardman Park Dist	New Irrigation Well	OR	Aluv	272	242	222	264	222	85	85
47	Columbia Jr. H.Schl.	--	OR	Aluv	290	230	230	257	230	58	58
48	USACE	Marina Park Well # 1	WA	Aluv	280	235	220	268	220	36	36
49	City of Irrigon	Well # 1 (Shallow)	OR	Aluv	300	247	234	268	232	121	900
2156	City of Boardman	Boardman Backup Well	OR	Bslt	300	-254	-285	238	-285	--	--
2158	USACE	Plymouth Park Campground	WA	Bslt	280	216	52	190	52	--	--
2163	USACE/Plymouth	Backup Well	WA	Bslt	290	-275	-339	290	-339	--	--
2167	Port of Morrow	Frederickson, Oregon Hay	OR	Aluv	320	246	240	269	235	Exempt	50
CH2M-1	Port of Morrow	Carlson Sump # 1	OR	Aluv	271	242	242	265	242	507	507
CH2M-2	Port of Morrow	Carlson Sump # 2	OR	Aluv	270	245	245	265	245	507	507
CH2M-3	Port of Morrow	Carlson Pmp St Sump#3	OR	Aluv	274	247	247	265	247	2334	2334
46	US Fish & Wildlife	Umatilla NWR Shop Well	OR	Aluv	285	208	208	259	208	N/A	60
CH2M-10	Umatilla NWR/McCrm U	Domestic # 1	OR	Aluv	280	--	--	--	--	--	40
CH2M-	Umatilla	Domestic # 2	OR	Aluv	270	--	--	--	--	--	40

11	NWR/McCrm U										
CH2M-12	Umatilla NWR/Whtcm U	Domestic # 3	OR	Aluv	300	--	--	--	--	--	40
CH2M-6	Umatilla NWR/McCrm U	Well # 1	OR	Aluv	280	--	--	--	220	1973	1973
CH2M-7	Umatilla NWR/McCrm U	Well # 2	OR	Aluv	281	--	--	265	221	1211	1211
CH2M-8	Umatilla NWR/McCrm U	Well # 3 (Well A)	OR	Aluv	279	--	--	265	224	807	807
CH2M-9	Umatilla NWR/McCrm U	Well # 4 (Well B)	OR	Aluv	280	236	213	250	204	879	879
	City of Umatilla	Ranney Well Collector	OR	Aluv	--	--	--	--	--	--	--
	City of Hermiston	Reservoir Intake	OR	--	--	--	--	--	--	--	--
	Irrigon Fish Hatchery	Ranney Well Collector 1	OR	Aluv	272	272	192	240	200	8800 e	8800
	Irrigon Fish Hatchery	Ranney Well Collector 2	OR	Aluv	279	279	191	230	210	16000[e]	16000
	Irrigon Fish Hatchery	Well 1	OR	Aluv	276	242	193	226	206	2800 [e]	2800
	Irrigon Fish Hatchery	Well 2	OR	Aluv	283	243	215	265	200	3500 [e]	3500
	Irrigon Fish Hatchery	Well 3	OR	Aluv	283	248	208	261	199	2000 [e]	2000
	Umatilla Fish Hatchery	Ranney Well Collector	OR	Aluv	280	280	211	230	207	15000 [e]	15000
	Umatilla Fish Hatchery	Well 1	OR	Aluv	284	249	214	257	201	400 [e]	400
	Umatilla Fish Hatchery	Well 2	OR	Aluv	286	242	212	266	209	1800 [e]	1800
	Umatilla Fish Hatchery	Well 3	OR	Aluv	286	243	223	266	216	1000 [e]	1000
	Umatilla Fish Hatchery	Well 4	OR	Aluv	285	253	223	266	216	2250 [e]	2250
CH2M-15	City of Hermiston	New Well # 2	OR	--	--	--	--	--	--	--	--

a. Ranney Collector System Well for the City of Boardman drinking water. In operation since 1976. Will require complete replacement under spillway or natural drawdown conditions.

b. Design yield. Ref: John Day Pool Drawdown/Water Supply Mitigation Study Publicly Owned Wells, prepared by CH2M Hill for USACE, dated November 1995.

c. Second Ranney System Well to be constructed in 1999.

d. Backup well for city water. Pump capacity selected as target yield.

e. Water rights not known. Default to existing pump capacity.

f. No number assigned.

g. Internal Identification number from past studies.

(--) Indicates information not available.

4.15 Utilities

Twenty-three utilities have been identified along the reservoir. Existing information on the utilities is shown in Table 9. Locations are shown on Plates 11 through 16.

Table 9.
Utilities

Utility Name	Preliminary Findings
Benton Rural Electric Association (Plymouth Park)	Possibly an underground cable to Plymouth Park.
William Gas Pipeline - West (formally Northwest Pipeline)	Two 20-inch-diameter gas pipes crossing under the Columbia River between east of Irrigon, OR, and Plymouth, WA.
City of Arlington, OR (Sanitary Sewer)	Sanitary sewer located in water approximately 90 feet deep (from pool elevation 264).
City of Umatilla, OR (Sanitary Sewer)	Sanitary sewer outfall exposed at elevation 263. If pool is lowered city is in violation of the mixing zone requirements under its NPDES permit.
City of Roosevelt, WA (Sanitary Sewer)	Sanitary sewer system with an outfall to the Columbia River. Outlet designed below pool elevation 257 (per as-built drawings). It is not currently operating.
City of Boardman, OR (Sanitary Sewer)	Sanitary sewer system with an outfall to the Columbia River. Outlet designed below pool elevation 257 (per as-built drawings). It is not currently operating
Goldendale Aluminum Co. (Sanitary Sewer)	Sanitary sewer outlet is approximately 27 feet below "low water."
Bonneville Power Administration	Aerial crossings at RM 262 (20 wires) and RM 290.5 (15 wires).
Umatilla Electric Cooperative	No underground facilities, only aerial lines. All lines are well back from river.
Klickitat County PUD	No underground facilities, only aerial lines. All lines are well back from river.
Wasco County Elec. Coop.	Their service goes upriver but stops at Rufus, OR.
Pacific Power and Light	No crossings. All other lines are aerial and set well back from the river.
Benton County PUD	They have no facilities that would be affected by pool drawdown.
U.S. West Communications	No crossings, only lines are parallel to the river.
United Telephone Co. of the NW	No crossings.
General Telephone and Electronics (GTE)	No facilities along the pool.
Pacific Telecom, Inc. (PTI)	Facilities in both Fossil and Boardman, OR, but none of system is expected to be affected.
American Telephone and Telegraph (AT&T)	No crossings of Columbia River, just parallel lines along I-84.
Sprint	No crossings.
MCI	No crossings.
Pacific Gas Transmission Co.	Their only facility is a pipeline that crosses the John Day River, south of Condon. Therefore, pool drawdown will not affect their system.
Cascade Natural Gas Co.	They have no facilities that would be affected by pool drawdown.
City of Moro, OR (Sanitary Sewer)	Sewer outfall does not use the Columbia River as a receiving water.

4.16 Hazardous, Toxic, and Radioactive Waste

This section describes the potential for encountering Hazardous, Toxic, and Radioactive Waste (HTRW) during drawdown. The focus is on lands currently inundated by the John Day Reservoir, that would be exposed during drawdown. While solid waste, and possibly HTRW, may be encountered throughout the reservoir, the greatest likelihood of such encounters is near towns that were totally or partially relocated for the reservoir, as well as the Goldendale Aluminum smelter located just upstream from John Day Dam in Washington.

Table 10 through Table 12 lists the sites that are within the immediate river valley and includes the federal or state law, regulated site, location, and date of regulation listing. Each site is additionally located on Plates 17-22.

Table 10.

Federal Regulated Sites

Law	Site	Location	List Date
CERCLA (Comprehensive Environmental Response Compensation, and Liability Act)	Umatilla Army Depot: a chemical weapons storage facility	South of Umatilla, OR	4/13/99
CERCLA: no further remedial action planned	John Day Dam		4/13/99
	Threemile Canyon: Portland District cleanup site	8 miles east of Arlington, OR	
	Puregro Company	Umatilla, OR	
	Goldendale Aluminum	Goldendale, WA	
	Northwest Pipeline	Plymouth, WA	
RCRA (Resource conservation and Recovery Act)	No RCRA treatment, storage, or deposal facilities		4/13/99
EPCRA (Emergency Preparedness and Community Right to Know Act)	Goldendale Aluminum	Goldendale, WA	4/13/99
	Lamb-Weston Inc.	Boardman, OR	
NPDES (National Pollution Discharge Elimination System)	Lamb-Weston Inc.	Boardman, OR	4/13/99
	City of Umatilla sewage treatment plant	Umatilla, OR	
	City of Arlington sewage treatment plant	Arlington, OR	
	Goldendale Aluminum	Goldendale, WA	

Table 11. **Oregon State Regulated Sites**			
Law	**Site**	**Location**	**List Date**
ECSI (Environmental Cleanup Site Inventory)	John Day Dam		9/2/99
	Portland District's Three-Mile Canyon cleanup site	East of Arlington, OR	
	Portland General Electric Carty Reservoir Power site	Boardman, OR	
	Morrow County Roadside Gasoline Release	Morrow County	
	Former Ready Mix Asphalt Batch Plant	Port of Morrow	
	Crop Production Services	Umatilla, OR	
	McNary Dam Substation.	Umatilla, OR	
	Wilbur-Ellis Company	Umatilla, OR	
	Texaco	Umatilla, OR	
	Unocal Service stations	Umatilla, OR	
Confirmed Release List	No Shoreline sites		4/7/99
UST (Underground Storage Tank)	8 total UST 14 total/5 active 27 total/14 active 16 total/7 active 27 total/11 active 1 active at pump station	Rufus, OR Arlington, OR Boardman, OR Irrigon, OR Umatilla, OR Umatilla, OR	2/9/99
UST Clean-up list	Umatilla Fish Hatchery	Irrigon, OR	1/19/99
	Umatilla Marina	Umatilla, OR	

Table 12. **Washington State Regulated Sites**			
Law	**Site**	**Location**	**List Date**
CSCS (Inventory of Confirmed and Suspected Contaminated Sites)	Goldendale Aluminum	Goldendale, WA	5/4/99
	The Flying J facility	North of Arlington on WA side of river	
UST (Underground Storage Tank)	3 removed UST 6 total/1 active 9 total/3 active 2 total/1 active	Goldendale, WA Roosevelt, WA Patterson, WA Plymouth, WA	2/9/99
UST Clean-up list	Crow Butte State Park	Washington	1/19/99

4.16.1 Specific Sites

Additionally, there are several potential contaminated sites located within the current John Day Reservoir area, which could pose contamination issues. Several towns were either totally or partially relocated prior to the construction of the reservoir include the Cities of Umatilla, Boardman, and Arlington in Oregon, and Roosevelt, Washington. Also, located within the John Day Reservoir inundated pool are the John Day Dam solid waste disposal site and the Goldendale Aluminum smelter site. These sites are located just upstream from John Day Dam in Washington and are considered sources of potential contamination. During the construction of the John Day Dam and Reservoir, Federal, state and local regulations concerning the disposal of hazardous, toxic and radioactive wastes did not exist. An overview of these locations is presented below.

4.16.1.1 Relocated Cities

The Cities of Umatilla, Boardman, Arlington, and Roosevelt were all at least partially moved during construction of the John Day Dam and Reservoir. Land parcels that once housed facilities, including gas stations, equipment shops, and maintenance yards, are now inundated.

4.16.1.2 John Day Dam Solid Waste Disposal Site

Two areas upstream from the dam on the Washington side contain possible solid waste disposal from the original dam construction. Both sites are currently inundated but will be exposed if the reservoir is drawn down below elevation 230-240.

One former construction debris disposal site downstream from the dam structure on the Oregon side of the river has been identified and evaluated; no contaminants of concern were found. It is possible that another waste disposal site exists on the Oregon shore, since it is unlikely dam construction waste materials were transported across the spillway for disposal and the identified site is believed to be too small to account for all waste disposal during powerhouse construction.

Hazardous chemical products are used during the normal operation of any hydropower facility. Such products include PCBs, asbestos, paint/sand blast grit, oil, mercury, antifreeze, solvents, greases, halon, petroleum fuels, batteries, and wastewater treatment residue. For many products, a continuous cycle exists as new products are bought, temporarily stored, used, and temporarily stored again prior to removal and disposal.

4.16.1.3 Goldendale Aluminum

Aluminum production began at this site in 1971. The plant's NPDES permit includes discharges to the river from the four settling ponds, which contain polyaromatic hydrocarbons (PAHs) and metal-contaminated sediments. Six aquifers are hydraulically connected via joints and fractures in the basalt rock that underlies the plant. Groundwater flow in all the aquifers is toward the Columbia River.

The shallow groundwater (top three aquifers) underneath the plant is contaminated by nickel, potassium, cyanide, strontium, chloride, iron, manganese, copper, thallium, sodium, calcium, zinc, nitrate, total phenols, fluoride, silver, sulfate, and TOC. The lower three aquifers,

underneath the plant are contaminated by cyanide, fluoride, chloride, iron, manganese, sodium, zinc, nitrate, total phenols, and sulfate. In general, contaminant concentrations are lower in each successive aquifer.

Sediments located within two surface impoundments and four settling ponds on site would be classified as Dangerous or Extremely Dangerous Waste under Washington State regulations if they were dredged. Sediment near the aluminum plant is contaminated with PAHs and heavy metals.

4.17 Recreation

The John Day Reservoir provides a broad range of recreational opportunities, including picnicking, camping, swimming, boating, windsurfing, fishing, and hunting. During the summer months, the reservoir provides a welcome escape from the hot, arid environment. Currently, access is from highways on both sides of the reservoir (SR-14 in Washington and I-84 in Oregon).

There are a total of 15 established river access sites: 12 operating recreation sites, 2 closed recreation sites (Railroad Island, and Rock Creek), and one emergency harbor-of-refuge (Blalock Canyon), located on the John Day Reservoir (see Plate 22). Five sites (Arlington Marina and Earl Snell Park in Arlington, Crow Butte State Park, Boardman Park, Irrigon Park, and Umatilla Marina Park) are leased and managed by public entities from USACE. Nugent Park is owned and operated by the City of Umatilla. The locations, management status, and a summary of facilities at each are summarized in Table 13.

4.17.1 Federal Sites Managed by USACE

Developed USACE recreation sites on the Oregon side of the river include Le Page Park, Philippi Park (on the John Day River arm), and Quesnel Park (Threemile Canyon). Sites on the Washington shore include Roosevelt Park and Plymouth Park. Railroad Island, and Rock Creek, are sites on the Washington side that were officially closed following a directive to USACE in the early 1980s to assess recreation sites and close those not being economically used. However, due to continued public use, USACE has continued to maintain minimal facilities, including portable toilets, mowing, and garbage collection. Blalock Canyon is a harbor-of-refuge on the Oregon side of the river; it is minimally developed and has a gravel boat ramp. The purpose of this site is to provide refuge to boaters during storms.

4.17.2 Federally Owned Sites Leased by Public Entities

Arlington Marina and Park (OR), Crow Butte State Park (WA), Boardman Park (OR), Irrigon Park and Marina, (OR), and Umatilla Marina Park (OR) are located on project lands and are leased and operated by state, city, or local parks departments. USACE constructed most of the facilities at these sites, before leasing them to local entities. Facilities at Irrigon Park were jointly constructed under a recreation cost-sharing contract. See Table 13 for a list of current leases, site manager, contact information, and USACE lease number.

4.17.3 Public, Non-Federal Sites

Nugent Park is owned and operated by the City of Umatilla and is located on the Umatilla River just upstream of the mouth. Most of this site lies outside of the federal project lands boundary. A fishing access structure for people with disabilities lies within project lands;

the city holds a lease for that structure and access. The structure was constructed with funds from the Land and Water Conservation Fund, administered by the National Park Service.

4.17.4 Windsurfing Launch Areas

Windsurfing on the John Day Reservoir has grown significantly in the last 20 years improving the local economy with increased tourism, and an influx of windsurfers moving to the area, buying homes, and opening businesses. The Columbia Gorge Windsurfing Association has approximately 1,000 members and is responsible for creating, maintaining, and improving windsurfing sites throughout the Columbia River area. There are 14 windsurfing sites on the John Day Reservoir and 7 sites below the reservoir. Approximately 600 windsurfers per week utilize the area during the windsurfing season (April to October). Recreation sites that support windsurfing are located in Table 13.

4.17.5 Columbia River Treaty Fishing Access Sites

Some public recreation areas also serve as treaty-fishing access (TFA) sites, which are located adjacent to the public facilities. Tribal members can use the public recreation facilities, but the public is not allowed to use the TFA sites. These sites are the only TFA sites discussed in this report. Discussion on all other TFA sites can be found in the Cultural/Tribal Resources Technical Appendix.

- Railroad Island (North Shore) (WA)
- Le Page Park (OR)
- Roosevelt Park (WA)
- Quesnel Park - (Threemile Canyon) (OR)
- Crow Butte State Park (WA)
- Boardman Park - Faler Road Site (OR)

Future development is planned for separate treaty fishing access facilities at the above sites. An exception is Boardman Park, which will remain a shared-use boat ramp with separate upland facilities developed for tribal use only. The Roosevelt and Faler Road sites were completed in 1999, with the remainder of the development to be completed prior to 2004. Alderdale Park has some public use, but it was designated as a treaty-fishing site on August 27, 1998, so it is not discussed in this report. In addition, Sundale Park sees public use, but upon completion of construction, it will be designated a treaty fishing site, so it was not discussed in this report. See the Cultural and Tribal Resource Technical Appendix for more detailed information on treaty-fishing sites.

Table 13.

Existing Water-Related Recreation Sites and Facilities on the John Day Pool

	Facilities															
Location	**State Location**	**River Mile**	**Boat Ramp**	**Day Use Moorage**	**Long Term Moorage**	**Marina**	**Picnic Tables**	**Swimming**	**Wind Surfing**	**Water Skiing**	**Camping**	**Well Water**	**Public Water Supply**	**Fishing**	**Rest Rooms[c]**	**Management Authority**
Railroad Island	WA	216	X				X			X				X		COE
Le Page Park	OR	217	X	X			X	X		X	X	X		X	X	COE
Philippi Park[a]	OR	JD-3.5		X			X	X	X	X	X	X		X	X	COE
Rock Creek	WA	229	X				X	X		X				X		COE
Blalock Is. Boat Ramp	OR	233	X							X				X		COE
Roosevelt Park	WA	241	X				X	X	X	X		X		X	X	COE
Arlington Marina	OR	241	X	X	X				X	X				X	X	Port of Arlington[d]
Arlington (Earl Snell) Park	OR	241		X			X	X	X				X	X	X	City of Arlington[e]
Quesnel Park	OR	255	X				X		X	X	X			X	X	COE
Crow Butte State Park	WA	262	X	X			X	X	X	X	X	X		X	X	Washington State Parks[f]
Boardman Park	OR	268	X	X	X	X	X	X	X	X	X		X	X	X	Boardman Park & Rec Dist.[g]
Irrigon Park	OR	282	X	X	X	X	X	X	X	X	X		X	X	X	City of Irrigon[h]
Nugent Park[b]	OR	U-.5	X				X						X	X	X	Private - City of Umatilla[i]
Umatilla Marina Park	OR	289	X	X	X	X	X	X		X	X		X	X	X	Port of Umatilla[j]
Plymouth Park	OR	289	X	X			X	X	X	X	X		X	X	X	COE

a. Philippi Park is located on the John Day River at RM 3.5. Access to this site is by boat only.

b. Nugent Park located on the Umatilla River and is a city park.

c. Railroad Island, Rock Creek, and Quesnel Park only have Vault/Portable Toilets.

d. Port of Arlington - Arlington Marina; Francie Morris, Executive Secretary; PO Box 279 Arlington, Oregon 97812; Lease No. DACW57-1-83-0065 expires 8 Dec 2008. The lease area contains approximately 14.13 acres of land and water.

e. City of Arlington - Arlington Park (Earl Snell Park); Fred Ericksen, Mayor - Kay West, Recorder, Tele. # (541) 454-2743. PO Box 68 Arlington, Oregon 97812; Lease No. DACW57-1-79-0122 expires 2 Oct 2003. The lease area contains approximately 12.41 acres of land and water.

f. State of Washington - Crow Butte State Park; Parks and Recreation Commission; 7150 Cleanwater Lane KY -11, Olympia, Washington 98504-2650; Lease No. DACW57-1-78-0106 expires 30 Jun 2003. The lease area contains approximately 727 acres of land and 584 acres of water.

g. Boardman Park and Recreation District; Ted Lieurance Park Ranger - Tele. # (541) 481-7217; PO Box 8 Boardman, Oregon; Oregon Lease No. DACW57-1-75-0046 expires 15 Jan 2000 (new lease currently being negotiated) The lease area contains approximately 88 acres of land and 39 acres of water.

h. Irrigon Park and Recreation Maintenance District; Burl Coolsy, Chairman, Tele. # (541) 922-3211; PO Box E Irrigon, Oregon 97844; Lease No. DACW57-1-79-0005 expires 5 Sep 2028. The lease area contains approximately 35.5 acres of land and water. /// City of Umatilla (Nugent Park); Bonnie Parker, Tele. # (541) 922-3226; PO Box 130 Umatilla, Oregon 97882; Lease No. DACW57-1-86-0063. The lease area contains approximately 1.82 acres of land and water. ///j Umatilla Marina Park - Port of Umatilla; Susan Daggett, Director of Operations, Tele. # (541) 922-3224; PO Box 879 Umatilla, Oregon 97882; Lease No. DACW57-1-94-0008 expires 12 Dec 2018. The lease area contains approximate 60 acres of land and water.///Corps Public Information Pamphlet, Corps 1989; Corps, 1999

4.18 Aquatic Resources

4.18.1 Listed Species of Concern

Salmonid fish species listed under the ESA that would potentially benefit from drawdown at John Day Dam are provided in Table 14. Other ESA-listed salmonid species in the region originating from areas located downstream of John Day Dam are unlikely to directly benefit from drawdown at John Day and were not evaluated during this Phase I Study.

Table 14.
ESA-listed Salmonid Fish Species Potentially Influenced by Drawdown at the John Day Project

Species	ESU[a]	Stock/Race	Listing Status	Date
Chinook Salmon (Oncorhynchus tshawytscha)				
	Snake River	Spring/Summer	Threatened	Apr. 92
	Snake River	Fall	Threatened	Apr. 92
	Upper Columbia	Spring	Endangered	Mar. 99
Steelhead (O. mykiss)				
	Snake River	Summer	Threatened	Aug. 97
	Upper Columbia	Summer	Endangered	Aug. 97
	Middle Columbia	Summer	Threatened	Mar. 99
Sockeye Salmon (O. nerka)				
	Snake River	N/A	Endangered	Nov. 91
Bull Trout (Salvelinus confluentus)				
	Columbia River (DPS)[b]	N/A	Threatened	June 98

a. ESU = Evolutionary Significant Unit
b. DPS = Distinct Population Segment

4.18.2 John Day Habitat Use

Salmonid fishes have adapted life-history strategies and occupied specific habitat features to maximize their production while minimizing competition with other species for resources (niche and guild theory; adaptive management). Life-history adaptations include variations in adult and juvenile run timing, spawning segregation (temporal and spatial), habitat preferences, prey selection, length of freshwater or ocean residence, and/or predator avoidance mechanisms, among others.

The different habitats in John Day Reservoir provide spawning and rearing areas for a number of resident and anadromous fish species. Twenty-one species of resident and anadromous fish have been sampled in the John Day Reservoir from 1983 to 1986. Although fish have been collected throughout the reservoir, densities are higher in the upper reservoir where some resident species show a preference for littoral (i.e., nearshore) habitat. While most juvenile salmon and steelhead simply migrate seaward through the John Day Reservoir, naturally produced fall chinook salmon rear in the upper reservoir's littoral zone (see the Aquatic Resources Section of the Biological/Environmental Technical Appendix, Attachments A and C).

Survival of hatchery fall chinook salmon juveniles passing the John Day Reservoir has been estimated at 83 percent. This estimate includes both reservoir and dam passage survival and may not represent survival rates and productivity for naturally produced fall chinook fry that rear in the reservoir.

4.18.3 Salmonid Life Histories

4.18.3.1 Chinook Salmon (Oncorhynchus tshawytscha)

Chinook salmon are the largest of all Pacific salmon and can weigh over 100 pounds; the average weight is close to 22 pounds. Chinook salmon are an anadromous fish, spending part of their life history in fresh water and part in salt water. Adults spend one to several years in the ocean where they grow and mature before returning to their natal stream to spawn. The eggs are deposited into a nest of clean gravel, referred to as a "redd." Adult salmon die after spawning.

The eggs remain buried in the gravel for 1 to 4 months, depending on stream temperatures. The alevins, or yolk-sac fry, remain in the gravel for 2 to 3 weeks after hatching. After emerging from the gravel, the young salmon can remain in the natal stream for days, months, or several years, depending on the race and stock, before migrating downstream to the ocean.

Adults can be divided into three races. Adults that spawn in the highest reaches of the tributaries enter the Columbia River first and migrate past mainstem dams in spring and are known as spring chinook. The race that spawns in the middle and lower reaches of tributaries generally return past mainstem dams in the summer and are known as summer chinook. Those that spawn in lower tributaries and mainstem rivers and arrive in the fall are known as fall chinook salmon.

Within the three races, chinook salmon have been classified into two life-history strategies. Ocean-type populations (summer and fall chinook) migrate to seawater in their first year of life (subyearlings) and spend most of their oceanic life in coastal waters. Stream-type populations (spring chinook) migrate to sea as yearlings and often make extensive oceanic migrations.

Distribution and Migration Habits

Fall chinook use nearshore littoral habitat in the reservoir for rearing in late spring and early summer. Unlike yearling stocks, fall chinook subyearlings remain most abundant along shoreline stations during outmigration. Recently emerged fall chinook fry drift downstream into John Day Reservoir and rear throughout the shallow, low-velocity areas of the reservoir in April through June.

After reaching approximately 50 millimeters in size, chinook move slightly offshore into faster flowing water and typically establish feeding territories along the river bottom. At night they have a tendency to move back inshore to shallow, quiescent resting locations. Chinook may feed on limnetic species (free-swimming invertebrates in the water column of lake-like environments) when available, but prefer benthic macroinvertebrates (bottom-dwelling insects) drifting in the current. Based on these observations, it appears that most suitable chinook rearing habitat is located in the upstream portion of the reservoir, where river velocities are greater and the substrate is more coarse (less fine sediment) than further downstream in the reservoir.

Rearing, growth, and overwintering of juvenile spring chinook salmon generally occur in headwater tributary streams. Juvenile spring chinook primarily use the John Day Reservoir as a migration corridor. They have a tendency to migrate along the Washington side of the river. The speed of migration through the reservoir is rapid for this stock, and little or no rearing occurs in the reservoir.

4.18.3.2 Steelhead (O. mykiss)

Steelhead exhibit one of the more complex life histories of pacific coast salmonids. There are two distinct life history forms of this species—an anadromous form, "steelhead," and a resident form, "rainbow" trout. The inter-relationship between the two life forms is poorly understood. Currently, only the anadromous steelhead life form is listed under the ESA.

Steelhead typically spend 2 to 3 years in the ocean before returning to their natal stream to spawn. There are two reproductive ecotypes of steelhead—"stream maturing" and "ocean maturing"—commonly called summer and winter steelhead, respectively. The ecotypes are based on their state of sexual maturity at the time of river entry and the duration of their spawning migration. Summer steelhead typically enter freshwater from May-October, requiring several months in the river before spawning. Winter steelhead typically enter fresh water from November to April, spending only a few months in the river before spawning. The two runs are differentiated by the timing of adult returns; however, they frequently share common juvenile life-history behavior patterns. Although both life-history strategies are present in the Columbia River, only summer run fish are influenced by the John Day action.

Steelhead typically spawn between December and June. In general, steelhead differ from spawning chinook and coho salmon by their use of faster, shallower, and higher gradient locations in tributary streams.

Fry emergence usually occurs within 40 to 80 days after spawning. Juvenile steelhead utilize stream margins and submerged rootwads, debris, and logs to provide shelter and cover while rearing in their natal streams. Juvenile steelhead rear in freshwater for 1 or more years before migrating to the ocean. Juvenile downstream migration for steelhead smolts occurs from April through June, with peak migration in general occurring in mid-April. Steelhead are capable of repeat spawning, although the incidence is relatively low. Steelhead will rarely spawn more than twice before dying.

Distribution and Migration Habits

Ninety percent of the steelhead production occurs in hatcheries in the region. The balance of the production occurs in tributary streams. Some minor amount of reservoir rearing may occur during overwintering or if individual fish residualize (i.e., become resident). Steelhead smolts migrate along the middle of the channel and pass through the forebay of John Day Reservoir at, or faster than, the mean water particle travel time, suggesting they do not spend substantial time rearing in the forebay area.

4.18.3.3 Sockeye Salmon (O. *nerka*)

Anadromous sockeye salmon exhibit a variety of life history patterns. They use lakes for juvenile rearing more than other species of salmon do. Anadromous sockeye, regardless of the life-history type, spend 1 to 4 years in the ocean before returning to their natal lake or river system to spawn. There are four major sockeye life history patterns.

- **Lake-type** represent the most common and typical life history form or pattern. They spawn in either inlet or outlet streams of lakes or along lakeshores. The juveniles typically spend 1 to 3 years in lake habitat before migrating to the ocean.
- **River-type** sockeye rear in rivers for 1 to 2 years. They are less common than the lake-dependent sockeye life-history forms, and little is known about them.
- River-type sockeye that migrate as fry to saltwater or lower river estuaries in the same year as emergence are termed **"sea-type"** sockeye.
- The **landlocked** or resident form, called kokanee, spend their entire life in fresh water and do not migrate to the ocean.

Adult sockeye reach lengths of 33 inches and weigh between 3.5 and 8 pounds. They are very accurate in their return to their natal stream, which is believed to help ensure that proper rearing habitats are available for juvenile sockeye. Many adult sockeye make long migrations, requiring higher stored energy reserves. Delays in migration can be very damaging to the success of spawning.

Sockeye spawn on lake shores at outwash fans of tributaries, along beaches where the substrate is free of fine sediment and the eggs are oxygenated by wind-driven water circulation, or in streams with suitable spawning habitat. Sockeye typically select spawning areas that contain upwelling of oxygenated water through sand and gravel substrate. In general, spawning occurs during periods of declining temperatures, incubation occurs throughout the cold winter temperatures, and hatching is associated with rising water temperatures.

After emergence (January to June), juvenile sockeye will migrate to rearing lakes, use river and estuarine habitat for rearing, or migrate directly to the sea. Initially upon emergence, juvenile sockeye exhibit photonegative response, traveling at night. This behavior is believed to be an anti-predator adaptation. Smolt out-migration to the ocean also occurs during darkness, beginning in March and extending through early July.

Distribution and Migration Habits

Although sockeye could conceivably rear in the John Day Reservoirs, the rapid flushing rate, low primary productivity, and lack of abundant zooplankton limit production potential. In addition there are not spawning areas in close proximity to the reservoir. Sockeye smolts migrate quickly through the reservoir at a similar rate to steelhead and spring chinook.

4.18.3.4 Bull Trout (Salvelinus confluentus)

Columbia River bull trout exhibit three life-history patterns.

- **Resident populations** of bull trout confine their migrations to within their natal stream.
- **Fluvial populations** migrate between their natal streams, used for spawning and early juvenile rearing, and large rivers used for adult rearing.
- **Adfluvial populations** migrate between their natal streams, used for spawning and early juvenile rearing, and lakes or reservoirs used for adult rearing. It is believed that

anadromy historically occurred, though it is not currently found in Columbia River bull trout populations.

Spawning in most bull trout populations occurs from August to November during periods of decreasing water temperatures. Spawning sites are characterized by low gradient, shallow water, uniform flow, and a gravel substrate. Spawning often occurs in small headwater reaches fed by cold streams or near other sources of cold groundwater.

Embryos incubate for approximately 100 to 145 days and hatch in late winter or early spring. The alevins remain in the streambed, absorbing the yolk sac, for an additional 65 to 90 days. Emergence from the streambed occurs in late winter/early spring.

Fry are usually found in shallow, slow backwater side channels and eddies. Juveniles are primarily bottom dwellers and are found among coarse substrate. Larger juveniles and adults are often found in deep stream pools or in lakes in deep water.

Distribution and Migration Habits

Bull trout in the mainstem Columbia River are usually associated with tributaries that contain resident populations. They may occur as lake resident adults, exhibit adfluvial life history forms (rearing in lakes and spawning in tributaries to the lake), or simply stray on occasion from upstream tributaries to Columbia River reservoirs.

4.18.4 Hatchery Production

Losses in spawning habitat due to construction and operation of John Day Dam are mitigated with annual hatchery production. The original estimate of loss and mitigation agreement was based on 30,000 fall chinook salmon spawners. At first, the fisheries agencies reared tule fall chinook salmon (a stock of fall chinook salmon reared at the Spring Creek hatchery in Washington) for John Day mitigation. Currently, upriver bright fall chinook are being reared at the Ringgold hatchery and other facilities for release in the Hanford Reach of the mid-Columbia River. This is done to provide an upriver fishery for the tribes. Releases of juvenile fish from the various facilities managed under John Day Reservoir mitigation currently represent approximately 11.9 million smolts annually. These releases are approximately four times greater than the anticipated smolt yield from 30,000 adult fall chinook spawning naturally.

4.18.5 General Habitat Description

The John Day Reservoir was created when the dam was completed in 1968, impounding 76 mile of riverine habitat. The reservoir has a surface area of about 49,400 acres at normal operating pool elevation 265, representing the second largest impoundment on the Columbia River. The reservoir consists of the inundated main channel area plus a number of backwater and wetland areas. These areas provide a diversity of habitats for aquatic organisms that were not available in the original river channel. Altered habitat conditions have favored development of biota preferring shallow and quiescent waters.

The reservoir is relatively flat from the dam upstream to RM 280. The pool elevation rises gradually upstream from this point, creating higher flow velocity conditions.

Twenty-five percent of John Day Reservoir is less than 16 feet deep. The majority of this shallow water habitat is in the upper third of the reservoir, where littoral zone (nearshore,

shallow water) habitat is provided in main channel and backwater areas. Littoral zones can be one of the most productive habitats in aquatic ecosystems, owing to the variety of aquatic macrophytes (large rooted plants) and attached algae that can grow in the shallow waters and the residency of many fish species for at least a part of their life history. Water depths gradually increase downstream, as the riverbanks become more steep-sided and littoral habitat is limited. Depths reach 164 feet near the John Day forebay.

4.18.5.1 Primary and Secondary Trophic Production.

Primary trophic (i.e., food) production in the reservoir is dominated by phytoplankton (i.e., algae suspended in the water column). However, the rate at which the reservoir's water volume changes is relatively rapid, which tends to reduce the production of planktonic organisms in the water column. As a result, the production of zooplankton, microscopic crustaceans suspended in the water column, that feed on phytoplankton is reduced. Zooplankton (the secondary trophic level) provide food for rearing juvenile fishes.

The densities of zooplankton in the John Day reach are generally low. Zooplankton are destroyed by turbulence and contact with suspended material. Zooplankton densities, like phytoplankton, are positively correlated with water retention time. Consequently, zooplankton may not have time to complete their life cycles in the John Day Reservoir. It is interesting to note that zooplankton concentrations were considerably higher at the protected Crow Butte backwater than at stations off the main river channel.

4.18.5.2 Aquatic macrophytes

Growth of aquatic macrophytes (rooted vegetation), primarily water milfoil (Myriophyllum spp.), is seasonally abundant in shallow littoral areas and provides habitat for fish and their prey. Aquatic macrophytes have greatly increased in abundance over the last decade, altering resident fish community structures, and may eventually influence juvenile salmonid rearing in shallow-water habitats of the John Day Reservoir. Aquatic vegetation could play a role in altering shallow water trophic dynamics in some areas of the reservoir by changing water circulation patterns, dissolved oxygen concentrations, acidity (pH), and local water temperatures.

4.18.5.3 Macroinvertebrates

Shallow water habitats have a higher biomass of benthic (i.e., bottom-dwelling) macroinvertebrates (e.g., insects and crustaceans) than deep-water habitats. The majority of the benthic community in the John Day Reservoir consists of burrowing invertebrate forms. These forms are less important as food for rearing juvenile salmonids. Earlier studies indicate the presence of a large number of other invertebrate types in backwater areas that are of more value as food for juvenile salmonids.

4.18.5.4 Water Temperatures

The general effect of mainstem reservoirs on water temperatures has been to delay the occurrence of maximum temperatures in late summer as well as to delay early autumn cooling. The surface waters of the John Day Reservoir during the summer months are warm, peaking around 22°C in August and staying above 20° C into October, annually. Because of the rapid turnover rate of water in the John Day Reservoir, temperatures throughout the pool

are relatively uniform. Bottom temperatures in the reservoir are 0.5 to 0.8C° cooler than surface temperatures. Backwater areas can be 1 or 2C° warmer than the mainstem.

4.18.6 Predation Estimates

In studies of the John Day Reservoir, four resident fish species were found to consume the greatest amount of juvenile salmonids: northern pikeminnow, walleye, smallmouth bass, and channel catfish. The estimated annual smolt loss to predation in the John Day Reservoir for all four species combined was approximately 1.4 million smolts. The northern pikeminnow accounted for approximately 78 percent of the salmonids lost to predation. Walleye and smallmouth bass were less significant predators, consuming an estimated 13 and 9 percent of the total.

The tailrace downstream of McNary Dam is an area of intense predation. However, given the large area and abundance of predators, the mid-reservoir area may account for the greatest volume of predation losses. Of the four predator species studied, only northern pikeminnow included juvenile salmonids as the dominant food item consumed during the spring and summer emigration periods through John Day Reservoir. Loss of juvenile salmonids to predation was concentrated in the tailraces below dams. Estimates of average predator population abundance in the John Day Reservoir are summarized in Table 15.

Table 15:

Average Predator Population Abundance Estimated in the John Day Reservoir

Species	Population
Northern Pikeminnow	85,000
Smallmouth Bass	32,000-38,000
Walleye	15,000

The relative abundance of Northern pikeminnow, largescale suckers, sand rollers, crappies, yellow perch, and walleye was greatest in the upper reach of John Day Reservoir. Most of these fish may favor the upper reservoir due to its slow water velocities and protected conditions provided in backwaters that offer preferred habitat conditions during at least a portion of their life histories.

Smallmouth bass are more prevalent in the lower reservoir along shoreline areas. This species is most common in embayments near the John Day forebay. These embayments provide protected areas and slow water velocities.

4.18.7 Reservoir Passage

Mortality of yearling outmigrants may occur mainly at dams. Conversely, reservoir-related mortalities as a function of predation may equal or exceed dam passage losses for subyearling outmigrants.

Mainstem impoundments can create increased rearing area and provide overwintering habitat for some juvenile anadromous salmonids. They can also affect the outmigration of other anadromous salmonid juveniles by causing extended travel times, residualization and

decreased survival rates. Juveniles, when exposed to extended travel times and increased water temperatures, can residualize and fail to migrate to the ocean that year.

4.18.7.1 Reservoir Survival Rate Estimates

Reservoir survival rates for juvenile migrants may be a function of travel time, if they are primarily related to predation rates. If the primary mechanism responsible for juvenile mortality associated with downstream migration through reservoirs is predation by piscivores (fish-eating fish), then faster migration rates would mean less exposure to predatory fish. It is generally believed that the slower rate of reservoir travel and greater overlap with predators exposes fall chinook stocks to levels of predation than other stocks. Estimates of reservoir travel time and survival rates are summarized in Table 16.

Reservoir-passage mortality for juvenile yearling chinook has been estimated at 5 to 10 percent. Reservoir mortalities for juveniles of all the salmonid species averaged approximately 4 percent.

Table 16.

Average Travel Time and Survival Estimates for Various Salmonid Stocks Passing John Day Dam

Species	Reservoir Travel Time (Days)	Survival from McNary Past John Day (%)
Spring Chinook/1998	3.9	83
Summer Chinook/1998	3.7	87
Fall Chinook/1998	5.1	83
Summer Steelhead/1997	2.3	NA
Summer Steelhead/1998	3.9	100

4.18.7.2 Passage Routes.

Fish passage occurs mainly through the John Day dam either through the juvenile bypass system or turbines, or via the spillway. Other seldom-used passage routes include the John Day Dam navigation lock and the two fish ladders.

4.18.7.3 Transportation of Juvenile Salmonids

Under existing conditions a high portion of juvenile Snake River spring and fall chinook are transported to below Bonneville Dam leaving small fractions of these stocks to pass through the John Day Reservoir. 1998 Survival rates used in the Plan for Analyzing Testable

Hypotheses (PATH) modeling for in-river juvenile emigrants from Lower Granite Dam to Bonneville Dam are 56 percent and 28 percent for spring and fall Snake River chinook salmon, respectively. Survival of transported fish below Bonneville Dam has been estimated at approximately 98 percent. Composite survival rates for both transported and in-river migrants to below Bonneville Dam are shown in Table 17.

Table 17.
Mean Juvenile Migrant Survival Rate Estimates

Management Actions	**Survival Estimates Snake River Stocks**	
	Spring Chinook	**Fall Chinook**
Existing Conditions (including Barging of Juveniles)	81%	78%
Existing Conditions (without Barging of Juveniles)	56%	28%

A variety of important assumptions drove the results obtained from life-cycle modeling. Among these, assumptions regarding "delayed mortality" to transported Snake River chinook salmon and "extra mortality" in the ocean were the most important.

It has been hypothesized that additional post-transportation mortality occurs below Bonneville Dam to juvenile chinook salmon transported from the Snake River. In the life-cycle modeling analysis performed by PATH, a "D-factor" was used to impart additional "delayed mortality" to transported verses non-transported Snake River migrants. Mechanisms responsible for this differential mortality have not been substantiated, and there is disagreement among biologists as to the magnitude of any delayed mortality that may occur. Assumptions regarding the size of this factor greatly affect results concerning the benefits of Snake River and John Day drawdown.

In addition, three alternative hypotheses concerning "extra mortality" occurring in the ocean were formulated and modeled under the PATH analytical approach. One hypothesis postulated that extra mortality in the ocean was attributable to hydrosystem effects in the Snake River. Alternative hypotheses attributed extra mortality in the ocean either to ocean environmental conditions or to reduced "fitness" of Snake River chinook as a result of hatchery program influences. Under these alternative hypotheses, benefits from drawdown would be substantially less than those obtained under the assumption that extra mortality was attributable to hydrosystem effects. In this report, modeling results were used that characterized the maximum potential benefits that could reasonably be derived from drawdown of John Day and Snake River dams. Actual benefits are likely to be less, and could be far less, than those reported here.

4.19 Wildlife Resources

4.19.1 Wildlife Habitats

Five wildlife habitats present in the study area surrounding the John Day Pool were evaluated for the alternative analysis: riparian, emergent wetland, shallow-water, islands, and drawdown/barren. These habitats were selected because of their sensitivity to changes in reservoir operations and water surface elevations, and because they affect a wide variety of wildlife. Table 18 indicates the extent of the habitats in the study area.

Table 18.
Existing Habitats In and Along the John Day Reservoir (From Aerial Photo Interpretation)

Habitat Zones	Approximate Area (acres)
Riparian	571
Emergent Wetland	2,283
Shallow-Water Habitats (ponds, embayments, and tributary backwaters)	8,836[a]
Islands[b]	1,755
Drawdown/Barren	--

a. 8,135 acres are directly connected to the surface water of the Columbia River.

b. This zone includes Crow Butte, which alone totals 1,347 acres.

-- Indicates no significant amount of these habitats is present.

4.19.1.1 Riparian

Riparian habitats are typically adjacent to waterways. Riparian habitats have been broken into three subcategories: hardwood, shrub, and herb.

In the riparian hardwood community, black cottonwood is the dominant tree species, with willow, Russian olive, alder, and hackberry constituting a smaller component. Riparian shrub habitat comprises willows, young hardwoods, false indigo, and other shrubby species. The riparian herb communities are typically found on sand, mud, or gravel bars. They are characterized by low-growing forbs and grasses but are typically dominated by weeds such as mustard, dock, pigweed, and Russian thistle.

4.19.1.2 Emergent Wetland

Emergent wetlands within the project study area are classic marshy areas typified by cattails and bulrushes. These habitats are inundated or saturated with water most of the year, although they may tolerate some drying. Wetlands depend on water depths and seasonal inundation patterns that are directly affected by reservoir operations.

Emergent wetlands usually occupy sites where seepage from upslope or subirrigation maintains wetland plant species. Study area ponds appear to be undergoing natural succession from emergent wetlands to uplands.

4.19.1.3 Shallow-Water Habitats

For the purposes of this evaluation, embayments, adjacent ponds, and tributary backwaters are used to represent shallow-water submergent plant habitats. These habitats can be very productive for aquatic vegetation, and benthic invertebrate populations, as well as the wildlife species dependent on the ecosystem for forage and cover. The productivity of these habitats can be affected by fluctuating pool levels. Aquatic plant beds are evident in some locations, and the relatively gentle topography and extensive shallow areas in the upstream end of the reservoir suggest their presence in this area may be substantial.

Embayments are bodies of water cut off from the main river by highway or railroad causeways or other features, which typically remain connected to the Columbia River by culverts or small channels. They provide unique wildlife benefits, including protected loafing and roosting areas and food resources for waterfowl and other waterbirds. Adjacent ponds encompass bodies of water adjacent to the river; the source of the water in these sites may arise from sub-irrigation and/or drainage from adjoining lands (e.g., irrigated croplands). Tributary backwaters are those areas of tributary streams that are upstream extensions of the reservoir slack water near the mouths of those streams.

There are approximately 17 embayments in the John Day study area. Ponds in the Paterson Unit of the Umatilla National Wildlife Refuge (NWR), and others just downstream of McNary Dam constitute the bulk of the acreage. Slack-water areas of tributaries provide 1,391 acres of backwater habitat, with the John Day River arm and Willow Creek comprising 1,272 acres of the total.

4.19.1.4 Islands

Islands may contain one, several, or all of the habitats described above, and as a result, they tend to support an abundance and diversity of wildlife. Islands are attractive to many species of wildlife because they provide security from mainland predators and are often used for nesting and reproduction. They are a function of water elevations, and any changes in operations may directly affect their habitat profiles and their value to wildlife. There are currently 137 individual islands in the John Day Reservoir, averaging three acres in size, and ranging in size from less than one acre to 85 acres. In addition to these islands, Crow Butte Island occupies an area of 1,347 acres on the reservoir. It is connected to the mainland, however, by a bridge, and does not provide the isolation and protection from terrestrial predators offered by most other islands.

4.19.1.5 Barren/Drawdown

Typically, the substrate of the John Day Reservoir comprises rock, gravel, sand, and silt, with rocky shorelines predominating in many locations. Gravel shorelines are prevalent in the upper John Day Reservoir. Sand and silt deposits are most evident in backwaters, inlets, and embayments and at the mouths of rivers. This habitat type currently occupies a very small portion of the project area.

4.19.2 Wildlife

Wildlife categories include endangered, threatened, and sensitive species; waterfowl; colonial nesting birds; shorebirds; non-game birds; upland game birds; raptors; aquatic furbearers; terrestrial furbearers; big game; and reptiles and amphibians. Existing conditions for each of these groups are described below. A list of wildlife species expected in the John Day Reservoir study area is included as Attachment B in the Wildlife Resources Section of the Biological/Environmental Technical Appendix.

4.19.2.1 Federal Threatened and Endangered Species

One listed threatened species occupies the John Day study area, the bald eagle. There are no known active bald eagle nest sites in Gilliam, Morrow, and Umatilla Counties in Oregon or in Klickitat and Benton Counties in Washington. However, wintering bald eagles are common along the John Day Reservoir study area. These wintering eagles rely heavily on the large concentrations of wintering waterfowl. More than 40 bald eagles may occur in the vicinity of the Umatilla NWR. The bald eagle has recently been proposed for delisting as a threatened species.

The project area may be within the range of other species, e.g., Canada lynx, but the area is not occupied or does not provide potentially suitable habitat for these species.

4.19.2.2 Waterfowl

The Columbia River and its islands provide protected, relatively undisturbed loafing, resting, and roosting habitat for waterfowl. The John Day Reservoir supports one of the most significant concentrations of wintering waterfowl. Backwater areas on the reservoir provide protected areas for wintering waterfowl to escape storms and to roost. Wintering waterfowl also depend on agricultural crops grown in the region, particularly field corn and winter wheat for forage.

A maximum of 131,000 ducks and an estimated 20,500 to 58,400 Canada geese winter on the John Day Reservoir upstream from RM 250. More than 14 species of ducks occur in the John Day Reservoir. Ducks begin arriving in the Umatilla NWR area of the John Day Reservoir in August, and a population of 100,000 ducks can be attained by the end of September. These early-arriving waterfowl appear to focus on aquatic, emergent, and moist-soil vegetation, rather than feeding in fields. Foraging on agricultural fields, however, is prevalent during winter.

Resident, breeding waterfowl numbers are generally low except for Canada geese and for a variety of ducks around the Umatilla NWR. A substantial number of Canada geese nest along the John Day Reservoir. In 1991, 323 nests were identified, the majority located on islands in the Umatilla NWR. Foraging geese use gently sloping shorelines with grass-forb communities. Low water levels increase the distance that geese with broods have to travel to access shoreline forage from open water. This increase in escape distance could have a significant positive bearing on predatory efficiency and a negative effect on the percentage of brood survival.

Waterfowl nesting (for species other than Canada geese) is also centered on the Umatilla NWR. Portions of the John Day Reservoir downstream from RM 250 are unproductive waterfowl habitat due to rocky, steep shorelines and the lack of islands. Upstream from RM

250, gently sloping shorelines with adjacent grass-forb communities are more prevalent and provide appropriate habitat conditions for waterfowl.

4.19.2.3 Colonial Nesting Birds

The colonial nesting bird complex includes herons, gulls, terns, and cormorants. The John Day Reservoir supports more colonial nesting birds than do other downstream reservoirs within the Columbia River system. These species are primarily dependent on fisheries resources associated with the Columbia River; however, amphibians, reptiles, small mammals, and invertebrates may provide important forage resources at times. Scavenging and foraging on agricultural lands also provides forage for gulls. Threemile Island, at RM 256, supports black-crowned night herons, California gulls, ring-billed gulls, and Caspian terns. There are approximately 184 and 4,377 breeding pairs of Caspian terns and California and ring-billed gulls, respectively. Sand Dune Island (RM 274) supports approximately 50 nests each of black-crowned night herons and great blue herons. Herons primarily forage along shorelines, in wetlands, and throughout shallow backwaters.

4.19.2.4 Shorebirds

Killdeer and spotted sandpipers are the primary shorebirds nesting in the John Day study area. They forage along the shoreline mudflats, and nest just upslope from the high pool line. No data are available on the abundance of nesting shorebirds in the John Day study area, but kildeer, sandpipers, and other shorebirds are frequently observed in the area. Black-necked stilts and American avocets took advantage of the short-term drawdown in 1992.

4.19.2.5 Non-game Birds

Several species of non-game birds occur in the vicinity of the John Day Reservoir, including neotropical migratory birds. These are species that breed in the United States or Canada and winter in Mexico, South or Central America, or the Caribbean. Waterfowl and shorebirds are typically not included in this group, even though they may follow this migration regime. Riparian and wetland habitats, as well as the ecotone to upland ecosystems, are important to these species.

Species that forage for insects in the airspace over the pool are present in substantial numbers. These species include cliff swallows, barn swallows, violet-green swallows, common nighthawks, and Vaux's swifts. Riparian forest also provides perch and roost sites for common nighthawks.

Riparian habitats provide important nesting and foraging elements for several species of woodpeckers, flycatchers, chickadees, warblers, kinglets, orioles, grosbeaks, and other neotropical migrants. Marsh habitats are important to several species each of sparrows, warblers, rails, blackbirds, plus marsh wrens and common yellowthroats in addition to other species.

4.19.2.6 Upland Game Birds

Upland game birds are more abundant in the upper reaches of the John Day Reservoir than further downstream. The Umatilla NWR is particularly important to these species. Ring-neck pheasant, California quail, mourning dove, and common are present. Chukar is the

most abundant species along the lower reaches of the John Day Reservoir. This species occurs mainly in upland grass habitats in steep areas associated with cliff and rimrock.

4.19.2.7 Raptors

Most raptor use is associated with upland habitats, wherein their principal prey base would occur. However, riparian forest habitats provide nesting and migration opportunities for some species, including red-tailed hawks, American kestrels, Swainson's hawks, Cooper's hawk, great horned owls, and western screech owls. Northern harriers and short-eared owls nest and forage in grassland, marsh, and wetland communities.

Osprey represents the most abundant nesting raptor whose foraging requirements are directly dependent upon the fisheries resources of the Columbia River.

Golden eagles occur throughout the John Day study area and are primarily associated with cliffs, shrub-steppe, and other upland habitats. Barn owls are found in association with the abundant croplands along the John Day Reservoir.

Peregrine falcons nest and winter along the lower reaches of the study area. Within the Columbia River Basin, this species feeds primarily on rock doves, gulls, and passerines. There are two known nest sites in the cliffs in proximity to the John Day Reservoir study area. More nest sites are suspected, based on the abundance of suitable nesting habitat, but extensive surveys have not been performed. The peregrine falcon has recently been delisted as an endangered species.

4.19.2.8 Aquatic Furbearers

Aquatic furbearers that present in the John Day study area include muskrat, beaver, river otter, and mink. These species are present in low densities. Most furbearers are located upstream from RM 263 as this is more suitable habitat than in downstream locations. Riparian forest, principally cottonwoods, is an important habitat feature for beaver. Muskrats are typically associated with cattail-bulrush marshes.

4.19.2.9 Terrestrial Furbearers

Riparian habitats of the John Day study area support coyote, badger, striped skunk, and raccoon. Coyotes are the most abundant, though they exhibit a preference for the sagebrush habitat. Raccoons are the next most abundant species, most prevalent in riparian habitats. Other species present in the area include opossum, red fox, and bobcat.

4.19.2.10 Big Game

Mule deer are the only species of big game typically observed in habitats immediately adjacent to the John Day Reservoir study area. Bitterbrush, cottonwood/willow, and marsh habitats are all used by mule deer. The islands in the John Day Reservoir, particularly those on the Umatilla NWR, appear to be important fawning areas for this species. Bighorn sheep, elk, and pronghorn are present on uplands immediately south of I-84. However, these species do not appear to be dependent upon the John Day Reservoir.

4.19.2.11 Reptiles and Amphibians

Seven species of amphibians and reptiles are commonly found in association with cottonwood/willow, riparian, and marsh habitats of the John Day Reservoir. The abundance

and availability of potential prey species make the ecotone between marsh and upland habitats important to toads, lizards, and snakes, including Woodhouse's toad, Great Basin spadefoot toad, sagebrush lizard, western yellow-bellied racer, and gopher snake. The introduced bullfrog is also found in the study area.

Other lizards common in other habitats of the project area include Oregon alligator lizard, western skink, short-horned lizard, and side-blotched lizard. Common snakes include striped whipsnake, Oregon rattlesnake, and wandering garter snake. Other amphibians likely to occur in the area include western painted turtle, long-toed salamander, Pacific treefrog, and leopard frog. The western painted turtle is identified as a sensitive (critical) species by the ODFW.

4.19.3 Important Sites

For the purposes of this study, 10 significant wildlife habitat and management areas have been identified within the John Day study area. These are the areas where potential habitat degradation or loss is expected to result from the drawdown and would be the most noticeable and potentially of consequence to wildlife and wildlife habitat. Elsewhere on the reservoir, emergent marsh and riparian habitat generally occurs as small pockets or narrow fringes along the full pool boundary. Rocky, steep shorelines typify much of the project area below RM 254. Table 19 below summarizes these important sites.

Table 19. Important Wildlife and Habitat Management Sites		
Refuge Name	**Location**	**Habitat Types/Refuge Functions**
Willow Creek Wildlife Management Area	Oregon shore at RM 252 to 253 (Plate 23)	This 646-acre embayment and upland complex includes riparian and emergent wetlands. Waterfowl and shorebirds forage on the exposed and vegetated flats. There are 119 acres of emergent wetland and 243 acres of shallow water habitat.
McCredie Islands	RM 254 near Washington shore (Plate 24)	Series of small, rocky islands.
Threemile Island	RM 256 near Oregon shore (Plate 24).	Island supports ring-billed and California gulls, Forster's and Caspian terns, and black-crowned night herons.
Crow Butte	RM262 to 264 near Washington shore (Plate 25).	Emergent wetland and open water habitats are found on both sides of the access road from SR-14 to Crow Butte Island. There are 37 acres of emergent wetland and riparian habitat.
Whitcomb Island	Backwater between Whitcomb Island and the Washington shore (Plate 26).	Shallow water, emergent marsh, and riparian shrub. There are 215 acres of emergent wetland and riparian habitat.
Glade Creek	Mouth of Glade Creek along Washington shore (Plate 27).	Area includes 19 acres of emergent wetland and 12 acres of open shallow water habitat.
Sand, Blalock, Coyote, Long Walk, and Straight Six Islands	RM 273 to 276 (Plate 28).	Vegetation on these islands (total area = 165 acres) includes scrub-shrub and barren sand. Islands provide nesting habitat for a variety of birds including black-crowned night herons.
McCormack Slough	RM 275(Plate 29).	A 494-acre unit of the Umatilla National Wildlife Refuge. It includes 272 acres of emergent wetland and 222 acres of open water.
Paterson Slough	Washington shore between RM 278 and 280 (Plate 30).	A 1,043-acre unit of the Umatilla National Wildlife Refuge. It includes backwater and associated small ponds and lakes, along with 353 acres of emergent marsh, and other open water.
Irrigon Wildlife Management Area	Oregon shore between Irrigon and Umatilla, OR – RM 283 to 289 (Plate 31).	Area includes ponds ringed with emergent marsh transitioning into riparian tree and shrub vegetation. This interspersion of habitat types supports many species of birds, furbearers, and a large population of painted turtles.

4.20 Cultural Resources

Human occupation of the region spans at least the past 12,000 years. Archeological investigations have revealed the presence of prehistoric groups in this portion of the Lower Columbia River valley since the close of the Pleistocene Epoch 10,000 to 12,000 years ago. Most tribal oral traditions speak of being along the river since "time immemorial." Occupation by Native Americans was continuous into historical times and many types of sites; large villages, fishing sites, burial grounds, rock art, sacred sites, among others-are found along the river margins. Early explorers, such as Lewis and Clark, settlers, clergymen,

miners, and railroad workers from many ethnic groups, also left sites along the river, and many sites with historical components are present.

Cultural resource sites within the reservoir have been recorded by archaeologists since the 19th century, but the bulk of investigations commenced with the River Basin Survey projects and archaeological site assessment work. Traditional Cultural Properties recordation is currently being conducted.

Accuracy concerning the total number of cultural resources sites suffers from several problems. Sources suggest that unrecorded sites may be exposed due to ongoing impacts at the operating project. Unresolved problems in site inventory records regarding site identification numbers, descriptions, and precise locations make it unclear whether new sites are emerging or older sites have been altered so much, that they no longer match their original descriptions. Oral histories and place names are only now being gathered, so some Traditional Cultural properties have not been listed.

Though there have been excavations at many sites, few have been formally evaluated for National Register eligibility; one was determined eligible, two have been nominated to the Register and two are listed. The vast remainder of the recorded sites are still potentially eligible for inclusion in the Register.

There is evidence that archaeological sites of both the prehistoric and historic periods are more numerous, generally larger, and more complex, as one descends into the river valley to the former river margins. Therefore, progressively lower drawdowns would potentially expose greater numbers of sites.

4.20.1 Tribal Cultural Resources Perspectives

Tribal perspectives on cultural resources are characterized by a holistic view that treats virtually all elements and features of nature as cultural resources possessing significance for Native American communities. By contrast, federal agencies working under federal law definitions of historic properties with agency archaeologists, engineers, and planners tend to emphasize identification and evaluation of physical sites and artifacts with defined boundaries over traditional cultural properties in management decisions. Although tribes, their elders, and community leaders acknowledge the importance of historic properties, they assert that their definition of cultural resources is much broader with an appropriate focus on traditional cultural properties. Many tribal members have a sense of place and belonging tied to the John Day Reservoir area, having learned their living heritage through participation in fishing, gathering, playing, and participating in religious and social customs within the context of this environment. These and other places of the heart spoken of in oral traditions are remembered by elders and the retelling merges into people's modern lives. The river itself, the salmon, oral traditions, useful plants, and the resting places of ancestors are interconnected in the tribal worldview.

4.20.2 Overview of Area Prehistory

Human occupation of the region spans at least the past 12,000 years. Changes in climate, floral and faunal assemblages, and geologic events have played a significant role in shaping human land use patterns. Although knowledge of the earliest groups is quite limited, the evidence from artifact assemblages throughout the region documents the presence of peoples

initially concentrating on big game hunting and later following a relatively unspecialized hunting and gathering way of life.

Beginning about 8,000 years ago, the archeological record in the Interior Plateau becomes more complex. Subsistence patterns show increasing specialization oriented toward the exploitation of the available natural resource.

Between 5,500 to 3,000 B.C., the presence of fine-flaked, medium-sized, leaf-shaped Cascade points and edge-ground cobbles, along with the first evidence of vegetal food processing, appear. Other traits appearing during this phase are salmon bones, pit house architecture, flexed and extended burials with accompanying grave goods, large lanceolate and triangular knives, polished stone atlatl weights, and a variety of small bone tools.

The next phase, Tucannon, spans 2,500 years between 3,000 and 500 B.C. Characteristic artifacts include triangular contracting-stemmed and corner-notched points, sinker stones, small end and side scrapers, hopper mortar bases, and pestles. Relatively large amounts of river mussel shells and salmonid fish bones are present, along with bones of terrestrial mammals.

The following Harder phase, dated between 500 B.C. and A.D. 1300, is characterized by villages of semi-subterranean earth lodges. Variation in projectile point size indicates the presence of the bow and arrow in addition to the earlier atlatl or spear thrower. Available evidence suggests the continuing importance of salmonids, and the domestic dog first occurs during this phase.

A late prehistoric phase, Piqunin, characterized by small corner-notched and stemmed arrowpoints, composite harpoons, and matting needles and a protohistoric phase, Numipu, span the centuries between 1300 A.D. and historic times. The later phase provides evidence for the horse and abundant indication of Euroamerican contact.

4.20.3 Overview of Ethnology

The ethnographic Plateau culture centered on the exploitation of salmon. Based on a bi-seasonal subsistence-settlement pattern, Native Americans concentrated their villages in linear settlement patterns along the Columbia and Fraser Rivers and their tributaries. The major habitations along the river floodplains were occupied in the summer and winter and nearly abandoned in the spring and fall as the inhabitants moved to upland areas to hunt and gather camas, lily and kous roots. Salmon taken during the summer were stored for winter use.

Linguistic groupings comprised two distinct clusters. Salish speakers inhabited the northern Plateau and were thought to represent a late influx of peoples from the northernmost Plateau. In contrast, Penutian speakers concentrated along the middle and upper Columbia Plateau to the coast and represent a long period of domination in these regions.

By the time Lewis and Clark reached the Plateau, the cultures of the region had been modified by the introduction of the horse; however, the basic patterns persisted. Winter survival depended on stored foods, salmon, and principally roots, which were made into flour. Salmon was filleted, dried, and pounded; roots were baked before being pounded into flour. Both foods were stored in salmon-skin-lined baskets and kept in storage houses or

cache pits. Other stored foods included cakes of parched, pounded sunflower seeds and cakes of dried berries. Hunted game and fowl supplemented these basic foods.

Sociopolitical organization among Plateau cultures consisted of autonomous villages headed by village chiefs. To varying degrees, a social hierarchy existed, comprising wealthy and chiefly individuals, commoners, and slaves. Villages were composed of extended and multifamily groups occupying a single dwelling.

Yearly ceremonials included life cycle rites, first fruits ceremonies, spirit dances, and war dances. Feasting was often associated with these ceremonials, as with weddings and funerals. Religious beliefs centered on vision quests for guardian spirits. Shamans served judicial and curing functions within villages, often exercising more power than village chiefs do.

The introduction of guns and horses increased raiding between groups. Other characteristics such as more centralized political organization among Columbia River groups, increased trade. Takings of slaves appear to result from contact. Introduced diseases greatly reduced the aboriginal populations, while alteration of the environment by mining, farming, and raising stock forced changes in subsistence patterns.

4.20.4 Overview of Area History

Explorations of the region by Euroamericans began with Lewis and Clark's journeys down the Columbia River to the Pacific Ocean in 1805. During the 1820s and 1830s, numerous trapping expeditions explored much of the region and recognized its grazing and agricultural potential.

Methodists established a mission at The Dalles in 1838, and it remained the only permanent community in the region until the mining rushes of the 1860s. The site served as a major Native American trading center and rest stop for early emigrants.

In 1862, gold was discovered at Canyon Creek, a tributary of the John Day River. The discovery brought thousands of prospectors, merchants, and camp followers. The influx of people stimulated road building and this greatly improved transportation in the region. In addition, the military reduced hazards posed by hostile Indian groups, while rising land prices in the Willamette Valley increased the appeal of the region east of the Cascades for stockmen and farmers.

Hostilities between settlers and Native Americans escalated in the late 1850s and 1860s as settlers' demands for farm and range land and miners' search for precious metals increased. In 1855, the Treaty with the Walla Walla, Cayuse, and Umatilla Tribes was signed. The tribes ceded lands, which include the John Day Project areas, while retaining several rights to the ceded lands, such as the "right of taking fish. . . at all other usual and accustomed stations." Through the treaty, the federal government established the Warm Springs and Umatilla reservations. Native American unrest during the 1860s and 1870s slowed growth in the region, but by the 1880s the Native Americans were restricted to the reservations and growth increased.

The open river improvements on the Columbia River done by USACE after 1867 facilitated the transportation of goods and people by steamboats. The completion of the railroad line

along the south bank of the Columbia in 1882 finally opened the region for agricultural development and settlers poured in.

During the 1870s and 1880s, the open range cattle business dominated the region's agricultural economy. By the late 1880s, competition between sheepmen and cattlemen and the influx of farmers hastened the end of the open range cattle enterprise. The 1890s were marked by peak wool production; however, overgrazing and reduced range allotments led to a decline in the sheep industry after 1900. Additionally, in the late nineteenth and early twentieth centuries, the fish canning industry flourished in The Dalles area.

Dry land wheat production replaced stock raising. Between 1910 and 1920, irrigation brought new lands into cultivation and regional growth continued. From the late 1890s to the 1920s, many new towns and post offices sprang up; however, some did not last, as the agricultural limit of the land was reached. Modern mechanized farming and extensive irrigation developments along the margins of the Columbia River. The latter, expedited by the construction of reservoirs such as John Day Dam, have increased the region's agricultural potential. Native American fishermen continue to exercise treaty fishing rights in the area (Figure 5).

4.20.5 Existing Cultural Resources

Approximately 254 cultural resources sites have been recorded at John Day Reservoir. Most are prehistoric sites, ranging in size and complexity from stratified, multicomponent, village sites to rock art sites. The present pool inundates over 70 archaeological sites. Sites are currently being adversely affected by erosion and looting.

Site data, taken from excavations, field surveys, and data gathering, are lacking on precise locations, elevations, character, densities, and depths of deposit for a great number of sites. Even the exact number of sites is uncertain, as some sites may have received more than one site number, some have been split, and others combined. Many sites are known only from older data descriptions. Site loss from slumping in shoreline areas may be as high as one meter of lateral movement in a year.

Early cultural resources investigators noted that some dense site clusters were practically one large site. They represent a palimpsest, an area where an original site occupation has lain cultural deposits down over a broad area. This in turn, is obscured by subsequent natural and cultural disturbances, and is overlapped and overlaid by successive occupations. This situation makes it difficult to distinguish discrete occupations or activities, and label, quantify, or interpret sites. This appears to be the case in some areas along the former river margins of the John Day Reservoir. Predictive modeling, under the conditions listed above, is not a reliable planning tool.

4.20.6 Native American Tribes

Native American losses in the region of the Columbia River were extensive and compounding after the construction of the Columbia River Locks and Dams. Their losses involved social and cultural values and included some of the remaining, permanently and intermittently occupied settlements; sophisticated fishing procurement and preservation methods; and places where ceremonial traditions were practiced. The relationship of lost opportunities and the construction of dams and locks on the Columbia River are complex.

The losses accrued with the construction of the Columbia River locks and dams, came in addition to the consequences from contact with Euro-Americans, not quite a century ago. Lost opportunities began with Euro-American occupation and settlement of the Columbia River shoreline. It was further reduced by treaties of the mid-1800's, that reduced access to the Columbia River shoreline and it fishing sites. Fishing opportunities decreased with the construction of the Columbia River projects. Flooding by the pools behind the dams reduced fish populations and fish habitat. In order to mitigate for the extensive losses that the Native Americans endured as a result of the construction of the Columbia River System, Congress passed Public Law 100-581 (Title IV). The law directed USACE to provide access to usual and accustomed fishing facilities for members of the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of Warm Springs Reservation of Oregon and the Confederated Tribes and Bands of the Yakima Indian Nation. Other tribes (federally recognized and not) that are more removed from the Columbia River are within the Federal Columbia River Power System. USACE has constructed 13 Treaty Fishing Access sites on the John Day Reservoir in response to this law. These are identified in Table 20.

Table 20.
Tribes and Treaties

Present Tribal Organization	Treaty	Signing Date
Yakama Nation	Treaty with the Yakama Tribes	June 8, 1855
Confederated Tribes of the Umatilla Indian Reservation	Treaty with the Umatilla Tribes	June 9, 1855
Nez Perce Tribe	Treaty with the Nez Perce Tribe	June 11, 1855
Confederated Tribes of the Warm Springs Reservation of Oregon	Treaty with the Tribes of Middle Oregon	June 25, 1855

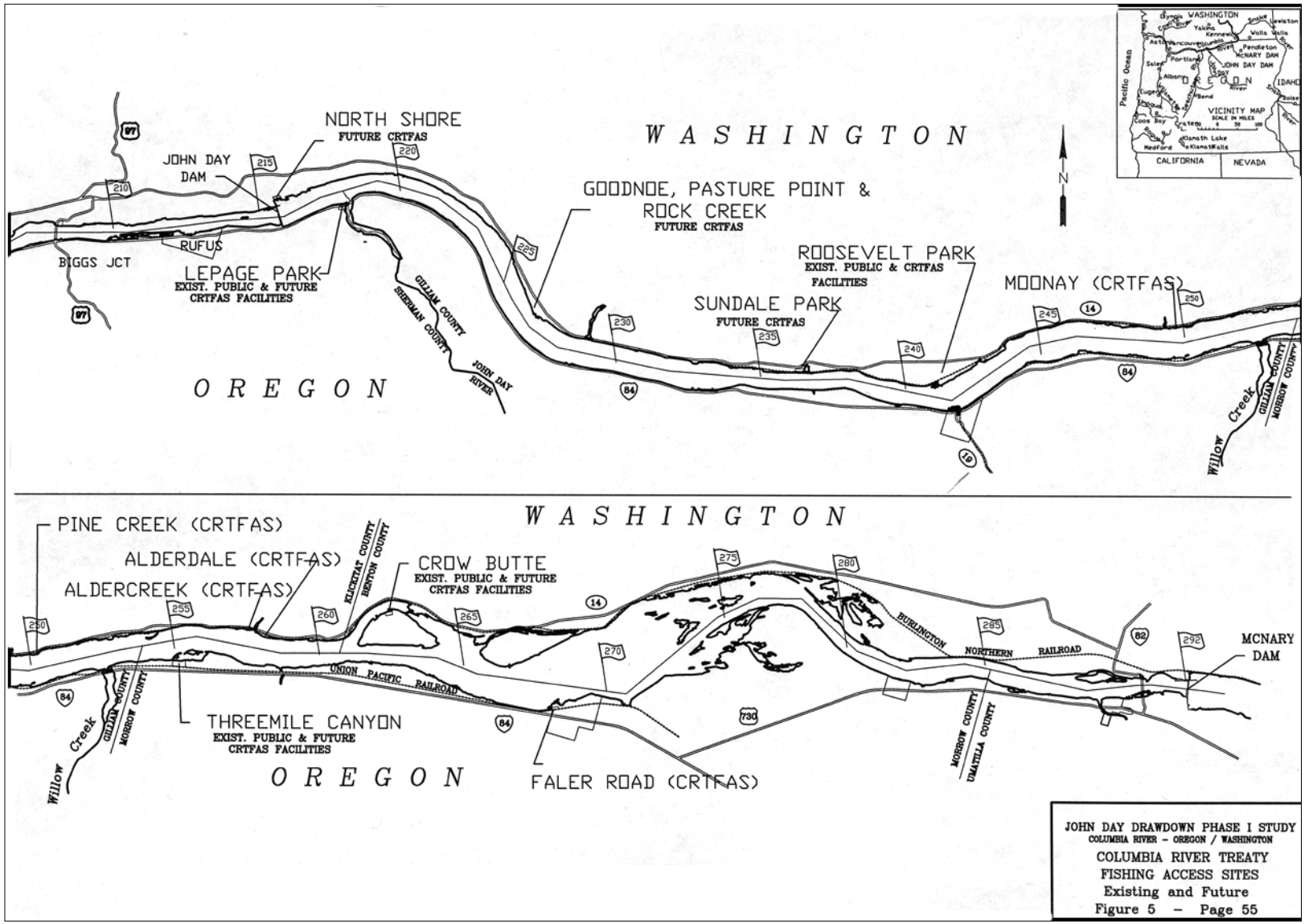

Figure 5. Treaty Access Sites

Section 5. Drawdown Alternatives

The objective from Drawdown, as discussed in Section 2, is to increase the survival rate of anadromous smolts through the 76-mile John Day Reservoir. NMFS, as part of the FCRPS BiOp recommended the drawdown of the reservoir to either spillway level (elevation 215) or a natural channel (elevation 165). The baseline condition and four alternatives that were evaluated for this Phase I Study are as follows:

5.1 Baseline Condition

The baseline condition is the existing condition that will prevail in the future in the absence of any new Federal action at John Day Dam. The project will incur no structural modifications and will be operated under current authorized "with flood control" conditions. This condition was used as a basis to evaluate the four drawdown alternatives described below.

5.2 Spillway Drawdown without Flood Control (Alternative 1)

The first drawdown alternative is based on requirements for improved downstream fish passage conditions during both low and flood flow conditions on the Columbia River. The existing 20-bay spillway will be operated differently from current operations, but without any structural modifications. All project inflows will be directly passed through the dam spillway with the spillway gates fully opened in free overflow condition, resulting in a pool elevation that will vary from elevation 217 to 230. Impacts downstream from John Day Dam were not studied.

5.3 Spillway Drawdown with Flood Control (Alternative 2)

The second study alternative is based on requirements for improved downstream fish passage conditions during low flow periods, while maintaining authorized flood control for the John Day Project. The existing 20-bay spillway will be operated differently from current operations, but without any structural modifications. During low flow periods, project inflows will be directly passed through the dam spillway with the spillway gates set in fully open, free overflow condition. During a flood event, however, the spillway gates will be controlled to reduce downstream flood flows based on using 500,000 acre-feet of allocated project storage space. Ponding will occur upstream from the dam. Impacts downstream from John Day Dam were not studied.

5.4 Natural River Drawdown without Flood Control (Alternative 3)

The third study alternative is based on a natural river drawdown for fish passage "without flood control" condition. Natural river conditions pertain to an opening at the John Day Dam that permits acceptable upstream fish passage conditions. The size of the total dam opening must conform to two criteria based on an invert elevation at the dam of 135. The first criterion is that the opening must be sufficiently large to meet maximum allowable stream velocity criteria for sustained swim speed for the weakest salmon species, which is estimated to be 10 feet per second (fps). The second criterion is that fish passage for this opening must correspond to the 10-year annual flood peak (515,000 cfs). This alternative will require extensive modifications to John Day Dam even beyond modification of the 1,228-foot long spillway structure. Impacts downstream from John Day Dam were not studied.

5.5 Natural River Drawdown with Flood Control (Alternative 4)

This fourth study alternative is based on natural river conditions for fish passage and includes the "with flood control" condition. It requires natural fish passage conditions for both upstream and downstream directions at the dam and includes a requirement for full authorized flood control. The calculated width of the total dam opening will correspond to that previously calculated for natural river conditions without flood control (Alternative 3). Impacts downstream from John Day Dam were not studied.

Section 6. Project Objectives and Constraints

6.1 Project Objectives

It has been proposed that drawdown of the 76-mile John Day Reservoir may provide substantial improvements in migration and rearing conditions for juveniles by increasing river velocity, reducing water temperature and dissolved gas, and restoring riverine habitat. Drawdown may improve spawning conditions for adult fall chinook by restoring spawning habitat and the natural flow regimes needed for successful incubation and emergence.

The regional goals for a drawdown of John Day Reservoir, as identified in NMFS's draft Recovery Plan for Snake River salmon, the Tribal Restoration Plan, and the Northwest Power Planning Council's Fish and Wildlife Program are to:

- Improve migration and rearing conditions for juvenile spring, summer, and fall chinook, sockeye, and steelhead
- Reduce water temperature and total dissolved gas to comply with Clean Water Act criteria and standards
- Improve spawning conditions for fall chinook

Given the regional goals stated above, the objectives of the Phase I Study are to:

1. Evaluate the potential of a John Day drawdown to protect, mitigate, and enhance fish and wildlife populations and habitat of the Columbia River and its tributaries, particularly anadromous fish; and, in addition, evaluate how drawdown might contribute to an increase in harvestable numbers of anadromous fish.
2. Evaluate the social and economic benefits and costs of a John Day drawdown to either spillway crest or natural river level. A preliminary evaluation will be done during the Phase I Study based on direct economic costs and on available information concerning the survival of anadramous fish. If the Phase I Study results in a decision to reduce the number of alternatives, the cost and time required to complete Phase II may be significantly reduced.
3. Provide needed input to USACE's ongoing Lower Snake River drawdown study, scheduled for completion in December 1999.
4. Develop information that may be used to determine whether it is appropriate to continue further studies to draw down the John Day Reservoir.

This Phase I Study was developed primarily from existing documents and from information being developed as part of the Lower Snake River drawdown study, currently in the feasibility phase.

If this Phase I Study results in a recommendation that USACE proceed to Phase II, the Phase II feasibility study will include a Coordination Act Report pursuant to the Fish and Wildlife Coordination Act and Environmental Impact Statement pursuant to the National Environmental Policy Act of 1969, Public Law 91-190. The Phase II scoping document would describe the scope of the engineering, biological, and economic analyses that would be required, at a detailed feasibility level, to fully evaluate the benefits and negative impacts (including cost) of lowering the reservoir.

6.2 Project Assumptions and Constraints

The purpose of this section is to state the assumptions, constraints, and criteria used to develop and evaluate the drawdown under all four of the alternatives. The assumptions discussed pertain to the hydraulic, structural, fish physiology, and wildlife portion of the study since all other aspects of the study are based on these fundamental components.

6.2.1 Hydraulics

The hydraulic assumptions state the water levels and flows used as constraints in developing the concept designs for the structural features at the John Day Project. The flows and water levels are divided into two types, maximum design and operating. The maximum design values are those used in designing the structure and in assessing its stability and the forces acting on it. The operating values are those for which the structure is designed to operate and perform its intended purpose. These can be both minimum and maximum values.

The following are the design flows for which the structures are designed.

Maximum Design Flows (cfs):	
Standard Project Flood	1,060,000 cfs
Spillway Design Flood	2,250,000 cfs
Operating Flows (cfs):	
Maximum for Fish Passage (10-Year Flood)	515,000 cfs
Minimum for Fish Passage	80,000 cfs
Maximum for Navigation	800,000 cfs
Minimum for Navigation	80,000 cfs

The current configuration of the flow management system in the Columbia River Basin was basically completed after the 1960s. Since that time, only three flood events have exceeded the 10-year level of 515,000 cfs. The duration of flows above this level lasted for approximately two weeks in June 1974, and for approximately one week in May and three weeks during late May through mid-June in 1997. Based on these events, adult fish passage under all four John Day drawdown alternatives would have been disrupted for from one to three weeks during May and June. Such delays would have a 10 percent probability of occurrence each year, on average.

6.2.1.1 Operating Water Levels

The operating tailwater levels at both John Day and McNary Dams were taken from backwater hydraulic analyses being performed in support of the Phase I drawdown study. The water levels upstream from the dam were derived from the same backwater analyses for the drawdown to natural river level.

For the purposes of this study, fish passage will be provided for upstream and downstream passage for the full year. Passage will also be provided all year during construction except that passage may be suspended during the in-water work period from December 1 through February 28.

The operating water levels for fish passage are shown in Table 21, and those for navigation are shown in Table 22.

Table 21.
Fish Passage Design Operating Water Elevation

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Maximum				
John Day Tailwater[a]	169	169	169	169
John Day Pool (Headwater)[b]	230	252	--	223
McNary Tailwater	270	270	270	270
Minimum				
John Day Tailwater	155	155	155	155
John Day Pool (Headwater)	213	213	--	--
McNary Tailwater[c]	251	251	251	251

a. Assumes a flow of 515,000 cfs and a water surface at The Dalles of 160 ft.

b. Elevation 230 is based on 10 units operating.

c. The tailwater elevations are the same for all alternatives for flows less than 600,000 cfs as verified by backwater modeling.

Table 22.
Navigation Operating Water Elevation

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
John Day, Minimum Tailwater	155	155	155	155
John Day, Minimum Operating Pool	213	213	155 (1)	155 (1)
John Day, Maximum Operating Tailwater	175	175	175	175
John Day, Maximum Operating Pool	230	252	177 (1)	223

Note: In Alternatives 3 and 4, there is no operating water surface for these values. Those shown are for natural river conditions.

6.2.2 Fish Criteria Upstream Passage

This subsection deals with biological and fish behavior characteristics of the target species, both juvenile and adult, at the John Day Project. The assumptions stated below deal with seasonality of passage at John Day Reservoir, swimming speeds, and project operational criteria.

6.2.2.1 Upstream Fish Passage Criteria

A dam breach/removal is only necessary for Alternatives 3 and 4. To set the minimum size of the breach width required to pass upstream migrants, a flow velocity of 10 fps was selected. Although this is faster than a fish can swim through the length of breach, it is expected that the boundary layer on the floor and walls of the breach would provide suitable velocities for passage.

6.2.2.2 Seasonal Timing

Both the adult and juvenile fish migration were taken from the John Day Dam section of the *Fish Passage Plan for Corps of Engineers Projects* (March 1998). The migration periods for juveniles and adults are summarized in Table 23 and Table 24 respectively.

Table 23.
Juvenile Passage Timing

Species	Migration Period
Yearling Chinook	4/20-6/18
Subyearling Chinook	5/1-8/19
Steelhead (hatchery and wild combined)	4/23-6/1
Coho	4/27-6/9
Sockeye	5/3-6/21

Table 24.
Adult Migration Timing

Species	Migration Period
Spring Chinook	4/17 - 5/22
Summer Chinook	6/7 - 8/2
Fall Chinook	9/2-9/25
Steelhead	9/6-10/6
Sockeye	6/23-7/10
Coho	8/4-10/15

6.2.2.3 Swimming Speed

Swimming speed values for juveniles and adults were obtained from the *Fisheries Handbook of Engineering Requirements and Biological Criteria* (1991). Three aspects of swimming speed are considered in the criteria for design of fish facilities. They are:

- Cruising - a speed that can be maintained for long periods of time (hours)
- Sustained - a speed that can be maintained for minutes
- Darting - a single effort burst of speed that is not sustainable

The assumed design criteria for juvenile and adult swimming speeds are listed in Table 25 and Table 26, respectively. Because the sustained speed for juveniles is the most applicable swimming speed for fish traveling through the project after drawdown, the sustained speeds for the affected species were assembled. These values provide the basis for the facility

design criteria. However, other factors affect swimming performance including water temperature. Water temperature or other effects on swimming performance throughout the migration season should be considered during a Phase II Study if the John Day Drawdown Project is considered further.

Table 25.
Juvenile Swimming Speeds

Species	Sustainted Speed (fps)
Chinook (2")	0.5-1.2
Chinook (>2")	1.0-2.1
Coho (2")	0.5 - 1.2
Coho (>2")	1.0 - 2.1
Sockeye (5")	1.8 - 2.2
Steelhead	1.8-2.2

Table 26.
Adult Swimming Speeds

Species	Speed (fps)		
	Cruising	Sustained	Darting
Chinook	0 - 4	4 - 11	11 - 22
Coho	0 - 4	4 - 11	11 - 21.5
Sockeye	0 - 4	4 - 11	11 - 22
Steelhead (2' - 2.7')	0 - 5	5 - 14	27

6.2.3 Project Feature Design

For conceptual design of structures considered in the drawdown study, general structural computations and construction staging were required. To be consistent with USACE design criteria and other structures at the John Day and McNary Projects, the following consistent criteria and assumptions were used in this study. A detailed description of the design criteria is presented in the *Feature Design Memorandum No. 52, John Day Lock and Dam Surface Bypass Spillway*.

6.2.3.1 Powerhouse

There are no low-level outlets below the spillway crest other than the turbine passages through the powerhouse. For the natural river option, power generation is not possible.

6.2.3.2 Navigation Lock

The navigation lock will require modifications with all of the alternatives. The following assumptions are based on *John Day Design Memorandum No. 16*, general knowledge, and inquiries to barge-operating companies. River traffic will pass the John Day Project during flood control operations. The impact to lock traffic will be kept to a minimum during drawdown. For all alternatives, the navigation lock, approach, and exit channels were designed with the minimum criteria of 5 fps maximum channel velocity, 15-foot minimum channel depth, and 80 feet minimum channel width.

6.2.3.3 Embankment Protection

It is expected that it will be necessary to place riprap in some areas of the drawdown zone along the reservoir to minimize erosion and undermining of railway lines, highways, and other infrastructure. Placement is anticipated to occur where such facilities are situated next to the John Day Reservoir.

6.2.4 Dredging

Under drawdown to natural river level (Alternatives 3 and 4), dredging of tributaries (i.e., Willow and Rock Creeks and Umatilla Rivers) would be necessary. The Tributary Sedimentation Evaluation Appendix provides a detailed assessment of the tributary dredging requirements.

6.2.5 Construction

The construction constraints placed on the alternatives are as follows:

- Construction work in the water is allowed only between December 1 and March 1. Construction behind cofferdams is not in-water work, and therefore is not subject to this requirement.
- In the spring and early summer, if water is available, more flow is released into the river from upstream storage and sent over the spillways. This restricts work on and near the spillways. The spill period typically extends from April 1 to Aug 31.
- In terms of construction sequencing, navigation is to be provided through the project at all times, to the extent practicable.

Land access to the project for some construction is limited. It is probable that much of the construction will be staged from barges and that transportation of materials to and from the site will be by barge.

6.2.6 McNary

McNary Dam was in operation prior to construction of the John Day Project. There were minor modifications to McNary during the construction of John Day that require attention if John Day is drawn down. For all four drawdown alternatives under consideration, the tailwater is assumed to behave as it did prior to the John Day Project. The design flows at the McNary Dam are 80,000 cfs minimum and 515,000 cfs maximum. The respective tailwater elevations are 251 and 270.

6.2.7 Wildlife

The assumptions and constraints relating to wildlife are identified below.

- The extent of habitat impacts is based on the operation of John Day Reservoir at elevations below those currently experienced during the period of May through August. Further, it is assumed that the pool elevation will not be adjusted higher for mitigation for other concerns (e.g., irrigation withdrawal).
- Development of plant communities are assumed to be directly related to forebay elevations.

- Acreage for shallow-water, wetland, and riparian habitats were derived from hydrographic surveys of pool areas upstream from RM 257.8. The topography of lands downstream is typically steep and rocky, and therefore provides minimal potential to support these types of habitats.
- For analytical purposes, it was assumed that 2,283 acres out of the total 2,854 acres, or 80 percent, of emergent marsh/riparian habitat are emergent marsh and the balance of 571 acres is riparian habitat. Furthermore, an estimated 1,009 acres of emergent marsh/riparian habitat occur between elevation 263 and 268 (i.e., within the reservoir), while 1,845 acres of this habitat occur above elevation 268.
- It is assumed that irrigation water will continue to be provided, and no change in wildlife carrying capacity on irrigated farmland is anticipated.
- No significant change to upland areas adjacent to the reservoir is anticipated.
- It is assumed that the currently submerged soils will retain the capacity to support vegetation after a drawdown of the reservoir. However, both noxious weeds and other weeds will compete with native species when establishing vegetative cover.
- Areas between maximum pool and a given year's high water level will generally be captured in increased upland/riparian/wetland acreage. Exceptions may occur, however, particularly where steep, rocky slopes or cliffs are exposed.
- USACE planning guidance policy, as outlined in ER 1105-2-100, 28 December 90, would be used in determining mitigation requirements and for establishing the level of replacement for lost wildlife refuge area.

SECTION 7. Impacts of Drawdown Alternatives on Project Resources

7.1 Project Features

The preliminary evaluation of the structural components defined both the prior modifications and operational requirements at John Day Lock and Dam and at McNary Dam for each of the four drawdown alternatives. Various design modifications are required under each of the four alternatives. These include modifications to the following facilities at the dam and adjacent to the reservoir:

- Adult fish passage facilities at both John Day and McNary Dams
- Hydropower facilities and powerhouse
- Spillway
- Navigation lock
- Newly constructed fish monitoring facility
- Roads, railroads, bridge piers, slopes, structures, and similar infrastructure

7.1.1 Alternative 1 -- Drawdown to Spillway Crest without Flood Control

In this alternative, the gates will be raised and the river will flow uncontrolled over the existing spillway. Modifications are required at several project features due to the lower reservoir level (approximately 30 feet). These include:

- Fish Ladders - Both north and south shore fish ladders will be rebuilt with a vertical slot fishway and two exits to accommodate the wider range in forebay water levels. New pump motors will be required for the auxiliary water supply on the south shore.
- Juvenile Bypass Systems - It is envisioned that new fish collection conduits will be bored in the dam. New extended length bar screens will also be required. Outside the dam, the transportation channel, dewatering structure, fish evaluation facilities, and outfall will all be rebuilt at a lower elevation, as necessary.
- Navigation Lock - The upstream sill on the navigation lock will be lowered and a new gate will be installed. New lock fill intakes with fish exclusion screens will also be built.
- Hydroturbines - New auxiliary systems will be required, but the existing turbines could be used after drawdown for reduced power generation. Also, restorations of existing synchronous condensing operations will require replacement somewhere in the transmission system.

This alternative would require eight years to plan and design and about 5-1/2 years to construct.

7.1.2 Alternative 2 - Drawdown to Spillway Crest with Flood Control

In this alternative, the gates will be raised and the river will flow uncontrolled over the existing spillway. However, the gates will be lowered for flood control operations about once every two to five years to provide up to 500,000 acre-feet of storage. Alterations are required at several project features due to the lower fluctuating reservoir level. These include:

- Fish Ladders - Both north and south shore fish ladders will be rebuilt with vertical slot fishways with four exits. The two lower exits will operate similarly to those in Alternative 1. The two upper ones will accommodate the higher forebay water levels during flood control operations. New pump motors will be required for the auxiliary water supply on the south shore.
- Juvenile Bypass Systems - It is envisioned that new fish collection conduits will be bored into the dam similar to those in Alternative 1. However, new orifices will be required between the gate well and fish collection conduit. Outside the dam, the transportation channel, dewatering structure, fish evaluation facilities, and outfall will all be rebuilt at a lower elevation. These will have higher sidewalls to contain the greater fluctuation in forebay water elevations.
- Navigation Lock - The navigation lock modifications will be the same as those for Alternative 1.
- Hydroturbines - The hydroturbines modifications are the same as alternative 1.

This alternative would require eight years to plan and design and about six years to construct.

7.1.3 Alternative 3 - Drawdown to Natural River Level without Flood Control

In this alternative, the river will be drawn down to approximate natural river conditions. Fish passage and navigation will be accomplished through the breach in the dam. The criterion used to design this alternative was to provide an average velocity of 10 fps or less through the opening in the dam during the 10-year flood. The size of the opening was calculated using a backwater model by adjusting the opening width until the required velocity was achieved. Modifications to the structure include:

- Structural Removal - This alternative consists of the removal of the entire existing 1,228 ft long spillway, the 37 ft long non-overflow section, and 996 ft of the powerhouse section, for a total length of 2,261 ft. The spillway concrete would be removed down to elevation 135, and the powerhouse and non-overflow sections would be removed down to elevation 128. Cutting down the spillway below 135 provides little hydraulic advantage. The voids in the powerhouse below elevation 128 would be filled in to achieve a uniformly sloping channel.
- Navigation Lock - River traffic was assumed to operate in water velocities of up to five ft per second. For the breach width considered for this alternative, navigation is possible through the breach in flows of about 400,000 cfs and below for water elevation of 160 ft at The Dalles. This occurs about 97% of the time. For flows over 400,000 cfs, river

traffic should transit the breach through the navigation lock. The lock would operate without the existing filling and emptying system. The lock would be modified for this alternative by removing the upstream sill to elevation 140 and installing a new upstream lock gate. A miter type gate about 65 ft tall would be installed with fill valves installed in the bottom of the gates. Upstream traffic would enter the lock channel with the upstream lock gate closed. After closing the downstream lock gate the upstream filling valve located in the bottom of the upstream gate would open, filling the lock. The upstream lock gate would then open and traffic would travel upstream in the navigation channel.

- Hydroturbine - Units will be removed by demolition of the powerhouse or taken out of service. Synchronous condensing operations will require replacement at another location on the transmission grid.

It is envisioned that the dam will be removed in two construction stages, as described below.

- Stage 1 - During Stage 1 construction, a cofferdam will be constructed around the center of the dam. An embankment cofferdam will be built upstream because the water is too deep to allow use of a cellular sheetpile cofferdam, which would be employed downstream. Inside the cofferdam, Spillway Bays 14 through 20, the non-overflow section, and powerhouse Units 10 through 20 will be removed. The spillway will be removed down to elevation 135, and the powerhouse units down to elevation 128. The draft tubes will be filled with concrete up to elevation 128. Fish passage baffles will then be built in the area of Unit 17. These baffles will provide upstream passage through the opening in the dam during Stage 2 construction. The reservoir will then be drawn down to free-flowing conditions.
- Stage 2 - The Stage 2 cofferdam will be built to encircle the northern portion of the spillway. This cofferdam will be cellular sheetpile. The remainder of the spillway will be removed to elevation 135. At the same time, a sheetpile cell will be built in the upstream navigation channel to dewater the upstream portion of the navigation lock. The upstream sill will be lowered to the floor of the lock, and a new upstream lock gate will be installed. Lock filling and emptying valves will be incorporated in the bottom of the two lock gates.

  No modifications of the fish ladders will be required since fish will pass upstream through the breach. The remainder of the powerhouse and the Juvenile Bypass System will be abandoned.

Studies and design for the drawdown will take about eight years to complete, and construction will take 4-1/2 years.

7.1.4 Alternative 4 - Drawdown to Natural River Level with Flood Control

In this alternative, part of the dam will be removed and the reservoir drawn down to approximate natural river conditions, and a gate structure would be added to regulate flow for flood control. This entails providing gates on a spillway with a crest near natural riverbed elevation. These gates would be raised during normal operation, and the river would run uncontrolled. When the flow at the flood control point at Vancouver is reached, the gates

would be lowered to achieve up to 500,000 acre-ft of flood control storage at the John Day Project. The modification or replacement of project features are described below.

- Structural Modification - This alternative consists of the removal of Spillway Bays 8 through 20, which is 794 ft long, the 37 foot long non-overflow section, units 10 through 20, 996 ft of the powerhouse section, for a total length of 1,827 ft. The spillway concrete would be removed down to elevation 125 and new concrete will be placed up to elevation 135.0. The spillway stilling basin would be retained. The powerhouse section would be removed down to elevation 128. The voids below elevation 128 that are formed by the powerhouse intake would be filled in with concrete and built up to elevation 135 with structural concrete. An energy dissipater would be constructed downstream of the new spillway on the downstream end of the powerhouse and tailrace fill.
- Spillway - The new spillway will consist of 29 bays with 12-foot wide piers to support new spillway gates. Each bay would be 50 ft wide and would be equipped with triple leaf fixed wheel gates that could be fully or partially closed to provide the 500,000-acre feet of flood storage. During normal operation of the project, the gates will be in the up position with all leaves fully raised. The gates will be lowered into position during a flood event to provide up to 500,000-acre feet of flood storage up to reservoir elevation 223. During normal operation, the three gates will be in the up position with the bottom of the gates above the maximum water surface elevation of 205 during the PMF. When closed for flood storage, the top of the gates will be at elevation 228, or 5 ft above the anticipated maximum water surface elevation for the required flood storage of 500,000-acre feet. Two 5-foot high stoplogs will have to be installed below the gates in Spillway Bays 20 through 29 to accomplish this.
- Upstream Fish Passage - Upstream fish passage for this alternative, during non-storage, would be through the breach in the dam similar to alternative 3. During flood control operations upstream fish passage through the breech is impacted. Thus a new fish ladder on the north shore would be constructed and would be a variable length, vertical slot fish ladder to provide upstream passage for forebay elevations between 176 ft and 222 ft. Five sections of 10 pools, 20 pools, 30 pools, 40 pools and 50 pool would be used depending on the forebay and tailwater elevations.
- Downstream Fish Passage - Downstream passage is provided through the gated breach. No JBS facilities are proposed due to the intermittent and short duration of the storage conditions.
- Navigation Lock - It is envisioned that a new navigation lock would be built through the embankment north of the existing lock. The existing navigation lock would not be modified because to do so would stop navigation for more than one year because of the extensive coffer damming requirements. Building a new lock would curtail navigation for less than a month while the downstream approach channel to the new lock is connected to the existing channel. The new lock would be similar to the existing one, except that the upstream sill would be at elevation 140. A new 105-foot high miter gate would be installed on the upstream sill. A shallow screened intake would be constructed

for lock filling flows. A new channel extending from the lock to the existing upstream channel would be dredged to an elevation of 140.

All river traffic will travel through the navigation lock under this alternative because the spillway bay gate openings of 50 ft are too narrow for navigation. For river flows of about 130,000 cfs and below the velocity through the breach would be three fps or less, and traffic would travel through the lock without operation of the lock gates. For flows over 130,000 cfs river traffic will transit the project through the operating lock.

- Hydroturbine - Units will be removed or taken out of service. Synchronous condensing operation will require replacement at another location on the transmission grid.

It is envisioned that construction will take place in three stages, as described below. The existing forebay water level will be maintained during Stages 1 and 2.

- Stage 1 - A cofferdam will be built around the center of the dam. An embankment cofferdam will be built upstream because the water is too deep to allow use of a cellular sheetpile cofferdam, which would be employed downstream. Spillway Bay 20, the non-overflow section, and powerhouse Units 10 through 20 will be removed. A new spillway will be built with 50-foot wide openings and 12-foot-wide piers. The southern 10 new spillway bays will be fitted with temporary ogee crests, 50 feet high, to accommodate flows and fish passage during Stage 2 construction when these bays will be used to maintain the forebay water level.
- Stage 2 - A cofferdam will be built around the northern part of the existing spillway. The forebay will be maintained at existing levels during Stage 2 construction by use of the gates completed in Stage 1. Again, this will require an embankment-type cofferdam upstream. The northern portion of the spillway (Bays 8 through 19) will be removed, new piers will be built, and gates will be installed. The navigation lock will be modified by lowering the upstream sill to the floor of the lock and installing a new 105-foot-high gate. New filling and emptying valves will be installed at the bottom of the lock gates. The reservoir will then be drawn down and the cofferdam removed.
- Stage 3 - A small cofferdam will be completed around part of the north shore fish ladder and the ladder will be rebuilt. A ladder is necessary to pass fish during flood control operations when the forebay water level will be raised as much as 50 feet. The temporary ogees will be removed from one spillway bay at a time, using bulkheads for dewatering.

Studies and design for the drawdown will take about eight years to complete, and construction will take 10-1/2 years.

7.1.5 Drawdown Effects at the McNary Project

All four alternatives are assumed to have an identical effect on the tailwater and fish passage at the McNary Dam for flows less than 600,000 cfs. McNary Dam was in operation prior to the completion of John Day Dam. Consequently, modifications to the fish passage facilities were required to provide for their continued operation when the John Day Reservoir raised the tailwater at the McNary Project. These modifications were outlined in *John Day Design Memorandum No. 30, Modifications to McNary Fish Facilities*. This memorandum was used

as the basis for anticipating the changes required to ensure fish passage at McNary Dam in the event that the tailwater returns to pre-John Day Project levels.

Changes required include reestablishing sill elevations at the fish ladder entrances, modifying the auxiliary water systems, adjusting several weir crests in the lower reaches of the north and south shore fish ladders, modifying juvenile fish return outfalls, and perhaps making some minor modifications to the fenders and fish-loading system at the barge facilities. Additionally, all alternatives for the drawdown will strand the spill deflectors installed after the John Day Project was completed. The deflectors will be removed and relocated. No changes to the hydroturbine operations are anticipated.

7.2 Hydrologic and Hydraulic Impacts

One of the crucial questions addressed by the study is how much the various alternatives change the travel time of flows through the John Day Reservoir. The concern is that long travel times, representing a relatively quiescent reservoir, are a barrier to downstream fish migration. This study assumes that there is a direct correlation between reduced time-of-travel estimates and improved survival of juvenile salmon. Time-of-travel estimates were developed for a wide range of flows by multiplying the average channel velocity between adjacent cross sections by the distance between them, and summing the results between the McNary tailwater (RM 291.6) to the John Day Dam. This analysis was performed for the existing, spillway crest, and natural river conditions. Results from the steady-state HEC-RAS model are shown in Figure 6.

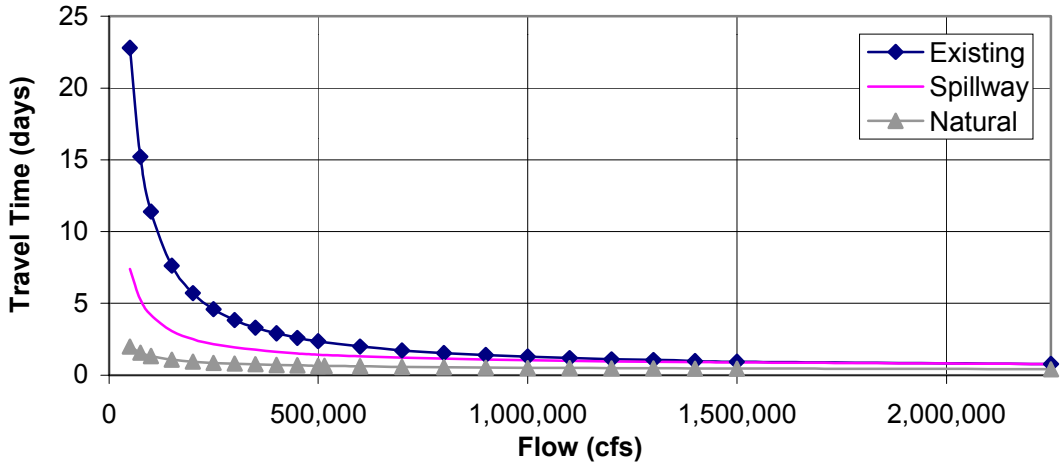

Figure 6. Water Particle Time of Travel

The results show significant differences for flows less than the two-year flow of 353,000 cfs. The natural river condition offers travel times on the order of one day (or perhaps 11/2 to 2 days for very low flows). By contrast, the spillway drawdown condition could vary from more than a week at 50,000 cfs to nearly two days at the two-year flow. The existing

condition varies from more than three weeks at 50,000 cfs to over three days at the two-year flow. For large flows, in excess of the two-year flow, travel times would be relatively short, on the order of one to two days.

In general, the spillway drawdown would tend to decrease water particle travel times by a multiple of two to three at these lower flows, whereas the natural river condition would tend to decrease travel times by a multiple of 4 to 11.

7.3 Sedimentation Impacts

7.3.1 Reservoir Sedimentation Impacts

The upper reach of the reservoir, which has incised into late Holocene glacio-fluvial deposits of immense volume and expanse, is expected to undergo a substantial change as a result of John Day Reservoir drawdown. The greatest impact will be turbidity caused by the influx of this sediment into the system from initial drawdown, increased water velocity, wind-generated wave impingement, and subsequent flood events. Contributing to the turbidity will be sediment washed from the reservoir side slopes and eroded from the river channel. The tributary streams to John Day Reservoir and the alluvial fans associated with the mouths of the Umatilla River, Willow Creek, Rock Creek, and the John Day River will also contribute significantly to the system turbidity.

Some minor tributaries are also expected to contribute substantial volumes of fine-grained silts and clays, increasing reservoir or river turbidity on a seasonal basis. These minor tributaries include Glade Creek, Alder Creek, Wood Gulch, Pine Creek, and Blalock Canyon. Deposition of the material downstream of the John Day Project is also expected.

An additional impact will be the increase in blowing sand and dust. The currently submerged sediment deposited on the reservoir side slopes, as well as the tributary alluvial fans, will be exposed after drawdown and become a significant source for blowing material. Revegetation of these areas will help control the amount of blowing material, but this will be difficult to accomplish in such a dry climate.

7.3.2 Tributary Sedimentation Impacts

Sedimentation in the major tributaries of the John Day Reservoir that has occurred since the completion of John Day Dam may affect fish passage under the proposed drawdown alternatives. Changes to the channel geometry will affect channel hydraulics, causing a potential blockage to adult fish migration. Such blockages could be caused by either high flow velocities and/or shallow depths. Hydraulic models for John Day River, Umatilla River, Willow Creek, and Rock Creek were developed based on existing (1994) geometry. Data was not available for Wood Gulch, and so a hydraulic model was not developed.

The flow depths and velocities were compared to fish passage criteria (developed for the fish species of concern) to determine potential passage concerns. Under the proposed drawdown conditions, changes in channel hydraulics would affect the sediment transport characteristics of the channel, potentially altering the channel geometry. Such changes could remove existing blockages and/or create new blockages.

The computed values represent the relative magnitude of changes in sediment transport characteristics expected under the different drawdown alternatives. Table 27 summarizes the results of the analysis. The computer package SAM (USACE, 1998) was used to estimate the capacity of the tributaries to transport sediment under both spillway drawdown and natural river drawdown conditions. Although sediment transport equations often do not accurately represent the true conditions of the river, they are used here for comparative purposes.

Table 27.
Tributary Average Annual Sediment Transport Capacity

Tributary	Existing Conditions (tons/year)	Spillway Crest (tons/year)	Natural River (tons/year)
John Day River	3,385	289,471	547,681
Willow Creek	12	165,700	326,066
Umatilla River	2,016	29,957	30,948
Rock Creek	19	6,000	6,262

The sediment transport capacity estimates were made using one of the upstream cross sections and bed material samples for each tributary. The purpose was to define transport conditions based on a transport reach rather than a depositional reach. As shown in Table 27, the transport capacity of the tributaries is affected by backwater. In all cases, the transport capacity of the tributary is highest under natural river conditions. It is recognized, however, that the estimates are for one cross section and existing geometry, which are not expected to represent the entire study reach. The transport capacity of the stream will vary by location, and the channel geometry will change as the river adapts to its new boundary conditions.

7.3.2.1 John Day River

Backwater from the Columbia River extends approximately 10 miles upstream from the mouth of the John Day River. This reduces the capacity of the river to transport coarse sediments. Under spillway free-flow and natural river conditions, the transport capacity would exceed the measured accumulation rate.

7.3.2.2 Willow Creek

Under spillway free-flow and natural river conditions, the estimated transport capacity of Willow Creek would exceed the measured accumulation rate. Consequently the channel should be able to pass the majority of its inflowing sediment to the Columbia River. Willow Creek Dam, which is located upstream and was completed in 1983, may act to further reduce the sediment supply to Willow Creek. Recent observations of the channel incision upstream from the John Day Reservoir backwater, suggest a reduced supply of sediment to this reach. The reduction of sediment supply would provide excess sediment transport capacity. Additional sediment would be propagated from the bed and banks to make up for the reduced supply. Subsequent erosion of the bed and banks is expected, causing alterations in the channel's existing geometry.

7.3.2.3 Umatilla River

At the mouth of the Umatilla River, located at the upper end of the reservoir, the Columbia River backwater is nearly the same for both spillway and natural river conditions. Thus, sediment transport capacity of the Umatilla River is nearly the same for both alternatives. Several irrigation reservoirs within the Umatilla River basin have likely reduced the amount of bed material available for transport.

7.3.2.4 Rock Creek

The outlet of Rock Creek is cut through rock, which acts like a weir during both spillway free-flow and natural river conditions. The weir acts to control the backwater and thus the sediment transport capacity in Rock Creek. Unless the outlet is reconfigured, Rock Creek will continue to trap sediment.

7.3.2.5 Minor Tributaries

A total of thirty-one (31) minor tributaries to John Day Pool were also investigated. Each minor tributary analyzed for this study has a drainage area greater than one square mile, and hence may potentially supply significant quantities of sediment to the John Day Pool. Eleven (11) minor tributaries are believed to supply insignificant quantities of sediment to the John Day Pool. Thirteen (13) minor tributaries are believed to trap the majority of the sediment at their outlet by culverts. This leaves a total of seven (7) minor tributaries that directly contribute sediment to the John Day Pool. With a total drainage area of 716 square miles, the total annual contribution for these seven tributaries is about 243,000 tons of suspended sediment. If the bed load transport were assumed to be roughly 10 percent of the suspended load, then the seven minor tributaries would transport about 24,000 tons of sediment on an annual basis to the John Day Pool.

For comparative purposes, actual field sediment measurements were taken for the four major tributaries (including John Day River, Willow Creek, Umatilla River, and Rock Creek), including those for suspended sediment load and annual contribution. The average annual suspended sediment load measured for these four streams is about 2,100,000 tons per year. Based on the 1955 and 1994 sediment condition surveys, the average annual accumulation of sediment measured for these four streams is about 240,000 tons per year. Hence, these four major tributaries contribute about ten times more sediment to the John Day Pool each year than the referenced seven minor tributaries.

7.4 Sediment Quality Impacts

Physical and chemical data available on sediment quality in the John Day Reservoir are limited. A sediment study at the Port of Morrow, comparisons with the drawdown of Lower Granite and Little Goose Reservoirs, and potential physical and chemical changes associated with the drying and rehydrating of sediments were used to determine the impacts of the John Day Reservoir drawdown.

7.4.1 Port of Morrow Sediment Samples

Sediment samples were taken in the Port of Morrow to determine soil makeup and chemical concentrations. The proposed dredge material from this project was determined to be acceptable for both unconfined in-water and upland disposal. No significant adverse ecological impacts are expected as a result of sediment toxicity. See the Sediment Quality Section of the Engineering Technical Appendix for results of the Port Morrow sediment study.

The drawdown at Lower Granite and Little Goose Reservoirs provided the following information regarding sediment quality as it relates to a drawdown at John Day Reservoir.

7.4.2 Erosion and Sediment Transport

Increased sediment transport, particularly bed load, was apparent in the confluence area of the Clearwater and Snake Rivers as the head of the reservoir shifted downstream. Tremendous quantities of sediment (more than 1 million tons during the 15 days of a 28-foot drawdown) were eroded from the confluence area and redeposited a short distance downstream. The quantity that could be resuspended in the water as a result of wind, wave, and rain action on exposed shorelines is unknown. The effects on the ecosystem of resuspension of contaminated sediments after the drawdown are also unknown. Reservoir embankment would have to be protected to the drawdown level to prevent undermining and failure caused by any wind and wave action.

7.4.3 Contaminants

Although the level of contaminants from the Lower Granite and Little Goose Reservoirs does not directly relate to the potential contaminants in John Day sediments, the following notation could apply. If sediment-associated metals concentrations carried by the stream flowing from Red Wolf Marina as it channeled through the deep sediment deposits are indicative of levels that would come from exposed mudflats, toxic conditions could be widespread along shorelines following storm events (see 7.4.5, Oxidation/Rehydration, below).

7.4.4 Turbidity

The surface turbidity data collected indicated that levels increased at Lower Granite Dam after drawdown. The increase first occurred approximately 2 weeks after the start of the drawdown. Much higher levels were recorded along the shorelines and at stream mouths.

7.4.5 Oxidation/Rehydration

Sediments under water are in a chemically reduced state (i.e., they absorb electrons from the decomposition of organic material). When sediments are exposed to air during an event such as a drawdown, the sediments begin to dry. With drying, oxidation or the giving up of electrons will occur (especially heavy metals). This will affect the solubility and availability of these elements as they are rehydrated or become airborne.

Certain metals, such as zinc, cadmium, copper, nickel, and manganese, significantly increase in solubility and can be found in surface runoff water when sediment is rehydrated after

oxidation. Metals in their reduced state are tightly bound to the sediments in an underwater environment. This bond is broken when the sediments oxidize (during the drying process), thereby becoming much more soluble and available for bioaccumulation when reintroduced to water.

7.4.6 Volatilization

Mass loss through volatilization of PCBs can be four times greater in the sediment exposed to the air than in the sediment maintained underwater. This is a potential air quality issue if a significant PCB level is present in the John Day Reservoir sediment. (No existing data are available to confirm or deny PCB presence in the study area). Other compounds have the potential to become volatile as well (e.g., petroleum products).

As the drawdown takes place and erosion occurs from currents, wave action, and wind, contaminated sediments below what is now the sediment current surface could be exposed. This process can create a new sediment surface from a source of contamination that was buried with cleaner sediment and was "effectively capped " in a pre-drawdown state. These conditions will require future monitoring if areas are identified as being contaminated.

7.5 Water Quality Impacts

Drawdown of the John Day Reservoir under any of the proposed alternatives may adversely affect water quality in the short term. Short-term impacts may be related to increased turbidity and suspended solids, resuspension of pollutants, increased nutrients, and possible downstream dissolved oxygen reductions. These impacts will dissipate over time and will return to pre-drawdown conditions. Estimates of the period of time before equilibrium is reestablished range from 2 to 15 years. Long-term water quality benefits will be in the form of reduced total dissolved gases downstream of the John Day reach, increased water velocities, and water temperature regimes shifting towards pre-impoundment conditions.

Negative water quality effects may be greater under Alternatives 3 and 4 because sediment will be exposed by erosion. A greater volume of bank material will be exposed and likely increase the occurrence of slope failures.

7.5.1 Turbidity/Suspended Solids

All four drawdown alternatives will increase turbidity and suspended solids in John Day and downstream reservoirs. Multiple processes will increase the amount of suspended sediments in the water and make it appear turbid or cloudy. Increased turbidity levels could have negative effects on aquatic life.

Exposure of previously submerged sediments to erosion by precipitation, wind, and wave action will cause increased levels of sediment within the water.

During drawdown, groundwater from newly exposed banks will drain into the reservoir, thereby reducing slope stability of the banks. Slope failures and slumps may increase the levels of sediment within the reservoir. Extensive cutting and scouring of the drawdown river channel will likely create high turbidities for an extensive period.

Construction activities, including the installation and removal of cofferdams, installation of riprap, and dredging of sediments, will also be a source of increased suspended solids and turbidity.

All increased levels of suspended solids will flow through John Day Reservoir more quickly since, under all drawdown conditions, water velocities will be increased. Higher velocities allow water to transport increased volumes of suspended solids. Upon reaching slack water in The Dalles reservoir, velocities will decrease, thus reducing the amount of suspended solids the water can transport. Sedimentation of fine particles, such as clays and silts, will likely occur at this interface of lacustrine and riverine environments. Larger particulates will not be transported as far and will likely settle out of the water column upriver from this point.

It has been observed that fish can survive high concentrations of suspended solids for short periods. Prolonged exposure for most species, however, results in complications with respiration. Suitable spawning areas will be limited within John Day Reservoir until equilibrium is attained. Although adult and juvenile salmon and steelhead will immediately be migrating through the reservoir following drawdown, spawning will not occur in the reach until areas that were inundated undergo flow events of high enough magnitude to dislodge compacted gravels and cleanse fine sediments from them. Increased turbidity may decrease salmonid losses to predation.

7.5.2 Dissolved Gas

Elevated levels of dissolved atmospheric gases in Columbia River water are caused by the operation of spillways at most dams. Elevated levels can cause mortality in juvenile and adult migratory fish, resident fish, and other aquatic organisms.

Near-field study at John Day Dam has shown dissolved gas generation to be highly related to spillway discharge and spill pattern. Generally, dissolved gas levels will increase as the amount of spill increases. Tailwater elevations are also a determining factor in dissolved gas generation and the effectiveness of flow deflectors. Flow deflectors limit the plunge depth of water over the dam spillway, reducing the amount of dissolved gas. To maintain optimum efficiency of flow deflectors, tailwater levels should be kept within the existing normal operating ranges.

Lower forebay elevations under Alternatives 1 and 2 will cause lower flows and hence lower levels of dissolved gas downstream of the John Day Project. However, since flow deflector efficiency is a factor of spillway discharge and tailwater elevation (submergence), elevated dissolved gas levels may still be a concern within the John Day Reservoir. This would result from the increased plunge depth at McNary Dam.

Under Alternatives 3 and 4, the problem of elevated dissolved gas generation from spill at the John Day Dam would be eliminated. Removal of the spillway and skeleton bays will allow water to flow freely past the dam. There is expected to be a reduction in dissolved gas levels within the river immediately below the John Day project. Lower in the Columbia system however, dissolved gas levels that exceed standards could be a possibility. The unimpounded river flows through John Day Reservoir may cause increased flows downstream from John

Day Dam, which in turn could increase spillway use and dissolved gas levels below The Dalles and Bonneville Dams.

Additionally, for any of the four alternatives, gas bubble trauma in fish may increase in shallow water habitat if fish are unable to locate deep-water compensation depths. However, supersaturated gas levels are likely to dissipate more quickly and be generally lower in shallow water areas, especially if the water is subject to agitation as in rapids and riffles.

7.5.3 Temperature

Heating and cooling rates vary inversely with changes in water volume. That is, as the volume of a body of water is reduced, it will absorb and dissipate heat more quickly. However, increased water velocities inherent with any drawdown reduce the retention time of the water, providing less time to absorb or dissipate heat. Increased stream flows inherent with drawdown generally result in shallower water depths and reduced volumes, which will heat and cool more quickly and counteract the effects of higher velocities. High-volume stream flows tend to result in less fluctuation in water levels. Increases and decreases in reservoir surface area also affect temperature since any heat exchange must occur through this boundary. The major effect of dams on water temperature in the Columbia River is to delay the occurrence of maximum temperatures in late summer and cooling in early autumn.

Since John Day Reservoir is currently operated as a run-of-river reservoir with relatively short retention times, drawdown effects on temperature can be expected to be minimal and of little benefit to aquatic life.

7.5.4 Water Pollution

Changes in elevation, flow, and circulation patterns in the vicinity of point source pollutant discharges may adversely affect dilution mechanisms. Reductions in dilution waters related to drawdown may cause licensed dischargers to John Day Reservoir to alter their discharge practices and extend sewer outfalls in order to maintain compliance with their NPDES permits. Due to the lower reservoir elevations under drawdown conditions, sewer and discharge outfalls may be exposed and rates of contaminated groundwater seepage into the Columbia River could increase.

Elevated pollutant levels could be harmful to aquatic and human life. No significant departure from current conditions (in regard to pollutants) is expected at Columbia River locations under any of the alternatives considered.

7.5.5 Nutrients

Erosion and resuspension of sediments could result in the introduction of increased levels of total phosphorus, total nitrogen, and total carbon into Columbia River. Increased nutrients could stimulate aquatic growth, which could lead to temporary but harmful reductions in dissolved oxygen levels due to increased consumption of oxygen by aquatic microorganisms. This may occur downstream in The Dalles reservoir, where the nutrients will tend to accumulate under drawdown conditions. Another source of nutrients may be detritus from benthic, periphytic, and other organisms exposed by the drawdown.

7.5.6 Primary Productivity

Primary productivity is the production of organic matter from light energy and nutrients principally by phytoplankton and aquatic plants. Water bodies with short detention times have reduced rates of primary production. The uptake of nutrients by phytoplankton, and the subsequent deposition within the reservoirs through sedimentation, will be reduced following any drawdown of the John Day Reservoir. Under drawdown conditions, fewer nutrients will be retained in the waters of John Day Reservoir. In addition, increased turbidity levels will reduce light levels within the water, thereby reducing the photic zone and temporarily limiting production.

Lentic (standing water) forms of phytoplankton may decrease due to reduced detention times, but they could be replaced by more lotic (moving water) forms preferable to salmonids and salmonid prey organisms. Such a shift in community structure would likely contribute slightly to salmonid survival.

7.5.7 Dissolved Oxygen

Increases in nutrients related to erosion, sediment suspension, and detritus might cause short-term but harmful reductions in dissolved oxygen in slack waters. In Alternatives 1 and 2 dissolved oxygen problems are more likely to occur in the lower reaches of the John Day Reservoir and in the upper reaches of The Dalles Reservoir. For Alternatives 3 and 4, the problem will occur in the upper reaches of The Dalles Reservoir. In either case, the low dissolved oxygen problems will be short term.

7.5.8 Alkalinity, pH, Conductivity, and Hardness

Increases in the concentrations of ionic compounds, such as carbonates, bicarbonates and hydroxides, salts, and organic and mineral acids related to increased erosion and sediment suspension, may cause short-term shifts in alkalinity, pH, conductivity, and hardness. Short-term increases may be possible for all parameters; however; no adverse consequences are expected. After erosion related to drawdown subsides, these parameters will return to their current healthy levels.

7.6 Air Quality Impacts

Air pollutant changes are expected for different types of emissions resulting from changes in the amount of hydropower production from John Day Dam. The reduction of hydropower production increases the use of fossil fuel power generation and associated air pollution. In addition, the loss of barge traffic increases the use of train and truck transportation and the increased ratio of fuel/ton/mile.

The Clean Air Act and concerns about greenhouse gasses are geared toward limiting emissions of pollutants into the air. One obvious advantage of hydropower generation is that pollutants are not emitted into the air. With the reduction of hydropower production, alternative generation sources will be used to replace lost electricity. These alternative sources will be thermal-based and fueled by fossil fuels, and therefore increased levels of several harmful emissions will be released.

Changes in air emissions were evaluated for the natural river drawdown alternatives (Alternatives 3 and 4); only changes in hydropower production were assessed. Air pollution percentages did not take into account impacts associated with construction or changes in navigation from barges to truck/rail. The percentage increase in emissions of sulfur dioxide and nitrogen oxides is below one percent. The increase in carbon dioxide in the Pacific Northwest is estimated to be about four percent due to the loss of hydropower generation from John Day Dam.

7.7 Slope Stability and Shoreline Impacts

7.7.1 Slope Stability

Drawdown will increase the exposure of the reservoir slopes to wave action, thereby expanding the potential for further slope destabilization. Railroad and highway embankments located on those slopes are also at risk of failure, not only from erosion, undercutting, and loss of underlying support, but also from rapid dewatering of the embankment material.

Known areas of mass movement may be affected by reservoir drawdown by either reactivation of slides or increased rates of movement. The reservoir includes a 15-to 20-mile zone of landslide topography associated with clay-shale interbeds. This zone would be susceptible to slope failure from erosional downcutting and the removal of enough material to initiate progressive failure.

Stability problems may also occur with currently submerged, fine-grained alluvial slopes located at the mouths of tributaries. Like the railroad and highway embankments, the unconsolidated, saturated sediment slopes may fail as a result of rapid dewatering.

7.7.2 Shoreline Impacts

Fluctuating pool levels are known to be the primary cause of shoreline erosion in reservoirs. Normally, shoreline erosion in run-of-river reservoirs is confined to a relatively narrow band. In the John Day Reservoir, it is limited to a pool impingement zone of about 11 vertical feet. High banks composed of granular soils with low cohesion have a higher vertical wave-cut bench. The presence of this high bank is due to undercutting of the inherently unstable material, which then causes the overlying upper slope to fail from lack of support at the waterline.

Upper bank stability between Crow Butte and McNary Dam has been adversely affected by the abnormally high pool stages reached during the peak of the 1997 spring runoff. There is less evidence of widespread bank instability between John Day Dam and Crow Butte on the Washington side and Willow Creek on the Oregon side. This may be due, in part, to the steep rocky shoreline in the reach downstream from Crow Butte and Willow Creek. However, there are soil areas within this rocky reach where bank loss estimates are reported to be as much as 10 horizontal feet as measured landward from the strand.

Shoreline erosion will also have an impact on cultural resources that have been identified in portions of the John Day Reservoir. Initial drawdown and future flood events may erode reservoir slopes through the processes discussed above, resulting in exposure and/or

destruction of identified cultural resource sites, as well as those that have not been identified. Vandalism may also occur at the exposed cultural sites. Further discussion of these impacts is presented in the *Cultural/Tribal Resources Technical Appendix.*

7.8 Transportation and Shoreline Infrastructure Impacts

7.8.1 Transportation

The initial drawdown of the reservoir is to take place within the lull in upstream fish migration from December 1 to February 28. To draw the reservoir down within this short time period will cause instability with the embankments on the reservoir. Drawdown effects from both initial drawdown and future flood events are assumed to cause failure of portions of the railroad/highway system due to this rapid dewatering of the embankment. Railroad and highway embankments are located in vulnerable areas where wave impingement, undercutting, erosion, rapid dewatering, and ultimately failure are a likely occurrence. Problems with embankment movement may cause track misalignment. Adjacent federal, state, and county roads may undergo movement, cracking, slumping, piping, and failure to varying degrees.

7.8.2 Shoreline Infrastructure Impacts

7.8.2.1 Columbia River Main Stem and Tributary Bridges

One Columbia River mainstem bridge (I-82 bridge) and 20 tributary bridges were evaluated as part of the shoreline impact analysis. Several criteria were assessed for each bridge. First, there is the possibility that drawdown might create scour that could potentially undermine the piers. Second, there has to be adequate fish passage after drawdown for the five tributaries that support migrating fish populations. Those tributaries are the John Day River, Willow Creek, Umatilla River, Wood Gulch, and Rock Creek. Third, several tributaries (John Day River, Willow Creek, Umatilla River, and Rock Creek) may require dredging to achieve a stable channel for sediment. This dredging could also undermine the bridge piers or make them vulnerable to scour. The 20 tributary bridges that were evaluated are as follows.

- John Day River I-84
- John Day River UPRR
- Arlington Viaduct
- Alkali Canyon UPRR
- Willow Creek I-84 Eastbound
- Willow Creek I-84 Westbound
- Willow Creek UPRR
- Umatilla River Highway 730
- Umatilla River Footbridge
- Rock Creek Highway 14
- Rock Creek BNSF Railway
- Chapman Creek BNSF Railway
- Wood Creek Highway 14
- Wood Creek BNSF Railway
- Alder Creek Highway 14
- Alder Creek BNSF Railway
- Dead Canyon Highway 14
- Dead Canyon BNSF Railway
- Glade Creek Highway 14
- Glade Creek BNSF Railway

The bridge evaluation determined that two bridges would have to be modified if the John Day drawdown was implemented. The two bridges are the SR-14 and BNSF bridges over Rock Creek. Both bridges would require modification because they would block fish migrating upstream during the drawdown.

7.8.2.2 Columbia River Main Stem Culverts

Because of the large number of culverts and limited culvert data, the culverts were screened into three categories: (1) those that spill directly onto the embankments bordering the reservoir; (2) those that are sufficiently removed from the reservoir, or spill onto a delta that is sufficiently large and vegetated; or (3) those that would be perched (leaving ponded water trapped upstream) if the reservoir is drawn down. It was assumed that culverts in the first or third category would require modifications.

The culverts observed in the field were categorized first, using information from the data sheets and photographs. The remaining culverts (those that were listed in the inventory but not viewed) were then categorized by first identifying their locations on 1:24,000-scale USGS maps and then determining whether they spilled directly onto the reservoir embankment or were located a sufficient distance away from the reservoir. The analysis produced a total of 159 culverts that spilled directly onto the embankment, 185 culverts that were set back from the reservoir or discharged into a large delta, and nine culverts that would be perched after drawdown.

For the 185 culverts set back from the reservoir, no modification would be required. Each of the nine culverts that would be perched would need to be modified. The remaining 159 that also need modification were further divided into five groups, based on location in the pool (river mile), and into three sizes. The smallest size consisted of culverts that were two feet or less in diameter. The medium-sized culverts were those greater than two feet in diameter but less than or equal to four feet in diameter. The large culverts were all those greater than four feet in diameter. The breakdown is shown in Table 28.

Table 28. Number of Culverts Spilling onto Embankments						
	Washington			**Oregon**		
	Small (<2 feet)	**Medium (2-4 feet)**	**Large (>4 feet)**	**Small (<2 feet)**	**Medium (2-4 feet)**	**Large (>4 feet)**
Group I (RM 216- 235)	10	51	14	0 (10)[a]	7 (51)[a]	7
Group II (RM 235- 250)	2	30	7	0 (2)[a]	3 (30)[a]	2
Group III (RM 250-265)	0	14	3	0	1	1
Group IV (RM 265-282)	1	1	1	0	2	0
Group V (RM 282-292)	0	0	0	0	0	0
Total[b]	13	96	25	12	84	10

a. Assumed number of culverts on the Oregon side is equal to the Washington side.

b. Total includes the estimated number of culverts assumed to be on the Oregon side.

The inventory shows that there are many more culverts on the Washington (north) side of the reservoir than on the Oregon (south) side. This is because the BNSF track profile provides a much more comprehensive list of culverts compared with the UPRR track profile. It appears that the UPRR track profile shows all of the large culverts but does not include many of the existing smaller culverts. The field reconnaissance supports this conclusion because several smaller culverts were observed on the Oregon side of the reservoir but were not found on the ODOT Bridge Log or the UPRR track profile. As a conservative estimate, it was assumed that the Oregon side has the same number of small and medium culverts as the Washington side for Groups I and II. These two groups are very similar on both sides of the reservoir in the sense that most of the rail lines are immediately adjacent to the water on both sides. By adding the estimated number of small and medium culverts on the Oregon side, the total number of culverts that spill onto the embankment and require mitigation is estimated to be 240.

7.9 Navigation Impacts

All four drawdown alternatives considered would affect the flow of commodities on the Columbia and Snake Rivers because each one would make the John Day Reservoir too shallow for the current fleet of 14-foot draft barges and tugs.

For the spillway drawdown alternative without flood control operations (Alternative 1) for an average flow condition of 200,000 cfs, the water surface elevation behind John Day Dam would be lowered from elevation 265 to about 223. For this flow condition, the slack-water pool elevation of about 223 feet created by the smaller dam would extend about 47 river miles from the dam to about RM 263. At that point, it would transition from a slack-water pool to a natural river condition or profile. Although the channel would not cross dry land, it would still lack sufficient depth to serve as an effective open river waterway for commercial

traffic at a number of locations upstream from RM 263. During periods of high flow, depth would be great enough to allow shallow-draft vessels to negotiate the low water areas. However, the channel would still lack the depth necessary to provide continuous navigation for modern barge configurations. Thus modern barging methods or fleets would have to change.

For the spillway drawdown alternative with flood control operations (Alternative 2), such as for the 1997 and 1974 flood events, barge traffic on the main navigation channel would operate with either great difficulty or be stopped due to the hazardous conditions. For the 1997 flood event at the John Day Dam forebay, the water surface would be about 16 feet higher for flood control operations compared with no flood control operations. For floods of this size, John Day Dam would require between 19 and 26 days of release at the maximum flow before the flood control volume is reduced to zero again. These impacts to barge traffic for this long duration would have a significant impact on commerce for the ports, related businesses, and also the barge lines. Thus modern barging methods or fleets would have to change.

For the natural river drawdown alternative without flood control operations (Alternative 3) for an average flow condition of 200,000 cfs, the water surface elevation behind John Day Dam would be lowered from elevation 265 to about elevation 165. As a result, the existing channel would not only lack sufficient depth for navigation in many locations, but its current alignment would cross some areas of emergent ground. Alternative 3 would, therefore, convert this reach of the Columbia River navigation channel from a canalized waterway to a natural river condition. Thus modern barging methods or fleets would have to change.

For the natural river drawdown alternative with flood control operations (Alternative 4), such as for the 1997 and 1974 flood events, barge traffic on the main navigation channel would operate with either great difficulty or be stopped due to the hazardous conditions. For the 1997 flood event at the John Day Dam forebay, the water surface would be about 55 feet higher for flood control operations compared with no flood control operations. For floods of this size, John Day Dam would require between 19 and 26 days of release at the maximum flow before the flood control volume is reduced to zero again. These impacts to barge traffic for this long duration would have a significant impact on commerce for the ports, related businesses, and also the barge lines. Thus modern barging methods or fleets would have to change.

The closure of the John Day Reservoir would force producers and manufacturers to find other routes and modes for shipping goods. The loss of upriver access by the existing barge fleet may result in an increase of truck and rail traffic.

7.10 Hydropower Operation Impacts

7.10.1 System Transmission Effects

The drawdown of John Day Dam and/or the breaching of the four Lower Snake River dams would render the powerhouses inoperable, thereby altering the configuration of power generation facilities in the Pacific Northwest. Because the transmission grid was originally constructed in combination with the generation system, and because they interact electrically,

loss of generation will affect the transmission system's ability to move bulk power and serve regional loads.

Power would then have to be supplied by another form of energy production (e.g., such as fossil fuel, geothermal, or other energy alternatives cogeneration, wind, and solar power). The predominant type of power plant that has recently been added is natural-gas-fired, combined-cycle combustion turbine plants. Such power plants are generally considered the most cost-effective new generating resource capable of operating over a wide range of potential plant factors. The major component of the production costs for any power system is the cost of the fuel expended to generate the electricity. Energy prices are expected to increase with a loss of hydropower production at John Day Dam.

7.10.2 Generating System Effects

If the Lower Snake River and John Day Dams are breached, and no other generating capacity is added, transmission system transfer limits decrease would by 1,800 MW (from 7,200 to 5,400 MW). This would limit the ability to sell and transfer Pacific Northwest generation to the Pacific Southwest to meet peak demands. If the John Day Dam is drawn down to spillway level and the Lower Snake River dams are breached; transfer capability would be reduced by approximately 1,000 MW.

7.10.3 Ancillary Services Effects

This section covers the ancillary services and the estimated economic values of these services provided by John Day Dam. These ancillary services are in addition to the energy, capacity, and transmission support benefits discussed in the Hydropower Operation and Regulations Section of the Engineering Technical Appendix. With the open access transmission ruling of the Federal Energy Regulatory Commission (FERC), power suppliers are now charging for many of the ancillary services that in the past were generally provided without charge by the entities owning the transmission facilities. Starting in 1998, BPA began selling these ancillary services. Since these services are a necessary element of a safe and reliable power system, their loss represents economic costs that must be accounted for in this analysis.

The John Day hydropower plant is used for Automatic Generation Control (AGC). Small, but very frequent changes in generation are necessary to perform this function. Hydroelectric projects, with stored water as their power source, are extremely flexible and very useful for this purpose. If John Day Dam were removed, its contribution to this system would have to be spread over the remaining projects or replaced from other sources. John Day could not continue to provide AGC at the spillway level because the project configuration at the spillway level will not allow for small, instantaneous changes in generation that are necessary for AGC.

John Day dam is also used to provide part of the required reserves for the federal power system. WSCC has established reserve requirements for all utilities. These contingency reserves are expected to be "on-call" in the event of emergency loss of generating resources in the system. Utilities are required to have both operating and spinning reserves. The spinning reserve units must be synchronized with the power system and provide immediate response, while the operating reserves must be available within 10 minutes. BPA estimates that the John Day plant is used for reserves throughout the year during the heavy load hours. BPA

relies on about 300 MW of reserves from this plant. The market value of these reserve services varies throughout the year.

7.11 Flood Control System and Operation Impacts

7.11.1 Flood Warning Analysis

Flood warning was considered in two ways. First, the peak flows of five flood hydrographs (for the floods of 1948, 1974, 1982, 1996, and 1997) were tracked through the reservoir, and the differences from the time of the peak flow "observed" at McNary Dam was noted. The second method was to identify a flood warning "trigger" flow, in this case the two-year flow of 353,000 cfs at John Day Dam, and track the times of occurrence of the two-year flow as it passed through the reservoir.

The concept of a flood warning, or "trigger," flow was used for two reasons. First, it was found that tracking the flood peak resulted in large differences between the individual flood events, probably caused by the shape of the hydrograph near the peak. Second, realistic flood warning tends to be based on some indicator flow that suggests an impending threat of flooding if it is exceeded.

An unsteady flow computer model was used to track the peak flows of the five flood events through the reservoir. Flood hydrographs for these flood events were computed at McNary Dam Tailwater (RM 291.6) and John Day Dam, and were then used to compute the time of travel of the peak flow. Table 29 shows the times of peak flow travel from McNary Dam to various locations in John Day Reservoir for the Existing, Spillway Drawdown, and Natural River conditions, with and without flood control.

Table 29. Peak Flow Travel Time Summary					
	Time (hours)				
	Existing	Natural River w/o Flood Control	Spillway Drawdown w/o Flood Control	Natural River w/ Flood Control	Spillway Drawdown w/ Flood Control
1948 Flood					
Port of Morrow	3	3	3	3	6
Arlington	8	9	21	8	16
John Day Dam	9	12	27	13	24
1974 Flood					
Port of Morrow	3	3	3	3	5
Arlington	5	8	12	8	17
John Day Dam	6	11	20	12	27
1982 Flood					
Port of Morrow	1	1	1	3	4
Arlington	2	4	3	8	20
John Day Dam	3	7	7	14	30
1996 Flood					
Port of Morrow	1	3	3	2	4
Arlington	3	8	10	7	15
John Day Dam	4	11	18	14	26
1997 Flood					
Port of Morrow	1	1	1	3	3
Arlington	2	4	4	8	19
John Day Dam	3	7	9	12	35

The results as shown in Table 29 indicate a number of things. First, the travel times through the upper (McNary Dam to Port of Morrow) and lower (Arlington to John Day Dam) thirds of the reservoir tend to be similar, with the travel time through the middle third (Port of Morrow to Arlington) being about twice as long. Second, while the travel times for the Natural River condition are generally longer than for the Existing condition, travel times for the Spillway Drawdown conditions are often significantly longer.

Table 30 shows travel times determined by tracking the occurrence of the two-year flow through John Day Reservoir. The results show much the same trends as before, however, the results are more consistent between flood events, and hence provide a more accurate estimator of flood warning times through John Day Reservoir. Where the Existing condition might have a two-year flow travel time of 3.5 hours, the Natural River condition would increase this time by about a multiple of three. However, the Spillway Drawdown condition would increase this time by a multiple of five or more, and seems to depend strongly on the rate of rise of the flood event (see second column of Table 30). The more quickly the flood rises, the more quickly the two-year flow travels through the reservoir.

Table 30. Two-Year Flow Travel Time from McNary Dam to Points Downstream						
		Time (hours)				
	Slope (cfs/hour)	Existing	Natural River w/o Flood Control	Spillway Drawdown w/o Flood Control	Natural River w/ Flood Control	Spillway Drawdown w/ Flood Control
1948 Flood Port of Morrow Arlington John Day Dam	1181	2 3 3.5	3 8 11.5	4 15 22	3 8 11.5	4 15 22
1974 Flood Port of Morrow Arlington John Day Dam	764	1.5 2.5 3.5	3 7.5 11	3.5 14 21.5	3 7.5 11	3.5 14 21.5
1982 Flood Port of Morrow Arlington John Day Dam	2917	1.5 3 3.5	3 7 9	3 8 15	3 7 9	3 8 15
1996 Flood Port of Morrow Arlington John Day Dam	1597	1.5 2.5 3	3 7.5 10.5	3 11 17.5	3 7.5 10.5	3 11 17.5
1997 Flood Port of Morrow Arlington John Day Dam	2593	1.5 3 3.5	3 7.5 10.5	3 10 16.5	3 7.5 10.5	3 10 16.5

This relationship between how quickly the flood rises and two-year flow travel time through the reservoir is caused by storage behind the reservoir's spillway as the flood rises. Under Existing conditions, as the flood rises, the dam (theoretically) responds by releasing more water, thus increasing the flow almost as soon as it enters the pool. For Natural River conditions, the flood rises relatively slowly compared to the travel time. The depth is very close to "normal depth" for a given flow, and thus again responds more directly to changes in flow with little dynamic storage. However, for the Spillway Drawdown condition, the head has to increase behind the spillway before the flow increases. This increase in head represents dynamic storage that slows down the apparent arrival of flow of a given magnitude (say a two-year "trigger" flow), thus attenuating the downstream rise of the hydrograph, and being dependent on the rate of rise.

7.11.2 Analysis of Conditions "With" and "Without" Flood Control

Table 31 shows the maximum (peak) flows and maximum reservoir stages for the Spillway Drawdown and Natural River conditions, with and without flood control. The table also shows the length of the time that the maximum flow is released over the spillway during flood control operations. The Existing condition was not included in the table as flood control operations were not included in the simulations of this condition.

The results show that during Spillway Drawdown conditions, the pool could be maintained between elevations 233 and 249 ft NGVD without flood control, for the five major floods modeled. When flood control (as modeled here) is imposed, the pool increases by almost 20 ft in each case, and 19-26 days of release at the maximum flow would be required before the flood control volume is reduced to zero again. It is also interesting to note that flood control only results in a lessening of the peak discharge by about five percent but increases the length of time of relatively large releases.

Table 31.

Flow, Stage, and Release Time Comparison at John Day Dam

	Natural River w/o Flood Control	**Spillway Drawdown w/o Flood Control**	**Natural River with Flood Control**	**Spillway Drawdown with Flood Control**
1948 Flood Maximum Stage (ft) Maximum Flow (cfs) Release Time (days)	178 990,000	249 990,000	235 940,960 20	265 940,960 20
1974 Flood Maximum Stage (ft) Maximum Flow (cfs) Release Time (days)	170 605,000	237 605,000	229 548,970 20	255 548,970 20
1982 Flood Maximum Stage (ft) Maximum Flow (cfs) Release Time (days)	167 474,000	233 474,000	226 415,820 24	251 415,820 24
1996 Flood Maximum Stage (ft) Maximum Flow (cfs) Release Time (days)	167 474,000	233 474,000	224 427,950 19	251 427,950 19
1997 Flood Maximum Stage (ft) Maximum Flow (cfs) Release Time (days)	170 600,000	237 600,000	227 535,060 26	254 535,060 26

During Natural River conditions, the maximum river stage would vary between 167 and 178 ft NGVD without flood control. The influence of flood control, however, is much more dramatic, and maximum stages could increase nearly 60 ft at the dam. Again, the effect of flood control would be to reduce the peak discharge by only about five percent and require 19-26 days to return to a "pre-flood-control" condition.

Table 32 denotes changes in water surface elevations at selected locations along John Day Reservoir for both "with" and "without" flood control conditions for both drawdown alternatives.

Table 32. Predicted Maximum Water Surface Elevations for 1997 Flood along John Day Reservoir				
	Elevation			
River Mile and Location	Spillway Drawdown Without Flood Control	Spillway Drawdown With Flood Control	Natural River Without Flood Control	Natural River With Flood Control
216 (John Day forebay)	237	254	170	227
218 (John Day River)	237	254	171	227
252.5 (Willow Creek)	239	254	216	229
264.5 (Crow Butte and Whitcomb Island)	241	254	229	233
276.5 (McCormack Slough and Paterson Slough)	247	255	246	246
280 (Umatilla NWR)	251	257	251	250
289 (Umatilla River)	264	265	264	264

7.12 Irrigation Impacts

Under each of the four alternatives, all 30 irrigation pump stations will be adversely affected. Impacts will include the following:

- Excessive head loss from lowered pool level
- Intakes no longer functional at the new water level
- Increased pumping costs due to higher lift and additional pumps
- Increased operations and maintenance (O&M) required due to higher sediment loads from lower pool levels
- Interim pumping required during construction of pump station modifications to reduce impacts to multiyear irrigated crops. This cost would be evaluated in Phase II.

Impacts to irrigation water rights were not evaluated during this Phase I Study. If a Phase II Study were conducted, irrigation water right impacts would be evaluated at that time.

7.13 Water Supply Impacts

7.13.1 Municipal Water Supplies

Water supplies potentially affected at spillway crest and natural river drawdown reservoir elevations are shown in Table 33; likely impacts are rated for both pool elevations. The greatest potential impacts for water supplies will occur where the water-bearing zone and current well intakes located within the alluvial aquifer become nonfunctional. The drawdown of the reservoir under spillway crest or natural river level conditions will first affect the alluvial aquifer, which is the higher aquifer in the pool area and is directly recharged by the reservoir. Drawdown will also likely affect the recharge of the basalt

aquifer at the lower natural river drawdown elevations, and to a lesser extent at spillway drawdown elevations.

All surface water intakes located above the alternative drawdown pool elevation levels will be affected. There will be major impacts to shallow wells in the alluvial aquifer where the pool elevation leaves little or no water above each well's intake zone. There will be no recharge of the alluvial aquifer above this elevation, which would leave the wells essentially unusable. All Ranney wells in the pool will also be affected through lower effective head in the intake lateral lines, leading to insufficient head for proper operation, greatly decreased inflows, and subsequent high inflow of sands and silts into the system. These conditions would lead to progressive shutdown of the Ranney wells.

7.13.2 Private Wells

Under any of the alternative drawdown options, the effect on the water supplies for individual owners (domestic users) will vary in relation to the new operational reservoir levels, the distance between the well and the reservoir, and well screen elevation in the alluvial or basalt aquifer.

Wells having well screens in both aquifers may be partially affected because reservoir water recharges the basalt aquifer. In addition, approximately 1,200 small domestic wells are located farther away from the reservoir area, with their well screens in the basalt aquifer; these wells are not directly influenced by fluctuations in reservoir levels. In summary, an estimated 400 wells may be directly or partially affected by reservoir drawdown.

Table 33:

Water Supply Impacts

Identification Number (a)	Current Well Owner	Common Well Name or Designation	State	River Elevation - Spillway	River Elevation - Natural River	Impact Potential at Spillway	Impact Potential at Natural River Elevation	Drawdown Effects on Well Under Spillway and Natural River Elevations	Impact	Potential Recovery Alternatives [c]
See Note 6	City of Boardman	Ranney Collector (# 1) [a]	OR	223	223	High	High	Lowering of SWL	System inoperable	Combined river intake, pumps, pipeline, water treatment
See Note 6	City of Boardman	Ranney Collector (# 2) [b]	OR	223	223	High	High	Lowering of SWL	System inoperable	Combined river intake, pumps, pipeline, water treatment
1	USACE	LaPage Park Well	OR	218	161	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Resize/adjust pump/intake or replace well.
3	USACE	Albert Philippi Park Well	OR	218	162	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Resize/adjust pump/intake.
5 and 7	City of Arlington	Both Wells	OR	218	185	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Resize/adjust pump/intake.
11	Washington Dept. of Parks and Recreation	Crow Butte State Park Domestic Well	WA	228	218	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake.
12	Port of Morrow	Redi-Mix Well	OR	224	224	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
18	Boardman Park District	New Irrigation Well	OR	223	222	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
47	Columbia Jr. High School	--	OR	232	232	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
48	USACE	Marina Park Well # 1	WA	232	232	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
49	City of Irrigon	Well # 1 (Shallow)	OR	233	233	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
2156	City of Boardman	Boardman Backup Well	OR	222	222	Low	Low	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.

2158	USACE	Plymouth Park Campground	WA	245	245	Mod	Mod	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
2163	USACE /Plymouth	Backup Well	WA	250	250	Low	Low	Possible decr. in SWL.	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
2167	Port of Morrow	Frederickson, Oregon Hay	OR	222	222	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
CH2M 1-3	Port of Morrow	Carlson Sump #1 ,2, and 3	OR	223	223	High	High	Lowering of SWL	Loss of Head/gpm	Combined river intake, pumps, pipeline, water treatment
46	US Fish & Wildlife	Umatilla NWR Shop Well	OR	232	232	High	High	Lowering of SWL	Loss of Head/gpm	Drill additional depth/adjust pump/intake or replace well.
CH2M-10,11	Umatilla NWR/McCrm U	Domestic # 1 and # 2	OR	228	228	High	High	Lowering of SWL	Loss of Head/gpm	Combined river intake, pumps, pipeline, water treatment
CH2M-12	Umatilla NWR/Whtcm U	Domestic # 3	OR	220	215	High	High	Lowering of SWL	Loss of Head/gpm	Combined river intake, pumps, pipeline, water treatment
CH2M-6,7,8,9	Umatilla NWR/McCrm U	Well # 1,2,3, and 4	OR	223	223	High	High	Lowering of SWL	Loss of Head/gpm	Combined river intake, pumps, pipeline, water treatment
	City of Umatilla	Ranney Well Collector	OR	250	250	Mod?	Mod?	Lowering of SWL	Loss of Head/GPM	
	City of Hermiston	Reservoir Intake	OR	250	250	Mod?	Mod?	Lowering of SWL	System inoperable	
	Irrigon & Umatilla Fish Hatcheries	All Wells	OR	232	232	High	High	Lowering of SWL	System inoperable	Combined river intake, pumps, pipeline, water treatment
CH2M-15	City of Hermiston	New Well # 2	OR	--	--	Mod/ Low	Mod/Low	Possible lowering of SWL.	Loss of Head/GPM	Well info unknown. May be located near Hermiston.

a. Ranney Collector System Well for the City of Boardman drinking water, in operation since 1976.

b. Second Ranney System Well to be constructed in 1999.

c. Combined river intake water supplies are grouped together

(--) Indicates information not available.

7.14 Utility Impacts

Seven utilities along and/or crossing the reservoir that may be affected include an electrical utility, gas pipeline, and five sanitary sewer outfalls (see Table 12). Impacts and possible modifications include the following:

- **Benton Rural Electric Association.** Possible exposure of an underwater electrical utility between Plymouth, Washington and Plymouth Park (RM 289.5) may require relocation.
- **Williams Company Gas Pipeline - West.** Two 20-inch-diameter gas pipelines crossing approximately 4 miles upstream of Irrigon, Oregon (RM 286.3). Increased velocity may result in increased scour, requiring riprap protection. See Plate 16 for location.
- **Sanitary Sewer Outfalls.** Sanitary sewer outfalls for the cities of Arlington, Umatilla, and Boardman in Oregon and for the City of Roosevelt and Goldendale Aluminum Company in Washington will be exposed, resulting in NPDES permit violations. Outfall pipes for the cities of Umatilla, Boardman, Arlington, and Roosevelt and for Goldendale Aluminum will require extensions into the lowered river level. See Plates 11 through 16 for locations.

Impacts to the electrical utility crossing, gas pipeline crossing, and the Umatilla sanitary sewer outfall remain the same for each alternative. Modifications to the sanitary sewer outfalls for Boardman, Arlington, Roosevelt, and Goldendale Aluminum change under each alternative.

7.15 Hazardous, Toxic, and Radioactive Waste Impacts

Although solid waste and possibly hazardous, toxic, and radioactive waste may be encountered throughout the reservoir, the greatest likelihood of such encounters is near towns that were totally or partially relocated for the reservoir (Umatilla, Boardman, and Arlington, Oregon, and Roosevelt, Washington), as well as the Goldendale Aluminum smelter located just upstream from John Day Dam in Washington.

Most of the federal and state listed sites mentioned in this section would not be adversely affected by drawdown because they are not located along the present riverbank. Goldendale Aluminum, John Day Dam, and the underground storage tanks (USTs) at Umatilla Marina, Umatilla Pump Station, Boardman Park, and possibly Crow Butte State Park may be affected by drawdown. The active USTs at Umatilla Marina and Boardman Park are located at the shoreline of the current reservoir. It is not known whether the former UST at Crow Butte State Park was located on the reservoir shoreline, but a release has been documented from that tank.

For all four alternatives, a construction debris disposal site on the Washington shore at the upstream side of John Day Reservoir will be exposed. The presence of this debris site may impact construction and may have an adverse impact on water quality as oxidation occurs even if undisturbed during construction. There is also the possibility that clandestine disposal of solid or hazardous waste may have also occurred in the reservoir. Drawdown of the reservoir may expose these areas (if any).

7.15.1 Specific Sites

7.15.1.1 John Day Dam

If hydropower generation were to cease at John Day Dam, all chemical products stored at the facility would require removal. Unused products could be transferred to another operating district dam for use. The Dalles/John Day Projects have contracts in place for the routine removal/disposal of used chemical products. Those contracts could be used for the final removal of used products from the John Day Dam. Additionally, two USTs located near the warehouse will require decommissioning if hydropower generation were to cease.

7.15.1.2 Goldendale Aluminum

Six hydraulically connected groundwater aquifers beneath the Goldendale Aluminum plant are contaminated. The lower two aquifers are hydraulically connected to the John Day Reservoir. Since groundwater flow is toward the river, drawdown might affect the groundwater flow regime under the plant. If drawdown occurs, groundwater flow to the river would likely increase. Greater contaminant loading from the aquifers to the lowered river can be expected.

Sediments in the vicinity of the Goldendale Aluminum plant, as well as the towns along the current shoreline, may be contaminated. Additional information about sediment quality is necessary to draw conclusions about potential impacts, and is discussed in the Sediment Quality Section of the Engineering Technical Appendix. If contaminated sediments were exposed during drawdown, they eventually would dry out and be subject to wind erosion, water action, oxidation, and volatilization. Vegetative growth, erosion control blankets, or soil cover would reduce erosion. Contaminated sediment will require some type of cover to avoid exposure.

7.15.1.3 Relocated Sites

All of the relocated gasoline stations, garages, maintenance shops, fuel tank farm, some of the residences, motels, and schools in the former towns of Boardman, Arlington, and Roosevelt used USTs for motor vehicle fuel or heating oil storage. When the relocations occurred during the 1960s, the potential for contamination associated with leaking USTs had not been recognized. Regulations governing the removal of USTs were nonexistent. At least some of the USTs probably remain in place. Most of the former City of Arlington was served by a sewer collection system that disposed of untreated sewage in the river. Sewage disposal in the rest of Arlington and the former City of Boardman consisted of individual septic tanks with ponds/drainfields. Many of those systems may remain in place. Because of the small size of the former town of Roosevelt, sewage disposal there likely consisted only of individual septic systems.

7.16 Recreation Impacts

With drawdown, the opportunities for river access would become limited due to topography. The parks themselves would not be lost, but the distance to the water and the boat ramps would increase, rendering certain key features of the facilities (e.g., boat ramps, beaches) nonfunctional. A major attraction for campers is the proximity of the camping sites to the water; therefore use of camping areas could be diminished under drawdown alternatives.

Under drawdown conditions (particularly Alternative 3, natural river without flood control), the river will become narrow, velocities will increase, and backwaters or large eddies that provide

suitable access will no longer exist. Without breakwaters or groins, launching of boats and windsurfing boards will be difficult. Beaches that feature safe swimming or areas for beginning windsurfers may be hard to re-establish since the quiet backwater pools will be eliminated. The remaining options for swimming will be in the Columbia River channel where river velocities may prohibit construction or safe access (USACE, 1994).

The aesthetic feeling that water provides will also be gone from many of the parks, so the recreational experience will change (as cited during site visit interviews, 1999). Many of the parks are dual-use parks. They not only offer sites for launching a boat and fishing, but are for camping and general enjoyment of the river. After drawdown, the parks will lose the attraction they had for campers. At drawdown, the exposed land will be barren. Due to the arid environment (and inherent temperature extremes in summer and winter), landscaping in and around the parks will be difficult to establish without irrigation and frequent maintenance.

7.16.1 Railroad Island (WA), RM 216

Plates 32 and 33 illustrate that all river access facilities would be dry with each of the drawdown levels. USACE has closed this area, but it is still used by the public and tribal fishermen. Consequently, coupled with the fact that the area will also be a treaty-fishing site, new facilities may be required to provide access to the river.

7.16.2 Le Page Park (OR), RM 217

The area around the boat ramp, the moorage on the landward side of the handling docks, and the established swimming area will be dry under all alternatives (see Plates 34 and 35). Consequently, coupled with the fact that the area will also be a treaty-fishing site, new facilities would be required to provide access to the river.

7.16.3 Albert Philippi Park (OR), John Day RM 3.5

Under all four drawdown alternatives, the Columbia River will not back up into the John Day River as it does under current operation (see Plates 36 and 37). The entire facility will be landward of the John Day River and dry. Recreational use will change from slack water to swift water activities.

7.16.4 Rock Creek (WA), RM 229

River access will be limited at this recreation site, with the exception of water coming down Rock Creek (see Plates 38 and 39). The backwater effect from the John Day Reservoir will be eliminated. All water-based facilities will be dry under all drawdown alternative elevations.

7.16.5 Blalock Canyon Boat Ramp (OR), RM 233.5

Access through the culvert will not be available under any of the four alternatives (see Plates 40 and 41); however, during flood conditions, where water surface elevations exceed minimum operating pool (elevation 257), access will be limited to very shallow-draft vessels. The boat ramp will not reach the water.

7.16.6 Roosevelt Park (WA), RM 241

It is possible that the boat launching facilities will be usable at the higher flows for alternative 2, but this would be a short-term effect while the water surface levels return to normal. Therefore, all facilities will be dry for all proposed alternatives (see Plates 42 and 43).

7.16.7 Arlington Marina (OR), RM 241

Plates 42 and 43 illustrate that the marina will be dry except during high flood events for Alternative 2.

7.16.8 Earl Snell Park, Arlington (OR), RM 241

Under Alternative 2, a very large flood event would raise the water surface level in the park close to current operating levels, but this level would recede as the storage from the flood is drawn down. Under all other alternatives, the lake in the park would be dry (see Plates 42 and 43).

7.16.9 Quesnel Park (Threemile Canyon) (OR), RM 255

Each of the proposed alternatives, except major flood events under Alternative 2, would cause Quesnel Park to be dry (see Plates 44 and 45).

7.16.10 Crow Butte (WA), RM 262

All river access facilities, including the irrigation intake, would be dry (see Plates 46 and 47). Most people who use the camping and day-use facilities do so without boats. The main attraction is the park itself and the water that surrounds the park, which is used for swimming, and provides an aesthetic feeling. Therefore, without the water, the recreation use of the park would be diminished.

7.16.11 Boardman Park and Marina (OR), RM 269

The entire facility would be dry (see Plates 48 and 49) under all alternatives except Alternative 2. Under Alternative 2, the marina could possibly return to current levels, but after a flood the water level would quickly recede.

7.16.12 Irrigon Park and Marina (OR), RM 282

All facilities will be dry at all but the highest high flood conditions under Alternatives 2 and 4 (see Plates 50 and 51).

7.16.13 Umatilla Marina Park (OR), RM 290

The average bottom elevation in the marina is 253. Therefore, the marina (and swimming beach) would be dry under all alternatives using the lower water surface elevations (see Plates 52 and 53 The higher water surface elevations under Alternatives 1 and 3 would create a marina that could be used by boats drawing less than 4 feet of draft, but it would only be for part of the year. The larger cruise ships would not be able to use the marina.

7.16.14 Plymouth Park (WA), RM 289

All river access facilities would be dry for all alternatives at the lower elevations (see Plates 52 and 53). At the higher elevations, water would reach the boat ramp, but it would be a seasonal effect. Except for the access by-way, the area is completely surrounded by water. The camping

facilities would not be physically affected by the drawdown (except water for irrigation), the aesthetic feeling that the water provides would be lacking, which might discourage people from using the park after the drawdown. The same can be said for the day-use area, but the effect due to the lack of water would be greater since the grassed area and picnic area border the water edge.

7.16.15 Nugent Park (OR), Umatilla RM 1

At drawdown, the John Day impoundment will not extend upstream to Nugent Park, thereby rendering the boat ramp unusable. Due to the low flows in the Umatilla River except during high flow events, boat access may no longer be practicable. The wheelchair access fishing structure would also be left dry (see Plates 52 and 53), making it unusable for its intended purpose.

7.17 Aquatic Resource Impacts

John Day drawdown alternatives would likely benefit native cold water fish adapted to flowing water conditions and negatively affect resident reservoir species that prefer quiescent conditions. Most of the fish that would be adversely affected are non-native species, introduced into the system over the last century. These exotic fish are well adapted to reservoir habitat, and they have increased in relative abundance in recent years. Under drawdown to natural river channel conditions, the fish community would likely revert to one more historically representative of resident fishes found in the Columbia River Basin. Suitable habitat for non-native species, such as crappie, pumpkinseed, bullheads, and yellow perch, would be largely eliminated. White sturgeon and native riverine specialists, such as cyprinids and cottids, would probably exhibit significant increases in abundance under drawdown. Populations of smallmouth bass and northern pikeminnow may not change substantially.

7.17.1 Potential Effects on Juvenile Salmonids

The influence of the various drawdown alternatives at John Day Dam on juvenile salmonid fish results from a combination of factors, including both juvenile passage past the dam and through the reservoir commensurate with different reservoir elevations, river discharges, and current velocities. Losses resulting from dam passage are a function of passage route selected by the fish (turbines, spill, bypass system, locks, or ladders) and the degree of injury inherent with each route. River discharge, water temperature, amount of spill, and size of the outmigrant can all affect passage survival rates. Reservoir-related mortalities are assumed to be primarily a function of passage timing (speed and season of the year) and the resultant degree of exposure to salmonid predators.

Extensive shallow and slack-water habitat located in the upper one-third of the John Day Reservoir would be lost as a result of drawdown. Loss of this habitat might substantially reduce the natural production of upriver bright fall chinook salmon, which is the only healthy stock of anadromous fish remaining in the upper Columbia River Basin.

7.17.1.1 Yearling Outmigrants

Drawdown will have little or no effect on reservoir rearing of species exhibiting primarily yearling or older juvenile outmigration strategies (stream-type fish), such as spring chinook, steelhead, and sockeye, because they do not rear in the reservoir. Benefits or impacts to these

species will arise primarily with decreased travel time through the reservoir, as discussed in the following section.

7.17.1.2 Subyearling Outmigrants

Juvenile fall chinook salmon that emigrate primarily as subyearling (ocean-type) fish are known to utilize the nearshore habitat of the John Day Reservoir for rearing during the spring and early summer months. Consequently, the John Day Dam drawdown alternatives could substantially affect the various stocks of fall chinook. The effect of reduced reservoir rearing space on the production of fall chinook in the John Day reach is uncertain.

The URB stock of fall chinook currently supports a robust and increasing population of salmon in the Columbia River. The extensive shallow-water rearing environment now present in the upper John Day Reservoir may provide considerable benefit to the production of this stock. Backwaters, off-channel ponds, and nearshore stream margins with low water velocities may constitute the best habitat conditions for rearing juveniles.

7.17.1.3 Habitat Changes

Changes in river morphology resulting from a reservoir drawdown to natural river level may provide slightly more rearing habitat area compared with current conditions. Thus, even with a loss of approximately 25,000 acres of near-shore reservoir surface area, there may be no net loss, and perhaps even a small increase, in available rearing habitat for fall chinook salmon under drawdown to natural riverine conditions.

The higher water velocities found in riverine systems promote a diversity of substrates and microhabitats that result in a richer, more abundant invertebrate community than that found in reservoir systems. Therefore, the natural river alternatives may offer greater production potential for juvenile fall chinook salmon than either current conditions or the spillway crest alternatives. However, compaction of substrate resulting from fine sediment deposition during inundation and continuing attenuation of peak flows following drawdown may prevent restoration of quality riverine habitat condition for many years or indefinitely. In Table 34 the total acres of high and low probability habitats were calculated for three alternatives.

Table 34. Acres and Probability of Habitat Cells Containing 10 or More Subyearling Chinook Salmon (300 kcfs) in John Day Reservoir

Parameter	Normal Operating Pool (acres)	Spillway Crest (acres)	Natural River (acres)
Total Acres	49,406	32,025	25,486
Total Usable Acres	1,399	1,305	1,434
Probability > 70%	686	628	785
Probability < 70%	713	554	649

from USGS, 1999.

For a discussion of potential changes in water quality conditions including turbidity, dissolved gas, temperature and other parameters, see “7.5 Water Quality Impacts”.

7.17.1.4 Rate of Migration

Juvenile anadromous salmonids move through the Snake River and lower Columbia River impoundments one-half to one-third slower than they would through free-flowing river sections of the same length. If the rate of fish outmigration is passive with respect to river velocities, then the potential benefit under drawdown would be equal to the change in water velocity.

Under normal conditions, during the outmigration period (300 kcfs), a benefit of approximately 2 to 3 days faster travel time could be realized with drawdown to spillway crest and natural river level, respectively. As river discharge increases above 300 kcfs, the level of change from existing conditions diminishes.

Although several studies indicated that water velocity is a primary determinant of juvenile migration speed, other studies suggest factors besides flow may be affecting the dynamics of outmigration. Migration speeds increase later in the outmigration season as water temperatures increase. There is also a strong correlation between the level of smolt development and the time of year. Migration speed is faster at higher levels of smolt development. As discussed previously, active rearing in the reservoir can also slow down the rate of migration, as evidenced by studies of fall chinook.

7.17.1.5 Predation Estimates

Increasing migration rates through the reservoir as a result of drawdown is intended to reduce exposure to predator fishes and decrease juvenile losses. The assumed change in predation losses through the reservoir for fall chinook, the species with the greatest overlap and exposure to predators, resulted in an increase in in-river survivals of 2 and 3 percent for Alternatives 1 and 3, respectively.

7.17.1.6 Total Project Juvenile Salmonid Survival (In-River Survival)

Mortality is attributed to direct dam mortality (as fish pass through turbines, bypass systems, or spillways of dams), predation (predator temperature response functions, predator consumption rates, and predator abundance indicators in the forebays, tailraces, and main bodies of the reservoirs), and gas bubble disease resulting from total dissolved gas supersaturation. Mortality and injury associated with turbine passage and gas supersaturation at John Day Dam would be eliminated under the natural river level drawdown option (Alternative 3).

Survival estimates based on juvenile fish passage modeling for Snake River spring and fall chinook from Lower Granite Dam to Bonneville Dam are summarized in Table 35. These estimates were based on the most optimistic assumptions regarding potential benefits of John Day drawdown that are scientifically defendable and were used in the PATH modeling analysis approach. However, survival estimates without barging in 1999 were 56 percent from Lower Granite Dam to Bonneville Dam. Though PIT-tag survival estimates specifically for John Day Reservoir are not available, high system survival in 1999 suggests that benefits of John Day drawdown may be substantially less than those estimated using the PATH modeling results.

Table 35. Mean Juvenile Migrant Survival Rate Estimates (LGD to BON) from CRiSP Modeling Analysis for Alternative with John Day Drawdown (percent)		
	Survival Estimates Snake River Stocks	
Management Actions	Spring Chinook	Fall Chinook
Existing Conditions (including Barging of Juveniles)	81	78
Existing Conditions (without Barging of Juveniles)	44	28
Alternative 1: Drawdown to Spillway Crest	47	30
Alternative 3: Drawdown to Natural River	50	31

7.17.1.7 Barge Transportation

The estimated mean smolt survival rates presented in Table 35 include survival rates for in-river migrants passing through the reservoir without the benefit of transportation under existing conditions. However, under current hydro system operations approximately 93 percent of the Snake River spring chinook and 97 percent of the fall chinook arriving below Bonneville Dam are transported.

Snake River chinook are primarily captured and barged or trucked to below Bonneville Dam and have higher survival rates to that point than fish migrating through the lower Snake River and Columbia River hydroelectric system. The present deep-draft barges used for transportation are too deep to navigate the reservoir under drawdown conditions. If transportation by barge is terminated, survival of juveniles to the point below Bonneville Dam is estimated to decrease for spring chinook outmigrants. However, these results do not consider possible post-transportation mortality effects, which are included in the modeling results presented in Tables 37 through 39. Transportation for Snake River fall chinook, which occurs primarily by truck, could continue even if barging was terminated, as long as collection of Snake River fish continued.

It has been hypothesized that additional post-transportation mortality occurs below Bonneville Dam to juvenile chinook salmon transported from the Snake River. In the life-cycle modeling analysis performed by PATH, a "D-factor" was used to impart additional "delayed mortality" to transported verses non-transported Snake River migrants. Mechanisms responsible for this differential mortality have not been substantiated, and there is disagreement among biologists as to the magnitude of any delayed mortality that may occur. Effects of transportation on straying rates of returning adults and on selection of certain life history strategies or species over others have been raised as concerns regarding the use of transportation. Associated impacts on survival may contribute to differential mortality (i.e., the “D” factor) between transported and in-river (i.e., non-transported) juvenile migrants. Assumptions regarding the size of this factor greatly affect results concerning the benefits of Snake River and John Day drawdown. We have used modeling results that maximize the potential benefits associated with John Day drawdown. Actual benefits are likely to be less, and could be far less than those reported in this document.

In addition, three alternative hypotheses concerning "extra mortality" occurring in the ocean were formulated and modeled under the PATH analytical approach. One hypothesis postulated that

extra mortality in the ocean was attributable to hydrosystem effects in the Snake River. The estimated benefits presented in this report are based on modeling results obtained under this assumption because they maximize potential benefits from drawdown. Alternative hypotheses attribute extra mortality in the ocean either to ocean environmental conditions or to reduced "fitness" of Snake River chinook as a result of hatchery program influences. Under these alternative hypotheses, benefits from drawdown would be substantially less than those reported.

7.17.2 Salmon Life-Cycle Modeling

Results of the juvenile fish passage model were incorporated into life-cycle models to characterize the effect of John Day drawdown alternatives on returning adult population levels. Two modeling approaches were used: 1) a Bayesian life-cycle model to assess the probability of complying with NMFS standards for survival and recovery of the stocks and 2) a deterministic life-cycle model to assess equilibrium levels of spawning populations and total returns (i.e., spawners plus harvest) under management to obtain maximum sustainable yield (MSY) for each alternative as a means to estimate gains or losses of spawning adults and total returns when comparing two separate management actions.

These models are based on the life cycle of salmon (Figure 7) with generally four important stages;

1) freshwater spawning and production stage (extending from eggs in redds [spawning nests], to the beginning of smolt migration);
2) freshwater smolt migration stage (from Lower Granite Dam to Bonneville Dam);
3) estuarine and oceanic survival stage (Bonneville Dam to Bonneville Dam) and
4) upstream adult migration stage (Bonneville Dam to the spawning grounds).

The number of adult spawning recruits (returning adults to the spawning grounds) is expressed as the product of survival at each of the above four life stages with the inclusion of ocean and river harvest mortalities. Refer to the Aquatic Resources Section in the Biological/Environmental Technical Appendix for details of the models.

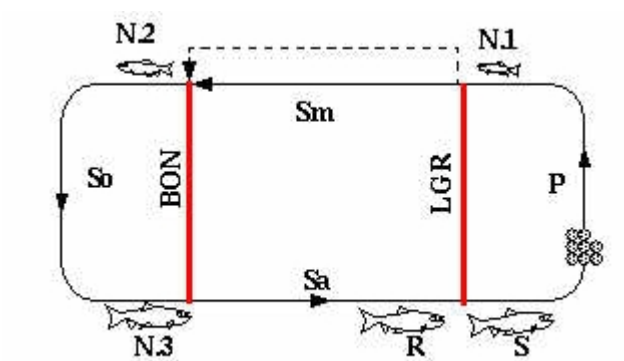

Figure 7. Life Cycle of Salmon - Life Cycle of Salmon extending from freshwater production stage, P, to hydrosystem survival, Sm, from Lower Granite Dam (LGR) to Bonneville Dam (BON), which includes in river and transport passage, to ocean survival, So, to upriver adult migration survival, Sa. S spawners produce R recruits.

A great deal of uncertainty exists over what survivals will be in free-flowing river segments after reservoirs are drawn down to natural river levels. To characterize the range of uncertainty, PATH estimated the upper and lower bounds of survival based on existing PIT-tag data in free-flowing areas of the Snake River as follows in Table 36.

Table 36.
Upper and Lower Bounds of Survival (Based on Existing PIT-tag Data)

	Survival	
Snake River Stock	**Upper Estimate**	**Lower Estimate**
Spring Chinook	96%	85%
Fall Chinook	90%	61%

The, 1998 PIT-tag data for the impounded John Day reach suggested a mean survival of 83% for both spring and fall chinook (Skalski and Townsend, 1999). Current passage survival estimates in the impounded reach for chinook lie within the range of uncertainty for survival in free-flowing reaches. The potential benefit of altering from impounded to a free-flowing reach then would range for spring chinook between two and 13 percent. The maximum benefit is anticipated to be a seven percent improvement in survival of fall chinook.

Actual survival estimates as modeled under the fish passage model for the John Day reach are in the range of half these maximum benefit assumptions.

7.17.3 Probability of Improved Juvenile Survival and Adult Returns with Drawdown Alternatives

In summary, the effects of John Day drawdown may change in-river migrant juvenile survival rates for Snake River spring and fall chinook by three to six percent and by one to two percent, respectively, depending upon the drawdown alternative. Differences among alternatives with respect to equilibrium spawning population levels for Upper Columbia spring chinook could range from as much as 101 to 184 spawners (a 10 to 17 percent increase) under the various drawdown alternatives). Relative changes in natural production of the Hanford Reach URB fall chinook stock located above McNary Dam, however, represent a decrease by 11 to 13 percent (16,876 to, 19,315 spawners). Similarly, Snake River spring chinook equilibrium spawning populations could decrease by as much as 7,980 adults, under Alternative 3 (John Day drawdown to natural river without flood control) while Snake River fall chinook equilibrium spawning populations could increase by as much as 6,179 adults, assuming that transportation effectiveness is low. Under this assumption, however, benefits from termination of transportation alone (i.e., without John Day drawdown) would result in a fall chinook equilibrium spawner population level increase of 5,631 fall chinook adults. The resulting net benefit for Snake River fall chinook from John Day drawdown, aside from benefits associated with termination of transportation, is an increase of only 548 or fewer fall chinook spawners. Conversely, under assumptions of high transportation effectiveness, John Day drawdown actions would be detrimental to these spawning populations. Regardless, Bayesian life-cycle assessment and PATH analysis indicated that small

levels of benefit would result from John Day drawdown for Snake River spring and fall chinook with respect to the probability of realizing 24-year survival and 48-year recovery standards discussed in the, 1995 NMFS Biological Opinion on Federal Hydropower System Operation (Table 38).

Mortality and injury associated with turbine passage and gas supersaturation at the John Day Dam would be eliminated under the natural river level drawdown option (Alternative 3). This improvement is one of several contributing to the results of the analysis presented above.

Table 37. Fisheries Benefit Summary (Alternatives 1 and 2: John Day Drawdown to Spillway Crest With or Without Flood Control)[a, h]

	Snake River		Columbia River	
Standard	**Sp/Su Chinook**	**Fall Chinook**	**Fall Chinook**	**Spring Chinook**
With Snake River Drawdown				
Decreased Travel Time[b]	4.0	6.0	NA	NA
Juvenile Survival Rate[c]	14%	5%	NA	1%
Probability of Survival[d]	NA	NA	NA	NA
Probability of Recovery[e]	NA	NA	NA	NA
Equilibrium Pop. Levelf,[g]	17,860	10,894	-19,315	101
Total Returns at MSY[f,g]	16,454	73,654	-64,178	88
Without Snake River Drawdown				
Decreased Travel Time[b]	1.1	1.0	NA	NA
Juvenile Survival Rate[c]	3%	2%	NA	1%
Probability of Survival[d]	NA	NA	NA	NA
Probability of Recovery[e]	NA	NA	NA	NA
Equilibrium Pop. Level[f,g]	-9,918	5,972	-19,315	101
Total Returns at MSY[f,g]	-5,396	16,877	-64,178	88
Reference Footnotes at the bottom of Table 39				

Table 38. Fisheries Benefit Summary (Alternative 3: John Day Drawdown to Natural River Channel without Flood Control)[a, h]				
	Snake River		**Columbia River**	
Standard	**Sp/Su Chinook**	**Fall Chinook**	**Fall Chinook**	**Spring Chinook**
With Snake River Drawdown				
Decreased Travel Time[b]	7.4	11.0	NA	NA
Juvenile Survival Rate[c]	27%	10%	NA	2%
Probability of Survival[d]	4%	1%	NA	NA
Probability of Recovery[e]	28%	33%	NA	NA
Equilibrium Pop. Level[f,g]	19,798	11,024	-16,876	184
Total Returns at MSY[f,g]	19,076	76,406	-57,322	165
Without Snake River Drawdown				
Decreased Travel Time[b]	2.1	2.4	NA	NA
Juvenile Survival Rate[c]	6%	2.0%	NA	2%
Probability of Survival[d]	0.50%	0.00%	NA	NA
Probability of Recovery[e]	3%	4%	NA	NA
Equilibrium Pop. Level[f,g]	-7,980	6,179	-16,876	184
Total Returns at MSY[f,g]	-4,484	18,058	-57,322	165
Reference Footnotes at the bottom of Table 39				

Table 39.

Fisheries Benefit Summary (Alternative 4: John Day Drawdown to Natural River channel with Flood Control)[a, h]

Standard	Snake River		Columbia River	
	Sp/Su Chinook	Fall Chinook	Fall Chinook	Spring Chinook
With Snake River Drawdown				
Decreased Travel Time[b]	NA	NA	NA	NA
Juvenile Survival Rate[c]	NA	NA	NA	NA
Probability of Survival[d]	NA	NA	NA	NA
Probability of Recovery[e]	NA	NA	NA	NA
Equilibrium Pop. Level[f,g]	19,190	11,024	-16,876	143
Total Returns at MSY[f,g]	18,202	76,406	-57,322	126
Without Snake River Drawdown				
Decreased Travel Time[b]	NA	NA	NA	NA
Juvenile Survival Rate[c]	NA	NA	NA	NA
Probability of Survival[d]	NA	NA	NA	NA
Probability of Recovery[e]	NA	NA	NA	NA
Equilibrium Pop. Level[f,g]	-8,626	6,179	-16,876	143
Total Returns at MSY[f,g]	-4,750	18,058	-57,322	126

a. Based on the most optimistic results regarding potential benefits derived from life-cycle modeling. Actual benefits may be less.

b. Change in days from current conditions for juvenile travel time from above Lower Granite Dam to below Bonneville Dam.

c. Change in percentage points from current survival conditions for in-river (i.e., non-transported) migrants from above Lower Granite Dam to below Bonneville Dam.

d. Change in percentage points of annual spawning escapements projected to be above a predetermined threshold of minimum (Survival Standard) abundance. The PATH process included analysis across both short-term (25-year) and long-term (100-year) time frames. The threshold values used were 150 and 300 spawners, depending on the particular index stock and stream modeled. PATH analyses compared modeling results to an informal survival standard set at 70% of all modeled runs, reflecting a "high likelihood" of spawner escapement being over the threshold. These criteria were used in the development of the, 1995 NMFS Biological Opinion for Columbia River Federal Hydropower System Operation.

e. Change in percentage points of life-cycle simulation model runs for which the average resulting spawner abundance over the last 8 years of a 48-year model run was greater than a predefined Recovery Standard level of abundance. For Snake River fall chinook, the level used was 2,500 spawners. For Snake River spring/summer chinook, the level was set at 60% of the pre-1971 average spawner count for each index stock. These criteria were based upon the, 1995 NMFS Biological Opinion for Columbia River Federal Hydropower System Operation.

f. Change in number of fish from current conditions assuming poorest differential survival (D) for transported juveniles in comparison to in-river migrants (D = 0.65 for Snake River spring/summer chinook, 0.05 for Snake River fall chinook, and 1.00 for Upriver Bright [URB] fall chinook salmon). Equilibrium Population (Pop.) Level (EPL) is at maximum sustainable spawner escapement (i.e., under no-harvest conditions). Total Returns are the combination of spawners and harvest at maximum sustainable yield (MSY) population levels.

g. Under the assumption of poorest D for transported juvenile fish (Item f), termination of Snake River fall chinook transportation alone (i.e., without drawdown of any dams) would result in benefits of 5,631 EPL spawners and 15,054 total returns.

h. NA = Not analyzed or applicable.

7.17.4 Potential Effects on Spawning Adult Salmonids

Adult fish passage past John Day Dam would be improved resulting in higher adult survival under most environmental conditions with drawdown to natural channel level (Alternatives 3 and 4). Under all John Day drawdown alternatives, adult fish migration could be terminated at flows exceeding the 10-year event of 515,000 cfs. Since completion of the Columbia River Basin hydropower system in the 1960s, flows at John Day Dam have exceeded this level only twice, in 1974 and in 1997. Flows above the 10-year level occurred in May and June, and had a duration of approximately 1 to 3 weeks. Adult passage curtailment during this time frame could have affected late runs of spring and early runs of summer chinook salmon, and perhaps very early runs of sockeye salmon. Earlier or later portions of runs would not have been affected.

Elimination of John Day Dam under Alternative 3 would also eliminate delay and reduce unintentional fallback of adult salmon and steelhead that currently occurs at the dam. Bjornn (1999) found that the fallback rate of John Day Dam for adult migrants ranged from 12 to 15 percent during periods of spill to aid juvenile migrant passage. Approximately 3 to 5 percent of those fish that fall back to below Columbia River Dams after passing then become lost in the system, either dying before spawning or straying into other areas. The benefit of eliminating spawner delay at John Day Dam under drawdown to natural river level could be offset by a slower average upstream migration timing because of higher flow velocities.

Prior to impoundment, the John Day reach of the mainstem Columbia River supported approximately 30,000 spawning fall chinook salmon. There is no historical evidence of other anadromous salmonid species or stocks utilizing mainstem reaches in the lower Columbia River for spawning.

7.17.4.1 Spawning Habitat Quantity Below McNary Dam

Under current conditions approximately 1,113 acres of potential spawning habitat are available to support spawning below McNary Dam during river flows of 100,000 cfs. This amount represents less than 5 percent of the wetted area in the John Day Reach. Most of the currently available potential spawning habitat is located in the uppermost 10 miles of the reservoir, as shown in Figure 8.

7.17.4.2 Estimated Benefits under Drawdown

The potential increase in salmon spawning for fall chinook below McNary Dam is a result of greater lineal distance available for spawning and the amount of potentially suitable habitat along the reach distance. Estimated fall chinook salmon potential spawning habitat quantities for both drawdown alternatives without flood control are shown in Table 40. Flood control operations with either alternative would not influence the levels of potential spawning or incubation because they do not occur during the flood season.

The potential benefits estimated in Table 40 are based on three important assumptions. We assumed that spawning, rather than rearing or some other life-history component, was limiting fall chinook production under both current and future, drawdown conditions. However, excess spawning habitat exists inmost years in the Hanford Reach above McNary Dam under current conditions. We assumed that all potential spawning habitat would be restored to a usable

condition under drawdown conditions. However, compaction of gravel and continuing attenuation of peak flows following drawdown could prevent or limit habitat recovery. Finally, we assumed that the potential spawning habitat (under both current and drawdown conditions) can, and would, become fully seeded with spawners. However, there is no documentation of the use of existing potential spawning habitat currently available in the John Day reach below McNary Dam even in years of strong adult fish returns.

Table 40. Potential Spawning Habitat and Estimates of Potential Seeding Capacity in the John Day Reach Under Three Drawdown Alternatives

	Potential Spawning Habitat (acres) [a]	Total Effective Spawning Area (acres) [b]	Redd Capacity (#)[c]	Spawner Capacity (#)[d]
Existing Condition	1,113	42	2,750	5,500
Drawdown to Spillway Crest	6,296	239	15,550	31,100
Natural River Drawdown	11,170	424	27,500	55,000

a. After Digital Atlas reservoir model using water depth and velocity criteria only; (USGS, 1999).

b. Assumed total effective area = 3.8% of available area (after Connor et al., 1994).

c. Assumed redd spacing of 65 redds/acre (after Swan, 1989).

d. Assumed one redd per female and a sex ratio of 1:1 males to females [approximately 2.0 fish/redd] (Swan, 1989).

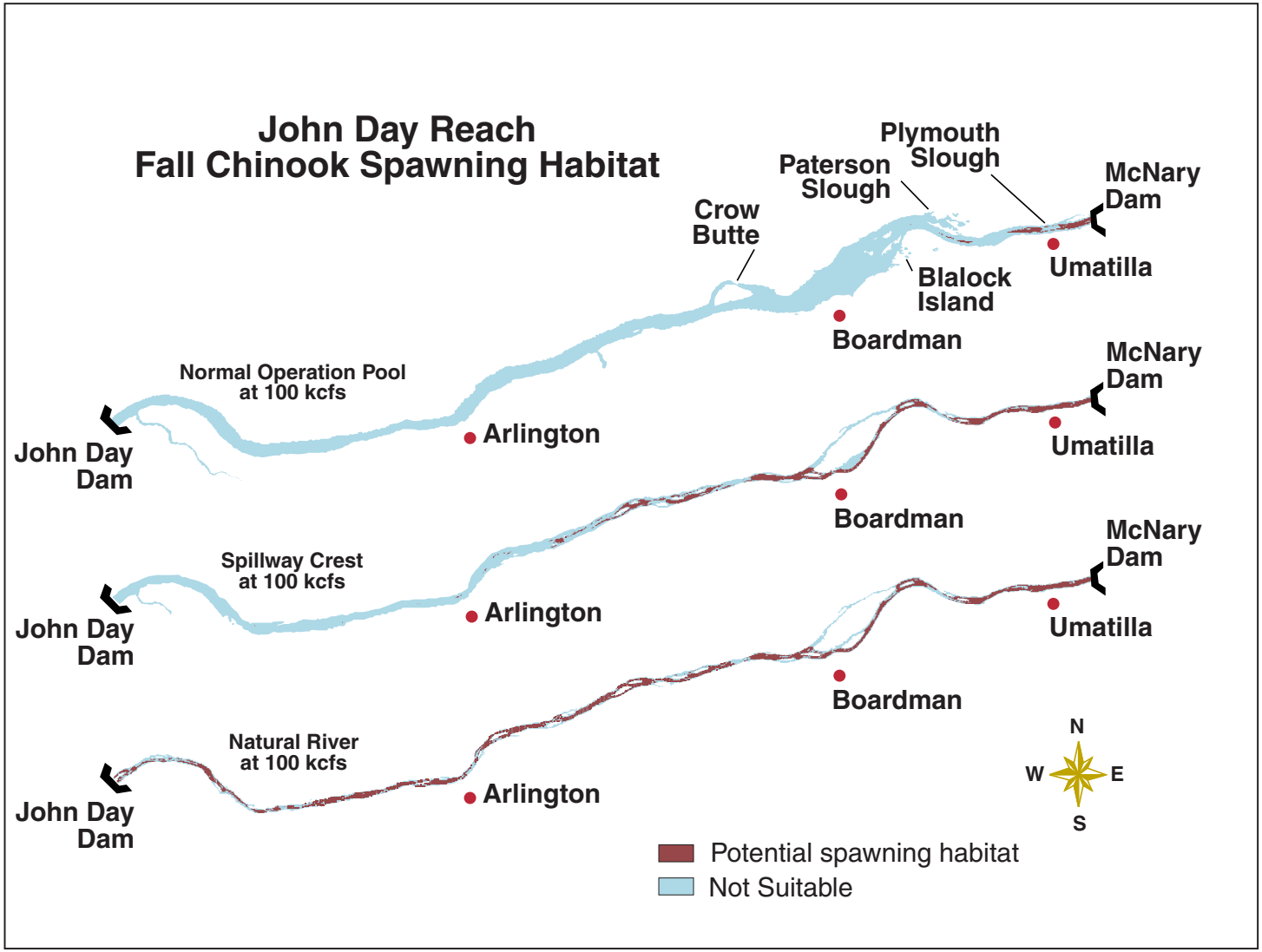

Figure 8. John Day Reach - Fall Chinook Spawning Habitat (from USGS 1999).

7.17.5 Potential Change in Harvest Benefits from Restored Natural Production Below McNary Dam

The potential increase in spawner levels below McNary Dam in a fully seeded John Day reach could produce approximately 2.56 million and 4.95 million more naturally produced smolts under Alternatives 1 and 3, respectively. However, as a result of improved egg-to-smolt survivals from artificial propagation facilities compared to natural production, the smolt production under current mitigation hatchery programs exceeds the natural river alternative by more than twofold (Table 41). Presumably, mitigation hatchery programs would be phased out as natural reproduction of fall chinook salmon in the John Day reach is restored. This would result in a slight decrease in numbers of harvestable fall chinook resulting from potential natural production in, or mitigation hatchery production directly associated with, the John Day reach.

Table 41.

Available Adults to Fisheries from Increased Habitat Capacity in the John Day Reservoir

	Spawner Capacity	Smolt Yield (100 smolts/ spawner)[a,e]	Hydro System Survival[b]	Potential Adult Returns[c]	Fish Available to Fishery[d]
Current Natural Production	5,500	550,000	314,500	16,100	10,600
Drawdown to Spillway Crest	31,100	3,110,000	1,960,000	100,600	69,500
Drawdown to Natural River	55,000	5,500,000	3,790,000	194,500	139,500
Current Hatchery Production	30,000	11,900,000	5,110,000	168,000	138,000

a. Assumes 4,300 eggs per female spawner and an egg to smolt survival of 4.65% in the wild (Chapman et al., 1994).

b. Assumes a project survival rate of 83%, and estimate varies by the number of hydro projects passed.

c. Assumes a smolt to adult return of 3.29% in good ocean conditions and in lieu of a fishery (Peters et al. 1999), and a survival level for naturally produced smolts that is 1.56 times better than that of hatchery smolts (Chapman et al., 1994).

d. Adult returns less spawner replacements under periods of good ocean conditions.

e. John Day Dam sponsored mitigation releases only (1999 goals).

Under poor ocean conditions and high harvest rates, adult returns under any alternative are insufficient to replace the spawning population.

In summary, drawdown to natural river level may result in an estimated 8- to 10-fold increase in fall chinook salmon spawning capacity below McNary Dam compared with current levels of potential spawning habitat in the John Day reach. Drawdown to spillway crest is expected to achieve perhaps 50 to 75 percent of the potential benefit achieved under drawdown to natural river conditions. Alternatives including flood control (Alternatives 2 and 4) are not expected to influence the level of spawning habitat improvements.

The potential improvements to spawning habitat would benefit the Upriver Bright stock of fall chinook salmon, which is not at risk of extinction, but would not benefit the listed Snake River

stock that is associated with the intended purpose of John Day drawdown. The Snake River fall chinook stock, listed as threatened, and the other ESA (Endangered Species Act) listed species that were evaluated would not benefit from changes in available spawning habitat. They would however, be potentially affected by modifications in the amount of reservoir rearing habitat, by improvements in reservoir travel time, by alterations in predator interactions, and by habitat alterations made to access local tributary streams as discussed elsewhere in this report.

7.17.6 Combining Estimates of Change in Fall Chinook Production from Above and Below McNary Dam

7.17.6.1 Purpose of Analysis Integration

The purpose of this analysis is to combine the estimates of change in production of Columbia River Upriver Bright (URB) fall chinook from three sources and to estimate the total potential change in URB production under each of three John Day drawdown alternatives: existing conditions, natural river drawdown and drawdown to spillway crest. The three production sources of URB fall chinook considered are naturally produced fall chinook from the Hanford Reach located above McNary Dam; potentially restored natural production of fall chinook from the John Day Reach, located below McNary Dam; and John Day mitigation hatchery releases, which currently mitigate for lost natural production in the John Day Reach below McNary Dam.

7.17.6.2 Comparison and Integration of Analysis Methods

Two different methods were used to assess the changes in production of fish from the three production sources. For the naturally reproducing Hanford Reach fish, Anderson et al. (1999) (Attachment F to the Biological/Environmental Technical Appendix, Aquatic Resources Section) assumed the production could be described by a Ricker production curve (Figure 9). For the naturally reproducing fish from the John Day Reach, R2 Resources Consultants estimated the maximum potential production in terms of the product of available potential spawning habitat, redds per unit area of potential spawning habitat, average fecundity of a spawning pair and an estimated egg-to-smolt survival rate for juveniles. Hatchery production was estimated from hatchery spawner capacity and average egg-to-smolt survival rates for juveniles produced in hatcheries. Production estimates made by R2 Resources Consultants used what has been referred to as a “hockey-stick” production curve (Figure 9). In this type of curve, next generation spawner recruits increase as a linear function of parent spawners at relatively low spawner levels, but the number of spawner recruits remains constant above some habitat or hatchery facility capacity threshold.

Since Anderson et al (1999) estimated natural production levels at MSY for fall chinook salmon above McNary Dam under various John Day drawdown scenarios using the Ricker function, and R2 Resources Consultants estimated maximum potential natural production levels for fall chinook in the John Day Reach below McNary Dam using the hockey-stick function, both types of production estimates were linked to the maximum potential harvest production in their respective areas. Thus, the two methods represent assessments of maximum sustainable yield (MSY) for URB fall chinook. The two curves intersect at Cs and at Ss as illustrated in Figure 9. Because the two types of production curves estimate production potential around a common

MSY value we can directly compare the results from the two analytical methods as long as we refer to the production results obtained at the common MSY value.

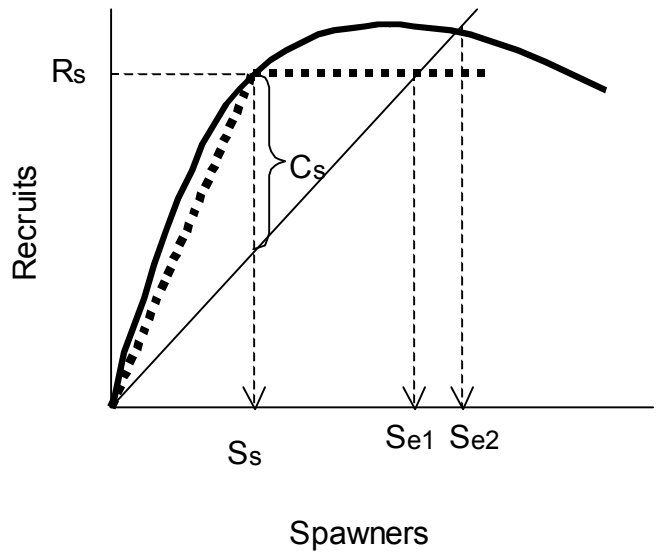

Figure 9 Ricker (solid line) and hockey-stick (dashed line) curves showing relationship between spawners and recruits. The maximum sustainable yield (MSY) is shown by Cs and the associated average spawner population size is shown by Ss. The equilibrium spawner population size levels (without harvest) are denoted by the intersections of the one-to-one spawner-recruit line with the production curves. Se1 is the equilibrium spawner population level for the hockey-stick production function and Se2 is the equilibrium spawner population level for the Ricker production function.

To integrate and compare the total production of fall chinook from below McNary Dam (Table 41) with production from above McNary Dam under the three John Day drawdown alternatives, the current mitigation hatchery program production must be included with estimates of current Hanford Reach and potential John Day Reach natural production. The production contribution from the mitigation hatcheries under good ocean conditions is given in Table 41.

The production of fall chinook from the Hanford Reach is based on the analysis of Anderson et al. (1999) (Attachment F to the Biological/Environmental Technical Appendix, Aquatic Resources Section). In Anderson et al. (1999), total returns at maximum sustainable yield were referenced to the spawning grounds in the Hanford Reach. To integrate these results with estimates of potential natural production in the John Day reach and with mitigation hatchery production, the Hanford Reach estimates were expanded to reflect total returns to the mouth of the Columbia River using an expansion factor of 1.36 for drawdown to natural river channel and 1.39 for drawdown to spillway crest. The differences in expansion factors relate to the differences in upstream survival under the different alternatives.

7.17.6.3 Integration of Results

The total effect of the drawdown alternatives on URB fall chinook production is given in Table 42 where adult productions are assumed to occur under conditions of maximum sustainable yield. Total recruitment to the mouth of the Columbia River is designated by R, the catch at maximum sustainable yield (or the maximum potential catch) is C, and the spawners needed to sustain production (referenced to the mouth of the Columbia River) is designated by S. The change in adult numbers under drawdown compared to current conditions is illustrated by Δ R and Δ S. Note that under natural river and spillway crest drawdowns the mitigation hatchery program is phased out. The total Upriver Bright fall chinook available to the fishery decreases under natural river and spillway crest drawdowns when compared to the existing condition if both mitigation hatchery and potential natural production are considered. However, harvestable surplus from natural production alone would likely increase under drawdown to natural river channel.

Table 42. Comparison of total Up-River Bright (URB) production under three alternatives: existing conditions (A1), natural river drawdown (B1), and spill crest drawdown (B2). R is the number of potential adult returns, C is the number of fish available to fisheries, and S is the number of spawner equivalents referenced to the mouth of the Columbia River. Δ terms are the total difference between alternative and existing conditions for each drawdown scenario. John Day Reach and hatchery productivities are based on a smolt-to-adult survival rate (SAR) of 3.4%

	Existing Conditions			Natural River Drawdown			Spill Way Crest Drawdown		
	R	**C**	**S**	**R**	**C**	**S**	**R**	**C**	**S**
Hanford	256,483	214,640	41,843	179,780	140,659	39,121	169,135	130,544	38,591
John Day	16,100	10,600	5,500	194,500	139,500	55,000	100,600	69,500	31,100
Hatcheries	168,000	138,000	30,000	0	0	0	0	0	0
Total Production	440,583	363,240	77,343	374,280	280,159	94,121	269,735	200,044	69,691
Natural Production	272,583	225,240	47,343						
			Change In	**Δ R**	**Δ C**	**Δ S**	**Δ R**	**Δ C**	**Δ S**
			Total Production	-66,303	-83,081	16,778	-170,848	-163,196	-7,652
			Natural Production	101,697	54,919	46,778	-2,848	-25,196	22,348

7.17.7 Potential Impacts on Resident Fish and Habitat

The greatest expected physical, chemical, and biological changes would occur under drawdown to natural river level. Habitat conditions and existing biota would be altered less with a drawdown to spillway crest, since reservoir-like conditions would prevail in the lower reservoir. Consequently, habitat for existing biota would be available, and the fish, plankton, and benthic community structure would not change appreciably in the lower portion of the reservoir.

Changes in biological communities are more difficult to predict for the two alternatives with flood control options, due to variable water depths. The time period for such flows is typically in May and June, which is an active biological period. As a result, flood control could modify the short-term rearing potential for a number of species.

The drop in water elevation would concentrate all water in the main channel of the reservoir, where water velocities would increase and depths would decrease. The drop in water elevation would effectively eliminate the littoral zone and backwater habitat in the upper reservoir. The loss of slow, shallow-water areas would decrease the availability of habitat currently used by some resident and anadromous fish in the upper reservoir. The fast water would transport small-sized material downstream, exposing large-sized gravel, cobbles, and boulders.

Drawdown would eliminate most submerged macrophytes due to exposure of the littoral zone and subsequent macrophyte desiccation. The change to a riverine environment containing gravel and cobble substrate would prevent the re-establishment of macrophytes in shallow water because these organisms do not tolerate fast water or coarse substrate.

The production of phytoplankton would decline due to decreased water depths, shorter water retention times, and reduced exposure to nutrients in the fast-flowing water. Zooplankton production would also be reduced because of the flowing water and the lack of phytoplankton. Shallow water depths would allow more light to reach the substrate and would promote the growth of attached algae. It is assumed that the attached algal community could substitute for the lost primary production resulting from the elimination of submerged macrophyte populations.

The shallow, swift waters and variable substrate conditions resulting from drawdown would create a greater diversity of benthic microhabitats. This diversity of microhabitats favors the colonization of substrates by a variety of rheophilic (current-loving) macroinvertebrates, primarily caddisflies, stoneflies, mayflies, and true flies. Such a change in the benthic macroinvertebrate community could increase the food supply under riverine conditions because a greater percentage of the benthic community would likely drift into the water column and be available as prey for juvenile salmonids.

Chiselmouth, peamouth, and redside shiner production would likely increase, and these species would dominate the fish community in terms of abundance and biomass. The production of white sturgeon would probably also benefit from a return to more riverine conditions due to the more favorable water velocities throughout the reservoir and the length of flowing water habitat that could offer successful embryo attachment. Rearing conditions for white sturgeon may not improve with drawdown. This life stage may subsequently limit the population size of sturgeon in the reach following drawdown. Connectivity between white sturgeon population segments, and those of other resident fish species, located in the John Day and The Dalles pools would be restored under drawdown of John Day to the natural channel level.

7.17.8 Estimated Change in Predation-Related Mortality after Drawdown

Predators and prey will redistribute in response to changes in habitat characteristics and distribution. With this new distribution, predator and prey encounters and consumption of salmonids may change. Populations of three of the most influential predators--the northern

pikeminnow, channel catfish and smallmouth bass--are expected to either stay the same or increase slightly. Walleye numbers may decrease.

Pikeminnow and smallmouth bass would likely be restricted to slow-moving waters, back eddies, embayments and littoral zones and would likely have less access to juvenile salmonids. Likewise, reduced travel time for juvenile salmonids due to higher water velocities might result in increased juvenile survival. Increased turbidity could reduce the effectiveness of predators under drawdown conditions.

Potential benefits to the various stocks with respect to reduced predator-related mortalities would be minimal for spring migrants (spring chinook, sockeye, steelhead), but might be considerable for fall chinook salmon that outmigrate during summer. Information needed for quantification of these benefits was not available.

7.18 Wildlife Resource Impacts

The drawdown of John Day Reservoir below the current normal operation level would result in a loss of wetland, riparian, and shallow-water habitats. Those habitat losses pose significant concerns for wildlife populations of the area. Lowering the pool elevation from existing levels would lower groundwater levels in areas adjacent to the river, resulting in withdrawal of water from established marsh and riparian habitats and exposure of currently shallow water habitat. Climate, terrain, and soil permeability would exacerbate these effects. The terrain in the upper portion of the reservoir adjacent to the river is relatively flat, with numerous shallow depressions that hold water during normal reservoir operation. The soil in the project area is highly permeable, which would result in a very rapid loss of standing and near-surface water in emergent marsh, open water, and riparian habitats upon drawdown. Further, the dry, hot climate would preclude survival of the plant species making up these habitats. Table 43 lists the predicted water surface elevations.

Table 43. Predicted Maximum Water Surface Elevations for the John Day Reservoir				
River Mile and Location	Elevation (feet)			
	Spillway Crest (215)		Natural River (165)	
	Without Flood Control	With Flood Control	Without Flood Control	With Flood Control
216 (John Day Forebay)	237	252	169	226
218 (John Day River)	237	252	171	226
252.5 (Willow Creek)	239	253	216	229
264.5 (Crow Butte and Whitcomb Island)	241	254	229	233
276.5 (McCormack Slough and Paterson Slough)	247	255	246	246
280 (Umatilla NWR)	251	257	250	250
289 (Umatilla River)	264	265	264	264

Typically, reservoir levels only influence a region immediately abutting the reservoir. Thus, the upland zone is not considered an area subject to significant impacts. The steppe and shrub-steppe habitats would remain largely unaffected. However, some disturbance to upland habitats is expected to result from activities necessary for removal and modification of the lock and dam facilities, for the protection of shoreline, and for the protection and modification of infrastructure. Compared with the potential impacts to wetland, riparian, and shallow-water habitats, the impacts to upland habitats would be minimal.

The potential impacts of the evaluated drawdown alternatives can be distinguished as short term or long term. These categories are highly subjective and variable depending upon an individual's or a species' life span, or a species' ability to adapt to habitat modifications. For the purposes of this evaluation, "short term" represents a period of less than 20 years of an event. "Long term" is considered to be greater than 20 years.

The nature and extent of drawdown effects would not differ substantially among the four alternatives. The potential effects to wildlife resources are therefore discussed together for all alternatives. However, where effects would be unique to a specific alternative, they are identified in the discussions below.

7.18.1 Wildlife Habitats

Modification of river levels would result in the loss of emergent marsh and riparian habitat currently associated with the reservoir, as well as extensive areas of shallow-water habitats. Table 44 presents the potential habitat modifications that would result from the drawdown alternatives. Over time, new habitats would develop in the barren/drawdown zone. The post-drawdown habitat development is discussed in the Habitat Abatement and Mitigation Opportunities Section. The impacts discussed here pertain to those that would occur within the area directly influenced by the reservoir hydrology.

Table 44. Expected Initial Habitat Changes from the Proposed Drawdown of the John Day Dam		
Habitat Types	**Approximate Change from Existing (acres)**	
	Spillway Crest	**Natural River**
Riparian	-571	-571
Emergent Wetland	-2,283	-2,283
Shallow-Water Habitats (Ponds, Embayments, and Tributary Backwaters)	-8,836	-8,836
Islands	+4,953	+5,770
Barren/Drawdown	+22,810	+30,625

7.18.1.1 Riparian and Wetland Habitats

An estimated 2,854 acres of riparian and wetland habitats would be lost, and the area of greatest habitat impacts would be on the Umatilla National Wildlife Refuge. Substantial loss of riparian and emergent marsh habitat would also occur in the Irrigon and Willow Creek Wildlife Management areas.

Poplar seedlings are intolerant of drought; however, saplings more than 2 years old are more drought-tolerant because they have larger root systems. Large trees with well-established root systems might survive in some areas; however, drought stress also influences mortality rates for mature poplars.

Seasonal inundation due to flood control would result in a "bathtub ring" and would be particularly evident on the downstream end of this reach of the river. The fluctuation zone might initially be revegetated by annual forbs and grasses, with the extent of cover determined by seed source and/or availability, soil moisture levels, soil type, and elevation. Vegetation might not establish permanently in the "bathtub ring," however, which is a function of flooding followed by extremely dry conditions.

7.18.1.2 Shallow Water Habitats

Existing shallow-water and backwater habitats are limited to the upstream end of the John Day Reservoir; they are found primarily in the areas of Willow Creek, Paterson Slough, Whitcomb Island, McCormack Slough, and Crow Butte. The Irrigon Wildlife Management Area includes numerous ponds and shallow water habitats. The existing submergent aquatic plant communities would be lost.

7.18.1.3 Islands

The number and area of islands would significantly increase in this reach of the Columbia River, as summarized in Table 45. Currently islands total an area of 408 acres. From 77 to 84 new islands would be revealed under the drawdown of John Day Reservoir.

Table 45. Estimated Change in Island Acreage from Existing Conditions			
Drawdown	**Potential Total Number of Islands after Drawdown**	**Potential Total Island Acreage**	**Potential Increase in Island Acreage Over Existing Conditions**
Spillway Crest	214	5,361	4,953
Natural River	221	6,178	5,770

It is very likely that the new islands would compensate for those existing islands that would be bridged with the mainland. However, for those species requiring forested or shrub vegetation for nesting habitat, these islands would not be suitable habitat for at least 10 to 25 years. The establishment of herbaceous vegetation would make some of these islands suitable for waterfowl nesting and rearing within a couple of years. Erosion of these islands would begin upon drawdown, so these values represent an optimistic estimate of the potential area of island habitat. Wind and water erosion would continue to reduce island size.

7.18.1.4 Barren/Drawdown

Immediately following drawdown under the spillway crest alternatives, there would be approximately 22,810 acres of mudflat or other barren land. Under the natural river alternatives, approximately 30,625 acres of mudflat or other barren land would be exposed. Upland and wetland seed would be applied to this drawdown zone, where practicable, and some areas would be planted to establish forested and shrub/scrub vegetation.

7.18.2 Wildlife

Regardless of the alternative, John Day drawdown would result in a loss of wetland, riparian habitat, and shallow-water habitat (e.g., embayments, ponds, backwater sloughs) and an increase in the distance to subsurface water at current shoreline habitats. The amount of time necessary to establish vegetation on the exposed areas is not known but would vary by location within the reservoir, depth of soil, proximity to water, aspect, slope, and other factors. The establishment of weedy species, such as cheatgrass, knapweed, and Russian thistle, is expected to be substantial.

7.18.2.1 Federal Endangered, Threatened, and Sensitive Species

The number of wintering bald eagles along the John Day Reservoir is not expected to decline substantially. While the number of wintering waterfowl (principal prey) may decline, other prey may be available. The loss of potential perch trees next to the water would not substantially affect this species, as ground perching is a common practice among some populations of bald eagles. Peregrine falcons would not be affected. Peregrine falcons may forage as far as 40 miles from their nest site and take a variety of prey species such as shorebirds, passerines, gulls, and rock doves. Exposed steep cliffs in the lower end of this reach of the river may offer potential nesting habitat for peregrine falcons in the long term.

7.18.2.2 Waterfowl

The anticipated potential loss of habitat would significantly affect resident and migratory wildlife resources of the Columbia River Basin. Forage and cover values of habitat for breeding and wintering waterfowl along backwaters and ponds would be severely compromised. Desiccation

of marsh and shallow open-water habitat would result in the loss of aquatic plants and benthic and other invertebrate populations that provide food resources for waterfowl and many species of waterbirds and shorebirds.

The Columbia River is used for loafing and night roosting. In the long term, a substantial reduction is potential due to decreased carrying capacity. While portions of the river after drawdown would be less than 10 feet deep, the velocity in most of this area would be too swift for substantial use by waterfowl.

Canadian geese nesting, brood rearing, and foraging would initially be affected. Islands currently used for nesting would be accessible to potential depredation by terrestrial predators. It is estimated that cover on new islands would be established in a few years and that Canada geese would use these sites. Foraging geese use gently sloping shorelines with grass-forb communities. In the short term, the distance that geese with broods would have to travel from water to access forage would increase. This increase in escape distance could have a significant negative effect on brood survival and a positive influence on predator efficiency. In addition, sloughs used for brood rearing would be dewatered. An initial net reduction in the nesting population of Canada geese might result, but the population would probably recover over the long term.

Wintering Canada geese, excluding the resident population, would also be affected. While the proposed action would not change the extent of irrigated and other cropland in the study area, habitat suitable for roosting and loafing by wintering geese would be eliminated, with a loss of over 2.5 million goose use days.

Ducks nesting in the John Day study area would be subject to a significant short-term and long-term loss of nesting habitat, particularly for those species that nest over water in emergent marsh vegetation. Typically, emergent marsh habitat is associated with shallow backwater areas, which provide foraging, nesting, loafing, and roosting habitat for ducks. All of this existing backwater habitat would be lost. In the short term, some emergent wetland marsh habitats might become established along the new river channel. Upland habitat development on the islands should provide future nesting habitat for mallards and other puddle ducks. A net loss in brood-rearing capability for ducks is anticipated even after all on-site habitat establishment or mitigation has occurred.

Some forage for wintering waterfowl would be maintained because irrigation water would continue to be provided to agricultural lands in the area. Wintering diving duck populations, however, would incur a loss of foraging resources because of the loss of shallow water habitats and the delayed establishment of a benthic invertebrate community. Furthermore, winter duck populations would never achieve current levels due to the long-term loss of shallow water habitat.

7.18.2.3 Colonial Nesting Birds

The long-term sustainability of great blue heron and black-crowned night heron populations in this reach of the Columbia River is uncertain. At the time of drawdown, the amount of suitable foraging habitat for great blue herons would be reduced, but stranded fish, amphibians, and other prey would be abundant. However, there would be an overall, long-term reduction in shallow water habitat that would support prey for this species. Mortality of willow and other riparian

trees currently used for nesting by these species is anticipated. However, while herons and cormorants prefer trees for nesting, they may also nest on the ground or in shrubby vegetation. Some birds may move southeast to the Cold Springs National Wildlife Refuge.

Colonial nesting birds at Threemile Island would also be affected. This island would be bridged to the mainland, thereby permitting access to mammalian predators. Caspian terns, Forster's terns, and gulls might benefit from newly exposed islands that would provide optimal nesting habitat. The effect of water level fluctuations on the establishment of backwater and shallow-water habitats would influence the abundance and availability of prey resources for many species of colonial nesting birds.

7.18.2.4 Shorebirds

Some shorebirds would benefit. Exposed flats in formerly shallow water areas attract black-necked stilts, American avocets, and killdeers that nest on the exposed areas and forage in the shallow water areas or their margins. Black-necked stilts and American avocets may also take advantage of barren areas.

7.18.2.5 Nongame Birds

Species such as pied-billed grebes, yellow warblers, red-winged blackbirds, and rails, which depend on shallow, protected waters for foraging and nesting habitat, would decline. Red-winged blackbirds and other species that depend on emergent marsh habitat would be subject to significant loss of nesting and foraging habitat. Many neotropical migrants would lose important foraging, nesting, cover, and migratory stopover habitat. While trees lost in existing riparian and wetland habitats would provide suitable foraging habitat (e.g., snags) for species such as hairy woodpecker and northern flicker, these areas may not provide cover and other habitat elements necessary to support such species.

7.18.2.6 Upland Game Birds

The loss of riparian habitat would eliminate nesting habitat for mourning doves. Ring-necked pheasant and California quail use riparian and emergent habitat for escape cover and protection during severe winter weather. Overall, however, chukar, quail, pheasant, and mourning dove would generally be unaffected, as these species use upland and other habitats as well.

7.18.2.7 Raptors

The potential loss of riparian habitat would result in a corresponding loss of suitable nesting habitat for great horned owls, Swainson's hawks, American kestrels, red-tailed hawks, western screech owls, and other raptors that require trees for nesting sites. Conversely, the availability of prey species may increase. While nesting habitat for some of these species may take 20 years or more to establish, some species may occupy suitable nesting habitat on cliffs exposed by drawdown.

The loss of emergent marsh wetland would decrease the abundance of foraging habitat for northern harriers, but the effect would not be substantial based on the ability of this species to use other habitats, such as grasslands. Because no change in cropland irrigation is anticipated, no effects on barn owls are anticipated. Osprey may be adversely affected by a change in the abundance and availability of fish.

7.18.2.8 Aquatic Furbearers

Beaver would incur substantial adverse impacts, due to loss of denning and foraging habitat. Existing dens would be dewatered, and trees in riparian forests would die. Beaver would likely be subject to increased predation because of the distance between the existing shoreline and a new shoreline. Beaver might become a nuisance in the establishment of woody riparian vegetation along the new river channel.

The existing river otter population is small and would be subject to decline. River otter, mink, and muskrat populations would incur substantial adverse impacts due to loss of denning and foraging habitats, and of prey. The decrease in backwater habitat would result in a decrease in fish and benthic prey species. New shallow-water habitat created along the margins of the new river channel may support these species of aquatic furbearers in the long run; however, the period of time necessary for these habitats to develop is not known.

7.18.2.9 Terrestrial Furbearers

Terrestrial furbearers in the project area would not likely be adversely affected. In the short term, coyote, raccoon, striped skunk, and red fox may respond positively due to response in increased rodent and other prey species. However, there would be a reduction in suitable denning habitat near water. Badger, opossum, and bobcat, which rely primarily on upland habitat, are not likely to be directly affected by the proposed action.

7.18.2.10 Big Game

Big game species would be affected to a limited extent. The loss of riparian and wetland habitat used by mule deer for cover and forage may adversely affect this species in the short term. Impacts to this species would also include the loss of island habitat that is currently used for fawning. In the long term, some of the exposed islands may provide adequate cover to serve as fawning habitat for mule deer.

7.18.2.11 Reptiles and Amphibians

Western painted turtles, which are found at the Irrigon Wildlife Management Area and McCormack Slough, are expected to incur severe population reductions. The western painted turtle is identified as a sensitive (critical) species by the ODFW. It is not known whether a viable population could be maintained. The ponds inhabited by turtles would permanently dry up. The ponds within the management area would dry up during the drawdown period, which would be 50 days for the spillway crest alternatives or 100 days for the natural river alternatives. While some turtles could successfully traverse the 3,000 to 4,000 feet to the river, habitat conditions along the new river channel would be unsuitable (i.e., there would be no suitable or comparable foraging and escape cover). No suitable alternative habitat for western painted turtles exists in the study area. Consequently, turtles would be subject to predation by coyote, fox, raccoon, and other species. Attrition of adults would probably be substantial, and neonate survival, and thus recruitment into the population, would be compromised by loss of forage and cover.

The loss of wetland, riparian and shallow water habitat may adversely affect native amphibian populations. The magnitude of potential effects would depend on the season of drawdown and the natural history of the particular species. Recruitment of any of the amphibian species present

could be significantly jeopardized, particularly if drawdown occurred before the young metamorphose.

In the long term, widespread and abundant species such as the long-toed salamander, tree frog, and spade foot toad, which are largely terrestrial, may be unaffected. The northern leopard frog may be the most adversely affected amphibian. This species has a limited distribution and depends on marshes, shallow-water habitats, and dense cover. It is the most aquatic of the native amphibians and spends its winters hibernating on the bottom of ponds and sluggish streams; it breeds in shallow vegetated margins of ponds and other slow-moving waters. Woodhouse's toad may likewise be adversely affected as it is usually found near permanent water throughout the year.

The non-native bullfrog might be adversely affected by the loss of ponds and other slow-moving waters, but a decline in the abundance and distribution of this species would benefit native amphibians, reptiles, small mammals, and other wildlife on which bullfrogs prey.

7.18.3 Important Sites

The potential effects of the drawdown alternatives are described in further detail below for each of the areas identified as important for wildlife in. Table 46 summarizes the seasonal and annual fluctuations in surface water elevation for various locations, which includes a subset of the identified important sites.

Table 46.
Seasonal (April-June) and Annual Surface Water Elevation Fluctuation

Location		Fluctuation			
		Spillway Crest (215)		Natural River (165)	
		Without Flood Control	With Flood Control	Without Flood Control	With Flood Control
Willow Creek WMA	Annual	15.5	19.6	12.3	15
	Seasonal	5	9	3.7	6.5
McCredie Islands	Annual	15.9	19.8	12.3	28.3
	Seasonal	5.1	9	3.8	5.7
Threemile Island	Annual	15.9	19.8	12.3	28.3
	Seasonal	5.1	9	3.8	5.7
Crow Butte	Annual	16.3	20	12.3	13.3
	Seasonal	5.2	9	3.9	5
McCormack Slough	Annual	12.3	14.6	10.9	11
	Seasonal	4	6.2	3.3	3.5
Irrigon WMA	Annual	10.3	10.6	10.3	10.3
	Seasonal	3.2	3.5	3.2	3.2

7.18.3.1 Willow Creek Wildlife Management Area

The Willow Creek embayment will be subjected to a total withdrawal of water and a loss of 119 acres of riparian and emergent marsh habitat (Plates 54 and 55). This loss of open water acreage is partially a function of the significant levels of sediment accumulated since the

John Day Dam impoundment. Dredging would be necessary at the mouth of Willow Creek to maintain the potential for fish passage during drawdown. Following project implementation, sedimentation would continue to be deposited at the mouth of the creek. Maintenance dredging volumes are shown in Table 47.

Table 47.
Initial and Annual Dredging Volumes

	Total Volume (cubic yards)		Areas Required for 15-ft Disposal Depths (acres)	
	Spillway Crest	**Natural River**	**Spillway Crest**	**Natural River**
Initial Dredging	468,400	1,052,000	30	70
Annual Dredging	70,000	106,000	4	7

Flows in Willow Creek and subsurface water depths are expected to be insufficient to maintain the present acreage of the plant communities and the wildlife species that use them. In the long term, upland vegetation is anticipated to establish on areas now occupied by wetland and riparian vegetation. Based on the prevalence of weedy species on lands adjacent to the pool, it may be difficult to achieve a dominance of native plants in the drawdown zone.

7.18.3.2 McCredie Islands

The formation of a land bridge between McCredie Island and the Washington shore is expected, resulting in depredation of nesting Canada geese and their abandonment of the site. The potential impacts of drawdown are shown in Plates 56 and 57.

7.18.3.3 Threemile Island

This island supports a large colony of nesting ring-billed and California gulls (4,377 pairs), some Forster's terns and Caspian terns, and approximately 35 black-crowned night heron nests. It is expected that Threemile Island would no longer exist, becoming part of the Oregon mainland (see Plates 56 and 57), which would give mammalian predators (e.g., coyote) access to the island. This is likely to result in the departure of colonial nesting birds and abandonment of the site.

7.18.3.4 Crow Butte

It is unlikely that flows from the upslope drainage into the delta would support any portion of the wetland plant community, including that along the drainage channel. Plates 58 and 59 illustrate the expected extent of habitat modification resulting from the drawdown alternatives.

7.18.3.5 Whitcomb Island

The shallow-water, emergent marsh, and riparian shrub habitats at Whitcomb Island would be completely dewatered. Riparian and marsh habitat along the Columbia River shore would be eliminated, and Whitcomb Island would be connected to the Washington mainland. Plates 60 and 61 present the expected extent of habitat modification. The seasonal and annual surface water elevations for this site along the Columbia River would be the same as those described for the Crow Butte area.

7.18.3.6 Glade Creek

The relatively small wetland, open water, and island habitats at Glade Creek would be substantially dewatered (Plates 62 and 63). The extent of dewatering is difficult to determine, given the influence of Glade Creek flows and the presence of railroad and highway causeways through the area. The seasonal and annual surface water elevations for this site along the Columbia River would be the same as those described for the nearby Crow Butte area.

7.18.3.7 Sand, Blalock, Coyote, Long Walk, and Straight Six Islands

The number and size of islands in the area of Sand, Blalock, Coyote, Long Walk, and Straight Six Island would be significantly modified. A single island would emerge that may total approximately 4,038 acres or 4,581 acres under the spillway and natural river drawdown alternatives, respectively. Long Walk and Coyote Islands would be joined with the Oregon mainland. (Plates 64 and 65). The seasonal and annual surface water elevations for this site along the river would be similar to those described for the Crow Butte area.

7.18.3.8 McCormack Slough

The approximate 272 acres of emergent wetland and riparian forest would be eliminated (Plates 66 and 67). There are two dikes in McCormack Slough; one abuts the Columbia River, while the other is approximately midway up the slough. These structures appear to lessen the rate of water loss from the slough during periods when the reservoir is operated below elevation 268. However, water level in McCormack Slough fluctuates commensurate with the level of the John Day Reservoir. Given soil permeability rates, the slough would be lost.

Runoff from upslope irrigation can influence McCormack Slough water levels, although more efficient irrigation systems appear to have lessened the influence of runoff on slough levels. Thus, it is unlikely that irrigation runoff would sustain the wetlands at McCormack Slough. Water withdrawal from wells on the refuge for hatchery water supply also appears to influence water levels in this Slough. Water supply from the hatchery wells would be adversely affected by drawdown and would require the establishment of an alternative water supply.

7.18.3.9 Paterson Slough

This unit of the Umatilla National Wildlife Refuge would be completely dewatered (Plates 68 and 69). Thus, all emergent marshes and riparian habitat, plus most of the submergent aquatic plant communities in Paterson Slough would be eliminated. Water surface elevations, both annually and seasonally, would be the same as those for McCormack Slough.

7.18.3.10 Irrigon Wildlife Management Area

Water levels in the wetlands and ponds (shallow water habitats) at Irrigon Wildlife Management Area are directly related to pool elevation. Irrigation runoff from upslope agricultural lands also contributes to water availability in these pocket wetlands. The high porosity of the soil within this unit would significantly affect loss of water from these wetlands. It is expected that drawdown would dewater and eliminate all wetlands and ponds within the management area (Plates 70 and 71), resulting in subsequent adverse impacts to wildlife use and occurrence in the area.

7.19 Cultural Resource Impacts

Project impacts to be considered include effects on Native American traditional cultural values, properties, and practices and effects on archeological sites or historic properties listed in or potentially eligible for the National Register of Historic Places.

Modern impacts to known sites from fluctuating pool levels, changes in groundwater and soil conditions, slumping, wash from watercraft, and artifact looting have been documented at John Day Reservoir, and these types of impacts would increase in the zones of newly uncovered lands following drawdowns. Computer modeling and experience with other reservoir drawdowns has also shown that severe impacts to formerly inundated cultural resources can be expected in many types of topographic settings extant in the project area. Formerly inundated areas would be devoid of protective vegetation, experience some loss of mantling soils and make very obvious exposure of artifacts, archaeological materials and sites, rendering them targets for illegal artifact collectors, and making them more prone to damage by erosion.

Numerous archaeological contractors working in teams would have to be assembled to record and assess sites as a drawdown is implemented and make rapid assessments of their potential and conditions. Sites which are potentially eligible for the National Register which have not been evaluated as to eligibility are required to be protected under the NHPA. Some provision would need to be made for the protection of the exposed sites by law enforcement, by hiring personnel or providing funding to policing agencies for a period of several years. Increased support and training for prosecuting cases under the Archaeological Resources Protection Act would be required.

Initial and ongoing consultation with the Four Treaty Tribes and other Native American groups would need to be initiated regarding cultural resources. Some of this could be accomplished through the Wana-pa Koot Koot cultural resources work group, comprised of the Treaty Tribes, the Portland District Corps, Bonneville Power Administration, the State Historic Preservation Officers of Oregon and Washington and other federal agencies with jurisdictional concerns within the Columbia River Gorge. However, government-to government consultation concerning specific Memoranda of Agreement and Programmatic Memoranda of Agreement on cultural resources would have to be entered into by the Corps, the Tribes and the SHPOs. An undertaking this large would also require initial review and comment by the Advisory Council on Historic Preservation under the new regulations implementing Section 106 of the National Historic Preservation Act, which went into effect in June 1999.

It is virtual certainty that greater numbers of cultural resources than are presently known will be found during a drawdown, but their integrity, scientific and sacred importance which would bear upon such sites' eligibility for the Nation Register is unknown due to the unpredictable effects of inundation.

Many new sites are expected to be found following drawdown. The highest expectation for site discovery is located where former populations were most dense. Exact data on the numbers, types, or sizes of sites cannot be determined prior to drawdown. Soils over much of the area to be affected by the drawdown alternatives are highly susceptible to erosion. Sites in potential fluctuation zone would be subject to wave wash and slumping. Sites might also be affected by vandalism and looting.

A drawdown to natural river level would have the greatest impact on sites and would expose more archeological sites. Adding flood control would increase erosion impacts due to added frequency and elevation range in the fluctuation zone.

7.20 Tribal Impacts

As with the construction of John Day Dam, implementation of a drawdown at John Day Reservoir would impact the traditional Native American cultural values, properties, and practices. Initial and ongoing consultation with the Four Treaty Tribes and other Native American groups would be essential. Regardless of the alternative, fishing practices would need to be modified in response to the change in hydrology and channel morphology. Treaty Fishing Access sites would need to be relocated and modified if a drawdown is implemented. Additionally, net fishermen would need to move to other pools along the Columbia River, which in turn could create the need for reallocation of the netting stations.

7.21 Environmental Compliance

This Phase I Study does not include any Environmental Clearances. If a Phase II Study is warranted, an Environmental Impact Statement will be prepared as part of the effort. In addition, a Coordination Act Report would be prepared and coordinated with U.S. Fish and Wildlife Service.

7.22 Impacts of John Day Reservoir Drawdown on Navy Defueled Reactor Compartment Disposal Program

7.22.1 Background

The U.S. Navy inactivates and disposes of naval nuclear powered ships at Puget Sound Naval Shipyard in Bremerton, Washington. Defueled reactor compartments are shipped up the Columbia River to Richland, Washington for land burial at the Department of Energy's Low Level Burial Grounds at Hanford, Washington. The Hanford site is the only approved radioactive disposal site in the United States that is accessible by navigable water for barge shipment of large packages weighing over 1000 tons.

Nuclear powered ships are decommissioned and defueled at the end of their useful life, when the cost of continued operation is not justified by their military capability, or when the ship is no longer needed. The Navy evaluated options for disposal of pre-LOS ANGELES class nuclear powered submarine reactor compartments in its 1984 Final Environmental Impact Statement (FEIS) and decided that land burial at the Hanford Site was the preferred alternative. In its 1996 FEIS on the disposal of decommissioned, defueled cruiser, OHIO class and LOS ANGELES class reactor compartments, the Navy reaffirmed that land burial at the Hanford Site was the preferred alternative[3]. The Navy has safely shipped 90 reactor compartment packages to the Hanford site since 1986 and plans to dispose of an additional 100 reactor compartments over the next 30 years.

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[3] United States Department of the Navy, Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants, May 1984 and United States Department of the Navy, Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, OHIO Class, and LOS ANGELES Class Naval Reactor Plants, April 1996.

7.22.2 Navy Disposal Alternative Evaluation

Besides the preferred land burial at Hanford, the range of disposal alternatives considered in 1984 and 1996 FEISs included indefinite protective waterborne storage, disposal and reuse of subdivided portions of the reactor compartments, indefinite storage above ground at Hanford, sea disposal, land disposal at sites outside of the northwest, and permanent above ground disposal at Hanford.

The alternatives for sea disposal, land disposal at other sites, and permanent above ground disposal at Hanford were not considered practical. Sea disposal appeared to be technically viable but is currently precluded by international agreement. Land disposal of the entire reactor compartment at other locations is limited by the size and weight of the reactor compartment packages, which require the site to be accessible by barge shipment with an unobstructed land transportation route to the final disposal area.

Two alternatives were identified and examined in detail. They were:

1) Land burial of the entire defueled reactor compartment at the Department of Energy Hanford Site, Washington, which requires river transportation.
2) Disposal and reuse of subdivided portions of the reactor compartments. The magnitude of this disposal effort would be at least ten times that of the preferred alternative. The transportation of many of the subdivided components can be accomplished by truck or rail. However, river transportation is still required for the larger components.

Table 48 shows that land burial of the entire reactor compartment package at Hanford, Washington is significantly less expensive than the subdivision alternative. Besides the pure monetary cost, the land burial at Hanford alternative also has significantly lower health impacts in terms of statistical occupational latent cancer fatalities due to radiation exposure. The difference in health impact remains significant even after reducing radiation exposure to levels that are as low as reasonably achievable (ALARA). Land burial of the entire reactor compartment was identified as the preferred alternative.

Table 48: Comparison of Current and Alternate Disposal Methods.

Disposal Method	Number of Shipments	Land Commitment	Estimated Cost[1]	Additional Occupational Fatalities[2]
Current: Burial at Hanford (transported by river)	100	10 acres	$1.5 Billion	0.602
Alternate: Disposal/Reuse of Subdivided Portions (transported overland and by river)	1571	10 acres	$9.4 Billion	9.1 to 43.7

[1]Estimated costs are based on a 30 year evaluation period.

[2] Occupational fatalities consist of on-site worker and transportation worker latent cancer fatalities.

7.22.3 Current Conditions

The Navy began shipping defueled reactor compartments for land burial at Hanford in 1986 and is currently shipping about eight reactor compartment packages a year. All of the reactor compartment packages to date have been transported via the Columbia River. The Navy anticipates that over the next 30 years about 100 additional reactor compartment packages will be shipped to Hanford.

7.22.4 National Economic Development (NED) and Regional Impacts of John Day Reservoir Drawdown

Potential NED Impacts: Permanent or temporary interruption of navigation upstream of the John Day Dam would have significant adverse impacts on the Navy's reactor compartment disposal program. Waterborne access from the Puget Sound area to Richland, Washington requires the use of the John Day Dam navigation lock system. Drawdown or breaching of the John Day dam would eliminate the functionality of the navigation lock system and the ability of the Navy to deliver decommissioned, defueled reactor compartments from nuclear powered ships for ultimate disposal at the Hanford Site. The only other viable alternative identified in the FEISs would require subdividing defueled reactor compartments and transporting so that the majority of non-reusable portions could be separated out and delivered overland to the Hanford Site. The sub-division alternative has been estimated to cost $9.4 billion over the 30-year decommissioning period compared to $1.5 billion cost associated with the current river navigation approach. Thus, the NED impacts associated with the drawdown of John Day reservoir could be as high as $7.9 billion over the 30-year decommissioning period[4].

[4] Because the $7.9 billion cost estimate represents the potential impact to the Navy disposal program, it is not reported in the economic impacts summary table of the main report. If Phase II of the John Day drawdown study is initiated, further refinement of the impacts to the navy disposal program will be required.

The $7.9 billion cost estimate represents the potential NED impacts to the Navy disposal program. The Navy has indicated that if the proposed drawdown of John Day reservoir is implemented, options to restore full navigation capability above John Day Dam should be explored because of the high occupational radiation exposure and cost of the sub-division alternative. Thus, if the phase II analysis of the John Day reservoir drawdown alternative is initiated, further review of possible options would be required and a more precise estimate of the actual NED impacts to the Navy disposal program would need to be determined.

Regional Impacts: In addition to the potential direct economic impacts to the Navy reactor compartment disposal program if John Day Dam drawdown occurred, there are also potential regional economic impacts.[5] The Navy has indicated that if barge navigation is interrupted, the Puget Sound Naval Shipyard would have to suspend the reactor compartment disposal program since prompt removal of reactor compartment packages from drydocks is necessary to ensure room for other shipyard work. According to the Navy, for every job lost in the Shipyard, about six other people in the community are adversely affected. Therefore, even a temporary shutdown of this work could result in a loss of hundreds of millions of dollars and thousands of jobs to the regional economy.

[5] FEIS and correspondence with Puget Sound Naval Shipyard, 23 Nov 99.

Section 8. Habitat Abatement and Mitigation Opportunities

8.1 Mitigation Measures for Wildlife Resources

USACE planning guidance, as outlined in ER 1105-2-100, 28 December 90, would be used in determining mitigation requirements and for establishing the level of replacement for lost wildlife refuge areas. This issue would be resolved during a Phase II study. Any potential replacement would be evaluated from the standpoint of both economics and practicality.

Any replacement or mitigation would be initially directed to in-kind (i.e., of the same type of habitat and species), with a focus on maximizing efforts on on-site federal lands rather than purchasing off-project lands. Out-of-kind replacement (i.e., managed for different habitats and species) would be considered as appropriate, and would be coordinated with resource agencies. In all cases, mitigation refers to replacement of existing facilities or elements within the John Day Reservoir.

Mitigation opportunities include avoiding impacts, minimizing the magnitude or extent of impacts, and compensating for impacts through habitat restoration or creation. Several measures would be undertaken on site during drawdown of the reservoir.

As mentioned earlier, portions of the total drawdown zone would be riprapped to protect existing infrastructure (e.g., rail and road embankments). All drawdown areas (including islands) would be seeded to vegetate and stabilize barren slopes to the greatest extent practicable. For this Phase I evaluation, it is assumed that wetland and riparian habitats may potentially establish within an elevation range of 1 foot above to 2 feet below average spring (March) water surface elevations. The drawdown zone above this area would be planted with a mix of upland grass seed. Native plant species would be preferred, and would include bluebunch wheatgrass, Idaho fescue, Indian ricegrass, and needle and thread grass.

New shoreline (Table 49) would also be seeded with a mix of native wetland plants, including hardstem bulrush, softstem bulrush, Columbia sedge, Baltic rush, and common cattail. Approximately 50 percent of the potential wetland and riparian zone would also be planted with native willow and other trees and shrubs to facilitate the development of habitats other than herbaceous. This proportion is similar to the proportion of forest and shrub riparian habitats compared to emergent riparian and wetland habitats that were lost when the John Day Reservoir was first inundated. Establishing upland, emergent marsh, and aquatic plant communities could occur within 3 to 5 years of the drawdown implementation. Riparian habitat, however, would take at least 25 years to attain present conditions. Fertilizer and herbicides would be applied only where appropriate to aid in the establishment of these new habitats along the Columbia River. Such applications would improve the establishment of desirable vegetation and control of invasive weeds.

Table 49. Potential Habitat Development Opportunities, by Drawdown Alternative		
Potential Habitat Types	**Approximate Area (acres)**	
	Spillway Crest	**Natural River**
Upland	21,684	29,186
Wetland or Riparian	1,126	1,439
Shallow-Water Habitats (ponds, embayments, and tributary backwaters)	5,539[a]	8,412[a]
Islands[b]	5,361	6,178

a. Velocity would not be suitable for waterfowl in most of this area.
b. Includes upland and wetland or riparian habitat types.

Table 50 compares the habitats that may potentially become established following implementation of a drawdown scenario, with present conditions, and with those habitats estimated to have been present before the dam was constructed. Due to sedimentation and other factors, however, it is highly unlikely that the habitats that existed prior to inundation behind the John Day Dam could be recreated following drawdown.

Table 50.
Comparison of Habitat Development Potential, by Alternative, with Current and Pre-dam Conditions

		Habitat Types (acres)				
		Riparian	**Wetland**	**Wetland/Riparian Total**	**Shallow Water**	**Island**
Pre-Dam Condition		2,171	1,689	3,860	192	8,385
Present Condition		571	2,283	2,854	8,836	1,755
Balance		-1,600	+594	-1,006	+8,644	-6,630
Drawdown Alternatives with Estimated Acreage for Wetland/Riparian Habitat Development						
Spillway Crest Alternative		563	563	1,126	5,539	5,361
Balance	Relative to Pre-Dam	-1,608	-1,126	-2,734	+5,347	-3,024
	Relative to Present	-8	-1,720	-1,728	-3,297	+3,606
Natural River Alternative		720	720	1,439	8,412	6,178
Balance	Relative to Pre-Dam	-1,451	-969	-2,421	+8,220	-2,207
	Relative to Present	+149	-1,563	-1,415	-424	+4,423

8.1.1 On-site Opportunities

In addition to the on-site seeding and planting opportunities described above, opportunities to avoid or minimize adverse impacts to wildlife resources may be possible during project

development and implementation. Consideration should be given to establishing large, woody debris and other structural elements along the new river shoreline. Such structures would provide habitat for a wide variety of wildlife species (e.g., basking sites for painted turtles).

Future studies should identify potential suitable shallow-water locations (i.e., slow-moving backwater areas) for submergent vegetation, and should consider establishing appropriate submergent vegetation to expedite the reestablishment of such habitats.

The population of western painted turtles at the Irrigon WMA should be studied to identify the population status and demographics. Temporary relocation or foster-care of as many individual turtles as possible should be considered.

Consideration should also be given to the use of bioengineering and other methods of bank stabilization methods, in order to minimize the extent of riprap. Bank stabilization may increase the establishment of riparian vegetation along the new river channel. As an alternative, vertical sheet piling or retaining walls could be considered in selected areas as a means of minimizing riprap use.

Native seeds and cuttings should be collected where possible from existing riparian and wetland habitats in the project area. Consideration should be given to collecting seeds and/or cuttings from sites within McCormack Slough and Paterson Slough.

A number of on-site opportunities were evaluated during earlier consideration of drawdown of the John Day Reservoir to elevation 257 (minimum operating pool). In that previous assessment, pumping, irrigation, diking, and other means of maintaining water to existing wetland and riparian habitats were proposed. However, for the spillway crest alternative (elevation 215) and the natural river alternative (elevation 165), a significant change in hydrology would occur. March surface water levels would drop from 20 to 27 feet. Coupled with high soil permeability (4 to 29 inches per hour) and lack of water rights, implementation of such possible options for the alternatives considered in this reconnaissance evaluation is not likely to be practicable. Further evaluation, however, may identify localized areas within sloughs, backwaters, and ponds, where short-term maintenance of wildlife habitats may be feasible.

8.1.2 Off-site Opportunities

Any off-site mitigation would be significantly more costly than on-site mitigation based on the need for land acquisition and the potential need for extensive vegetation modification and land management. Off-site mitigation would require identification and acquisition of lands where development of wildlife habitats and/or populations is comparable to those lost by project implementation – i.e., wetland, riparian, and shallow-water habitats.

With the loss of the Umatilla NWR, it may be feasible to enlarge or improve habitat quality in existing refuges elsewhere in the region. Examples include carp eradication, water quality improvement, and aquatic weed control, which have been demonstrated at both Malheur and Umatilla NWRs to improve the occurrence and production of waterfowl and other aquatic-associated species.

A Planning Aid Letter from the U.S. Fish and Wildlife Service (USFWS) includes recommended mitigation for the four alternatives and a recommended course of action. The letter is included in the Biological/Environmental Technical Appendix.

SECTION 9. Modifications

9.1 Modifications to Project Features

The Modifications section describes both structural actions and potential physical measures that could be taken in response to drawdown. Implied in this analysis are several economic assumptions. For example, while salmon recovery might not require road and highway embankment protection, it is assumed that protecting the integrity of the highways will be economically sound, and that efforts will be undertaken to maintain the highways. Likewise, for recreation, the economic analysis has assumed that, where physically feasible, new boat ramps will be built to provide river access at most existing locations, but a site-by-site analysis of each location was outside the scope of this study.

There are some actions described in the Modifications section that will not necessarily be implemented. For example, all measures that would be required in order to maintain navigation have been described, but the economic analysis assumes that navigation would not be either feasible or competitive under all drawdown conditions. For the purposes of measuring the economic impact associated with navigation, the increased cost of shipping goods by rail will be identified in the economic analysis. In the case of irrigation, two different options for maintaining irrigation are described, but only one of the two has been selected as a measure of the economic impact associated with irrigation.

9.1.1 Alternative 1 - Drawdown to Spillway Crest without Flood Control

In this alternative, the spillway gates can be raised above the flow or removed so that the river can run uncontrolled through the spillway. Implementation of this alternative will entail modifying or replacing the navigation lock, the adult and juvenile fish passage facilities, and the power-generating equipment. The powerhouse structure or embankment section on the north and south sides of the project will not be affected. Modifications to other project features may also be required. The options for modifying or replacing project features are described below.

9.1.1.1 North Shore Fish Ladder

The modification option chosen for the North Shore Fish Ladder (NSFL) consists of full reconstruction of the fish ladder from the entrance channel to the new fish ladder exit. The ladder is designed for operation over the design operating water levels in the forebay and tailrace between elevations 213 and 230.

Under Alternative 1, a vertical slot fish ladder would be constructed with low-level and high-level fish ladder exits to allow operation over the range of headwater and tailwater fluctuations. The fish ladder would provide 52 pools when using the low-level outlet, and 60 pools when configured for the high-level outlet.

NSFL operation during normal operation would maintain the pool at elevation 215 ((2 feet) between April and August, and at elevation 220 (+10 feet to -2 feet) for the remainder of the year. It is assumed that some regulation of John Day Reservoir level will be provided through the operation of the turbines. Even during the low pool operation in April through August, high flow conditions will occur and will raise the pool level above the "normal" levels indicated. Flow in the fish ladder depends on the depth at the upstream end of the ladder.

The 0.4-foot to 1.5-foot operating range represents reasonable limits preferred for fish passage. The average slot velocities within these limits (5 to 10 fps) are well within the swimming capabilities of the adult fish. At drops less than 0.4 foot, delay in the ladders can become an issue. Drops above 1.5 feet (10 fps) could create a hydraulic barrier to some weaker fish and cause excessive turbulence within the pools, resulting in erratic jumping.

9.1.1.2 South Shore Fish Ladder

Modification of the South Shore Fish Ladder (SSFL) would consist of full reconstruction of the fish ladder from the entrance channel to the new fish ladder exit. In this alternative, a vertical slot fish ladder would be constructed with a low-level exit and a high-level exit. The low-level exit would be used with the 52-pool ladder configuration, and the high-level exit would be used with the 60-pool configuration. The SSFL operation would be the same as that described for the NSFL.

9.1.1.3 Downstream Passage

Downstream passage for juveniles would make use of the existing spillways and a reconstructed juvenile bypass system (JBS) in the powerhouse. Structural modifications required for the new lower forebay level and larger operating range would include the following:

- Modify the screened by pass equipment including new vertical barrier screens and extended length bar screens (assumed). If the existing equipment will not function properly with necessary modifications, new screens and vertical barrier screens will be constructed.
- Bore new fish transportation conduits (FTC) the length of the dam.
- Bore new orifices.
- Bore a new service tunnel from which to maintain the orifices.
- Construct new transport channels and dewatering screens.
- Construct a new elevated bypass transportation flume.
- Modify the existing evaluation and monitoring building.

A new system would also be required to transport fish downstream from the dam from the gate well. In this arrangement, two new FTCs and a new service gallery would be constructed the full length of the active powerhouse.

Both conduits would exit the south end of the dam and transition to an elevated transportation flume. The transportation flume would follow the same alignment as the existing elevated flume to the dewatering facility.

The juvenile bypass outfall pipe and evaluation features would be lowered to match the new dewatering structure. The outfall discharge location would remain unchanged. The evaluation structure would require modification in order to collect fish at the lower elevation.

JBS operation would require monitoring the forebay level and selecting the correct orifices and FTC to use. At forebay levels between elevations 213 and 222, the lower FTC would be used; and from elevations 222 to 230, the upper FTC should be operated. It is assumed that

the hydraulic design of the new concrete flume, dewatering structure, and transportation flume would match the existing features.

Predicting the passage characteristics of the JBS has proved to be a challenge for current operations at John Day Dam and is expected to be the same for Alternative 1. An extensive evaluation program would be required to properly configure and test the new JBS system.

9.1.1.4 Hydroturbine Operation

John Day turbines are rated at 212,400 hp when operating at 90 rpm and a net head of 94 feet. The design operating range is 83.5 to 110 feet net head. Normal operation range has been between 88 and 108 feet net head. The Structural Analysis Section of Engineering Technical Appendix provides predictions of turbine performance for the John Day Project from 80 feet gross head down to 20 feet gross head, which is the Speed No Load (SNL) lower limit for these turbines. The SNL lower limit is the minimum head at which the turbines are capable of spinning at the synchronous speed of 90 rpm without generating electrical power. Operation below SNL is possible, but it requires manual operation and is not recommended because of increased uncertainties and risks.

At head ranges far outside the design operating range of the turbine, there is a significant decrease in efficiency. The low efficiency operation means that substantial energy must be absorbed by the equipment and structure, which translates into shorter life and reduced power generating capabilities.

John Day Fishwater Turbines

Auxiliary Water Supply (AWS) for the SSFL is provided by three turbine-driven fish pumps. Pump discharge capacity for each of the fish water pumps is 1,100 to 1,300 cfs. For the two spillway crest drawdown alternatives, current AWS pump discharge capability will be maintained. The operating head for fish unit turbines would be reduced, and consequently fish pump discharge capacity would be reduced approximately 40 percent. For all four drawdown alternatives, replacement of fish turbines with electric motors would be required. The three replacement motors would be rated at 600 rpm at about 1,000 hp each. If this method does not supply adequate flow, the pumps would need to be replaced.

John Day Powerhouse Water Systems

For the spillway drawdown alternatives, supplemental cooling water would be required to augment existing water systems¾for example, supplemental water for thrust and guide bearing cooling, gland water, and generator cooling would be required.

9.1.1.5 Navigation Lock

The existing navigation lock is designed to operate between forebay water surface elevations of 257 and 268. Therefore, the minimum design water depth across the upstream sill is 15 feet. This depth was used as the design criterion for the lock modifications. The sill would be cut down to elevation 195, assuming that the lowest possible pool would be at elevation 210. The high design flow for lock operation would be 800,000 cfs. At this flow, the upstream water surface with no spillway gate control would be about elevation 246.

In order to provide the same overflow protection for the lock, the upstream lock gate would extend up to elevation 268.8; this would require a 74-foot-high gate. The present lock gate is about 27 feet high, so a considerably larger lock gate would be required. The only type of

gate that would likely be feasible is a miter-type rather than the present vertical lift gate. Stoplogs would be provided to dewater the gate.

Removal of 47 feet of sill would reduce the height of cross-bracing at the upstream end of the lock where the earth loads on the north lock wall from the embankment section are highest.

Filling and Emptying System

To provide adequate flow for the filling and emptying culverts, the existing intakes would need to be modified. There are two entrances, one for each culvert. The existing north entrance draws water from the upstream approach channel. The existing south entrance draws water from the pool just upstream of the non-overflow section between the lock and the fish ladder. Each entrance consists of four openings measuring 8 feet wide and 30 feet high. The top of the entrances are located at elevation 200, which is just 13 feet below the minimum design water surface. Although the flow and velocities through the entrances should be less than at present, vortexes are likely to develop during filling operations.

The new intake, constructed of concrete, would be located east of the dam embankment and north of the navigation channel. It would be 50 feet high, 480 feet long, and vary in width from 40 to 90 feet. The 14 intake openings would be covered with trash rack panels and fish screens would be located behind them. A platform would be located on top to facilitate maintenance during low flow periods.

Guidewall

The existing guidewall can be used after drawdown. However, a new slot for the mooring connection would be fabricated from steel and attached to upstream monoliths by divers.

9.1.1.6 Spillway and Stilling Basin

The spillway and stilling basin were designed for a flood of 2,250,000 cfs, which requires an upstream water elevation of 276.5. The spillway crest shape was designed at 75 percent of design head on the spillway. In Alternative 1, the spillway would remain the same. However, at other than design flood conditions, the spillway flow would be free surface rather than controlled by tainter gates. It is assumed that the spillway gates and the gate machinery will be removed and disposed of.

9.1.1.7 Project Sequencing

Project sequencing is detailed in the Structural Section of the Engineering Technical Appendix.

9.1.2 Alternative 2 - Drawdown to Spillway Crest with Flood Control

In this alternative, the spillway gates would not be removed. They would be raised during normal operation, and the river would run uncontrolled over the spillway. When the flow at the flood control point at Vancouver is reached, the gates would be lowered to achieve up to 500,000 acre-feet of flood control storage at the John Day Project. The set point for triggering flood control operations at John Day would probably be lower than the 10-year flood design flow of 515,000 cfs used for fish passage. Therefore, the design forebay elevation over the range of operating conditions would be about 25 feet higher to account for use of the full 500,000 acre-foot flood control pool.

With this alternative, the spillway gates can be used to control depths upstream of the dam. This would benefit operation of the two fish ladders because the proper flow and head drops between pools could be maintained more closely.

Implementation of this alternative would involve modifying or replacing the navigation lock, the adult and juvenile fish passage facilities, and the power-generating equipment. The powerhouse structure or embankment sections on the north and south sides of the project would not be affected. Modifications to other project features might also be required. The options for modification or replacement of project features are described below in the following subsections.

9.1.2.1 North Shore Fish Ladder

The modification option chosen for the NSFL consists of full reconstruction of the fish ladder from the entrance channel to the new fish ladder exit. The ladder is designed for operation over the design operating water levels in the forebay and tailrace (elevations 213 to 252).

For this alternative, a variable length, vertical slot fish ladder would be constructed with four exits to allow operation over the range of headwater and tailwater fluctuations. As the forebay level and the differential between the forebay and the tailwater level increases, additional sections of the ladder would be used to raise the fish to the forebay level. Exits 1 through 4 are provided for each of the four ladder configurations (52 pool, 60 pool, 70 pool, and 80 pool, respectively. The low-level outlet is for the 52-pool configuration, and the highest exit is for the 80-pool configuration.

Project operation described in the scope of work assumes a normal operation to maintain the pool at elevation 215 ((2 feet) between April and August and at elevation 220 for the remainder of the year, with a maximum forebay elevation 252 with flood storage. As with Alternative 1, coordinated operation of the John Day Project and The Dalles Project would be required to keep the ladders operating within the criterion for drop between pools i.e., 0.4 foot to 1.5 feet, with a target of 1 foot.

Flow conditions in the ladder would be the same as those described for Alternative 1. Exit channels are 7 feet wide and would provide a 2-fps transport velocity to the forebay. The transport velocity stays the same for varying forebay levels.

9.1.2.2 South Shore Fish Ladder

The modification option chose for the SSFL consists of full reconstruction of the fish ladder from the entrance channel to the new fish ladder exit. A variable length, vertical slot fish ladder is provided with 52-pool, 60-pool, 70-pool, and 80-pool configurations, as described for the NSFL. Excavation in the channel of the dam at the ladder exits would be similar to that described for Alternative 1, but would be extended to include fish ladder Exits 3 and 4. SSFL operation would be the same as described for the NSFL.

9.1.2.3 Downstream Passage

Downstream passage for juveniles would make use of the existing spillway and a reconstructed JBS in the powerhouse. Structural modifications required for the new lower forebay level and larger operating range would include the following:

- Modify the screened bypass equipment including extended length bar screens (assumed) and vertical barrier screens.

- Bore two new FTCs the length of the dam.
- Bore new orifices.
- Modify the existing service gallery from which to maintain the orifices.
- Construct new transport channels and dewatering screens.
- Construct a new elevated bypass transportation flume.
- Modify the existing evaluation and monitoring building.

In addition, a new system would be required to transport fish downstream from the dam from the gate well and vertical barrier screens. Two orifices, at two different elevations, would be bored from the gate well to new FTCs at each of the 48 bays.

A new service gallery would not be constructed for this alternative due to the distance and difficulty in boring to each of the orifices. Orifice gate controls and lighting equipment would be located in the existing service gallery. Conduits would be excavated into the wall of the gate wells from the existing service gallery to each FTC.

Both FTCs would exit the south end of the dam above the outfall chute. Each FTC would transition into a separate elevated concrete transportation flume 5 feet wide. The lower flume would have a telescoping weir gate to regulate the head in the lower FTC. The upper flume would be constructed parallel to the lower flume and would also include a telescoping weir gate. The existing dewatering facility would be demolished and replaced with a new dewatering structure having two sets of screens to accommodate both flumes.

The juvenile bypass outfall pipe and evaluation features would be lowered to match the new dewatering structure. The discharge into the outfall chute would remain unchanged. The evaluation structure would require modification in order to collect fish at the lower elevation.

JBS operation requires monitoring the forebay level and selecting the correct orifices and FTC to use. Orifices are sized for 8 fps. The FTC size would increase to maintain transport velocities between 4 fps and 10 fps. It is assumed that the hydraulic design of the new concrete flume, dewatering structure, and transportation flume would match the existing features.

As with Alternative 1, predicting the passage characteristics of the JBS will be a challenge. It is considered that an extensive evaluation program will be required to properly configure and test the new JBS system.

9.1.2.4 Hydroturbine Operation

Turbine operations and modifications would be the same as those for Alternative 1.

9.1.2.5 Navigation Lock

The operation of the dam and navigation lock under Alternative 2 would be the same as that for Alternative 1, with one exception: under flood control conditions (flows above about 450,000 cfs), the gates would be lowered, thereby raising the water in the John Day Reservoir for flood control. Flood conditions are expected to occur only once every 2 to 5 years. However, fish passage would be maintained for flows up to 515,000 cfs, even during flood control operations.

The mode of operation and the changes to the structures would be the same as for Alternative 1. That is, the upstream sill would be cut down to elevation 195, and a 74-foot-high miter gate would be installed on the upstream sill. This gate would be high enough to cover all water levels during flood control operation. Stoplogs would be provided for dewatering the upstream lock gate. A new water intake would be constructed upstream.

Operationally, there is no difference between Alternatives 1 and 2 until flood control operations commence. Under flood control operations, the upstream head could be as much as 20 feet higher than Alternative 1. Because the new gate would extend up to elevation 269, the lock would be protected from overflow under flood control operations to the present level of flood protection.

9.1.2.6 Spillway and Stilling Basin

The spillway and stilling basin would be operated the same for Alternatives 1 and 2. During flood control, however, the tainter gates would be lowered and the spill would have as much as 20 feet of additional head and energy. Since about 97 percent of the time the spillway would be operating the same as under Alternative 1, the same potential problems would be encountered. That is, rocks could be drawn into the basin, potentially eroding the concrete and causing higher maintenance costs. It is assumed that the spillway flow deflectors would have to be relocated.

9.1.3 Alternative 3: Drawdown to Natural River without Flood Control

In this alternative, near natural river hydraulic patterns would be reestablished. No regulation of the river would take place. Enough of the dam structure would be removed to provide passage of upstream migrants at the 10-year flood of 515,000 cfs. A maximum average velocity of 10 fps was set as the criterion for upstream fish passage.

During implementation of this alternative, fish passage would be maintained at all times except for the in-water work period of December, January, and February.

9.1.3.1 Hydraulic Computations

Alternative 3 includes removing the spillway and a portion of the powerhouse to create hydraulic conditions similar to the pre-dam natural river channel. Several configurations were studied to determine the minimum amount of structural modifications required to meet fish passage and, if deemed necessary, barge traffic criteria. The fish passage criteria include a maximum 10 fps average velocity for a discharge of 515,000 cfs through the removed section of the dam. The barge traffic requirements include a target velocity of about 5 fps during Phase II construction for the majority of the construction duration. Barge traffic requirements during Phase II construction would be the controlling factors in sizing the opening for this alternative.

The bottom elevations of the removed portion of the powerhouse and the spillway would be 128 and 135, respectively. A riprap dike would extend downstream from the south side of the powerhouse to the south shore. Another dike would extend upstream from the powerhouse. Table 51 provides the average velocities and water surface elevations (NSEL), at the downstream face of the dam.

Table 51. Average Velocities and Water Surface Elevations			
Discharge (cfs)	The Dalles Forebay Elevation	Computed WSEL at Downstream Face of Project	Computed Velocity at Downstream Face of Project (fps)
80,000	155	155.8	1.5
80,000	160	160.4	1.2
515,000	155	167.6	6.4
515,000	160	169.5	6.1

9.1.3.2 Structure Removal

Alternative 3 consists of the removal of the entire existing 1,228-foot-long spillway, the 37-foot-long non-overflow section, and 996 feet of the powerhouse section, for a total length of 2,261 feet. The spillway concrete would be removed down to elevation 135, and the powerhouse and non-overflow sections would be removed down to elevation 128. Cutting down the spillway below elevation 135 would provide little hydraulic advantage. The voids in the powerhouse below elevation 128 would be filled in to achieve a uniformly sloping channel. This action would provide safer hydraulic conditions by preventing local turbulence caused by such voids.

9.1.3.2 Passage

For natural river drawdown, the structure, as described in previous sections, would be removed to obtain satisfactory passage conditions. Upstream fish passage would be provided in the boundary layer along the perimeter of the breach. Downstream passage would be provided through the breach. No special features or operations are necessary.

9.1.3.3 Navigation Lock

River traffic was assumed to operate in water velocities of up to five fps. For the breach width considered Alternative 3, navigation would be possible through the breach in flows of about 400,000 cfs or less for a water elevation of 160 at The Dalles. This would occur about 97 percent of the time.

For flows over 400,000 cfs, river traffic would transit the breach through the navigation lock. The lock would operate without the existing filling and emptying system. Upstream traffic would enter the lock channel with the upstream lock gate closed. After the downstream lock gate is closed, the upstream filling valve located in the bottom of the upstream gate would open, filling the lock. The upstream lock gate would then open, and traffic would travel upstream in the navigation channel, which would have to be dredged about seven feet deeper. Downstream traffic would pass in a similar manner, using the new filling and emptying valves to equalize water levels.

The lock would be modified by removing the upstream sill to elevation 140 and installing a new upstream lock gate. A miter-type gate about 65 feet tall would be installed. This would prevent overflow for river flows below about two million cfs. The downstream gate would remain in service, and the existing inlets and outlets for the fill and drain system would be plugged with structural concrete. Both upstream and downstream lock gates would be fitted with valves at the bottom of the gates for filling and emptying the lock. The total head across

the lock is expected to be from 1.5 to 2.5 feet at the design flow of 800,000 cfs. Stoplogs would be provided for dewatering the upstream lock gate.

The upstream navigation channel would be dredged to elevation 140. The area underneath the floating guidewall would be dredged to the same elevation to provide space for the floating guidewall during lower water surface operations. A new mooring structure would be built to accommodate the floating guidewall operation at lower water surface elevations.

9.1.3.4 Restoration of Synchronous Condensing Operation

During April to November, six units at John Day Dam are currently dedicated to synchronous condensing operation by agreement between BPA and USACE. Under Alternative 3, portions of the powerhouse would be removed and the power plant abandoned. Existing transmission system stability benefits and rating of inter-tie, as currently provided at John Day, are to be maintained. This would require conversion of six similarly sized units to synchronous condensing operation at another project.

9.1.4 Alternative 4 - Drawdown to Natural River with Flood Control

In this alternative, part of the dam would be removed to approximate natural river hydraulic patterns and a gate structure would be added to regulate flow for flood control. This work would entail providing gates on a spillway with a crest near natural river bed elevation. These gates would be raised during normal operation, and the river would run uncontrolled. When the flow at the flood control point at Vancouver is reached, the gates would be lowered to achieve up to 500,000 acre-feet of flood control storage at the John Day Project. The set point for triggering flood control operations at John Day can be lower than the 10-year flood design flow of 515,000 cfs, depending on downstream conditions and tributary flow. For the design of fish passage features, it was assumed that flood storage operations can be triggered at discharges of 360,000 cfs (2-year) or higher. The modification or replacement of project features is described below.

9.1.4.1 Hydraulic Computations

Alternative 4 includes modification of the John Day spillway to reflect natural river conditions while providing flood control. In all four alternatives, the entire spillway was modified to resemble a broad-crested weir structure. In addition, different sections of the powerhouse were removed and replaced with gate bays. The minimum amount of structural modifications required to obtain a maximum average velocity of 10 fps at a discharge of 515,000 cfs and a Dalles forebay elevation of 155 was determined by modeling a variety of options. Since the navigation lock would be rebuilt for Alternative 4, the barge traffic criteria were not a concern when sizing the opening. Backwater calculations were required to estimate the velocities and water surface elevations along the modified reach of river.

There are 29 spillway bays in this run, all at a crest elevation of 135. A riprap dike extends downstream at an expansion rate of 1:2.9 from the south side of the powerhouse until reaching the south shore. A dike also extends upstream from the powerhouse from the south shore at a 1.5:1 contraction rate. Table 52 provides the average velocities and water surface elevations at the downstream face of the dam.

Table 52. Run 4-6 Average Velocities and Water Surface Elevations			
Discharge (cfs)	**Dalles Forebay Elevation (ft)**	**Computed WSEL at Downstream Face of Project (ft)**	**Computed Velocity at Downstream Face of Project (fps)**
80,000	155	155.7	2.4
80,000	160	160.4	1.9
515,000	155	167.3	9.7
515,000	160	169.2	9.2

9.1.4.2 Structure Removal

This alternative consists of the removal of Spillway Bays 8 through 20 (a total of 794 feet), the 37-foot-long non-overflow section, and 996 feet of the powerhouse section, for a total length of 1,827 feet. In the south end of powerhouse Bay 10, 41 feet would be filled in with structural concrete to provide the required opening length. The spillway concrete would be removed down to elevation 125, and new concrete would be placed up to elevation 135.0. The spillway stilling basin would be retained. The powerhouse section would be removed down to elevation 128. The voids below elevation 128 formed by the powerhouse intake would be filled in with concrete and built up to elevation 135 with structural concrete. An energy dissipater would be constructed downstream from the new spillway on the downstream end of the powerhouse and tailrace fill.

9.1.4.3 Spillway

The new spillway will consist of 29 bays with 12-foot-wide piers to support new spillway gates. Each bay would be 50-feet wide and would be equipped with triple-leaf fixed-wheel gates that could be fully or partially closed to provide the 500,000-acre feet of flood storage.

To withstand forces from the new spillway gates, the existing concrete would be excavated to elevation 125 and new reinforced concrete placed up to elevation 135. This slab will form the foundation for the spillway piers. In the area of the powerhouse, a reinforced concrete slab would be placed on the intake floor up to elevation 135 to form the foundation for the piers located on the spillway.

Each of the new Spillway Bays 20 through 29 would be equipped with triple-leaf fixed-wheel gates and a set of 50-foot-high stoplogs with a temporary ogee section. These stoplogs would be used as dewatering stoplogs for gate maintenance and replacement after the project is built. During Stage 2 construction, these gates would regulate flows to maintain the forebay elevations between 260 and 265. Each gate leaf would be furnished with a separate 50-hp, motor-driven cable drum hoist located on the spillway deck so it can be operated under unbalanced conditions to maintain the reservoir water level elevation between 260 and 265. Additional stoplogs would be provided to permit complete dewatering of any single spillway bay to service the fixed-wheel gates. A 150-ton gantry crane would be provided to permit installation and removal of the stoplogs and gate leafs.

During Stage 1, the gates, stoplogs and ogee section downstream of the stoplogs would be installed. A new energy dissipater would be constructed in new Spillway Bays 14 through 29, located within the limits of the removed powerhouse. The gates would be in the closed

position to maintain a reservoir elevation of 265. Flow releases would be made by raising the lower gate leaf, permitting water to discharge over the top of the stoplogs and the ogee section. After completion of the Stage 2 construction, the stoplogs and ogee section would be removed and the gates would operate in a fashion similar to the Stage 2 spillway gates shown on Plate 25.

The Stage 2 spillway would be constructed with a deck elevation of 245 in the space now occupied by Spillway Bays 1 through 19. A 300-ton gantry crane would be installed on this portion of the spillway to operate the fixed-wheel gates. These gates would be operated only under balanced head during flood conditions up to a reservoir elevation of 223, so a cable drum hoist would not be required for the new Spillway Bays 1 through 19.

During normal operation of the project, the gates would be in the up position with all leaves fully raised. The gates would be lowered into position during a flood event to provide up to 500,000-acre feet of reservoir flood storage up to elevation 223. During normal operation, the three gates would be in the up position, with the bottom of the gates above the maximum water surface elevation of 205 during the probable maximum flood (PMF). When closed for flood storage, the top of the gates would be at elevation 228, or 5 feet above the anticipated maximum water surface elevation for the required flood storage of 500,000 acre-feet. Two 5-foot-high stoplogs would have to be installed below the gates in Spillway Bays 20 through 29 to accomplish this.

9.1.4.4 Upstream Fish Passage

Upstream fish passage for this alternative, during non-storage, would be through the breach in the dam similar to Alternative 3. When it becomes necessary to begin storing water for flood control, and the gates are lowered into the water, upstream fish passage through the breach will be affected. During flood control operation, a new fish ladder on the north shore would be used to provide upstream passage during flood control operations.

New, variable length, vertical slot fish ladders with five sections would be constructed to provide upstream passage for forebay elevations between 176 and 222. Five sections of 10 pools, 20 pools, 30 pools, 40 pools, and 50 pools, respectively, can be used depending on the forebay and tailwater elevations.

A new fish ladder would be the same size and would be constructed starting at the same location as the NSFL under Alternatives 1 and 2. The invert of the low-level exit would be at elevation 162. The remaining four exits would be located at 10-foot intervals up to elevation 202. Exit channels will be 7 feet wide by 24 feet high. Due to width restrictions between the lock and spillway, the alignment of the 40-pool and 50-pool ladder would switch back over the lower portions of the 10-pool and 20-pool ladders, respectively. The exit channel from the two upper ladders would be sloped to maintain a 2-fps transport velocity. The SSFL would be abandoned and cut off from the river by the flow control berms.

When operation for flood storage is initiated, the dam gates would be closed to raise the forebay elevation to a minimum elevation of 176, to allow operation of the fish ladders. After reaching elevation 176, forebay levels would then be varied according to flood control needs. Depending on the river flow and tailwater from The Dalles Dam, gate closures in excess of those required for flood control might be required to keep the fish ladders operating within specified criteria.

Sequenced operation of spillway gates during flood control would have to be developed to prevent potential fallback of fish exiting the ladder. Flow conditions, energy dissipation, and drop between pools in the ladder are the same as described for Alternative 1. Exit channels would be 7 feet wide and would provide a 2-fps transport velocity to the forebay. The transport velocity would stay the same for varying forebay levels.

9.1.4.5 Downstream Fish Passage

Downstream passage would be provided through the gated breach. For non-storage conditions, the gates should not affect flow or drop through the spill section. During storage conditions, the design and operation of the gates and spill sections are assumed to provide safe downstream passage and minimize dissolved gas concentrations. No JBS facilities are proposed due to the intermittent and short duration of the storage conditions.

9.1.4.6 Navigation Lock

A new navigation lock would be built through the embankment north of the existing lock. The existing navigation lock would not be modified because to do so would stop navigation for more than one year as a result of extensive cofferdamming requirements. Building a new lock would curtail navigation for less than a month while the downstream approach channel to the new lock is connected to the existing channel. The new lock would be similar to the existing one; however the upstream sill would be at elevation 140; the bottom of the lock would be at elevation 138. A new 105-foot-high miter gate would be installed on the upstream sill. A shallow screened intake would be constructed for lock-filling flows. A new channel extending from the lock to the existing upstream channel would be dredged to elevation 140. Stoplog slots and stoplogs would be provided for dewatering the upstream lock gate. The existing downstream floating bulkhead would be used for dewatering the downstream gate.

Under Alternative 4, all river traffic would travel through the navigation lock because the gate bay openings of 50 feet are too narrow for navigation. For river flows of about 130,000 cfs or less, the velocity through the breach would be 3 fps or less and traffic would travel through the lock without operation of the lock gates. Assuming that velocities through the open lock are the same as through the breach, navigation through the open lock without operating the gates could only occur at flows below 130,000 cfs. This would happen about 30 percent of the time. For flows over 130,000 cfs, river traffic would transit the project area through the operating lock. The head across the locks is expected to be about 1.5 feet at a flow of 515,000 cfs with no flood control operation in effect. During flood control operations, the lock could operate up to the design river flow of 800,000 cfs. At the design flow of 800,000 cfs under flood control, the head across the project would be about 50 feet.

9.2 Slope Stability Modifications

No surface inspection or data study can anticipate all the hidden physical conditions, flaws, or adverse circumstances in geotechnical work, so drawdown of the reservoir to new levels should be treated somewhat like pool raising. Careful inspection and monitoring should be programmed for the reservoir perimeter during the drawdown period. Some additional protective measures are discussed below.

9.2.1 Potential Landslide Area Instrumentation

The known ground cracking that has occurred west of Alderdale, Washington, between the highway and railroad should be monitored with instruments before any drawdown. A survey should be conducted to establish both horizontal and vertical control points in the area, and at least one slope indicator should be installed to determine the depth and type of movement and whether it occurs during or after drawdown. Consideration should be given to performing similar surveys and installing a slope indicator at the Murphy slide on the Oregon side.

9.2.2 Railroad/Highway Embankment Protection

Various measures can be used to protect slopes and embankments from erosion and failure, including bioremediation (vegetation), riprap, gabions, or reinforced earth. Existing slope protection along the John Day Reservoir shoreline consists almost exclusively of riprap, because of the water velocities and wave heights that present. The four alternatives proposed for John Day drawdown would each have similar or greater water velocities and wave heights, plus significant water level fluctuations, such that riprap would be the only protective measure that could provide adequate protection from erosion and failure in a cost effective manner. For railroad/highway embankments, riprap erosion protection should be placed on all slopes steeper than 1 vertical to 3 horizontal (1V:3H) from five feet above the one percent chance exceedence flood event (100-year frequency event) to five feet below the low water operating level for each study alternative (50,000 cfs). Water surface levels for the 1 percent flood event for Alternatives 1-3 were either at or above the existing toe of riprap placed on railroad/highway embankments to elevation 252. Riprap quantities for these alternatives were calculated using elevation 252 as the top of riprap. The top of riprap for Alternative 4 was calculated as being 5 feet above the 1 percent flood event water surface levels from John Day Dam upstream to where that elevation was within 10 feet of elevation 252; elevation 252 was then used as the top of riprap elevation. This situation occurred only at the uppermost reach of the area identified as requiring riprapped.

Areas to be protected with riprap were approximately identified during a reconnaissance boat trip. These areas included places where the existing railroad/highway embankment was immediately adjacent to or actually in the reservoir. According to USACE's Riprap Classification Chart, Class IV riprap should be used based on observations and on field measurements of existing riprap that was sized according to calculations presented in the John Day design memorandum for railroad relocations (DM 7.6). Riprap size requirements were also presented in the Flood Control Section of the Engineering Technical Appendix, where Class IV riprap was determined based on increased water velocities. Preliminary wave heights were also evaluated and indicated a Class IV riprap size requirement. Future studies should further evaluate the areas that require riprap erosion protection, refine the riprap size requirements, and more accurately determine the slope angle where riprap would be placed.

9.2.3 Shoreline Erosion

The areas of greatest concern are those areas where the railroad/highway embankments are located immediately adjacent to the reservoir. Other river access features, such as docks, boat ramps, marinas, swimming beaches, ports, culverts, and bridges would be either abandoned or relocated (see Recreation, Navigation, and Shoreline Infrastructure Sections of

the Engineering Technical Appendix). Erosion control measures similar to those proposed for the railroad/highway embankments could be used where unstable shoreline conditions were identified, but those areas have not been quantified for this Phase I Study. Future studies should address this issue.

9.2.4 Estimated Quantities

The Implementation Cost Estimates Section of the Engineering Technical Appendix contains a detailed description of the costs associated with riprap erosion protection. Table 53 summarizes the riprap quantities required for the four alternatives. Quantities are the same for Alternatives 1 and 2 because the area of placement is the same. As discussed above, the top of riprap used in the quantity calculations for the first two alternatives was elevation 252, which is the bottom of existing riprap. This elevation is either at or below the water surface elevation for the one percent chance exceedence flood event (100-year frequency event). The bottom elevation for riprap was also the same for the first two alternatives and represents an elevation five feet below the low water operating level (50,000 cfs). The quantity of riprap for Alternative 4, natural river without flood control, is less than the other alternatives because the top of riprap was placed at five feet above the water surface for the one percent flood event. This elevation is significantly below the bottom of existing riprap and results in reduced quantities.

Table 53.
Riprap Quantities per Alternative

Study Alternative	Riprap Quantity (cubic yards)
Spillway without Flood Control	3,371,500
Spillway with Flood Control	3,371,500
Natural River without Flood Control	2,635,900
Natural River with Flood Control	5,732,500

9.3 Sedimentation Modifications

9.3.1 Reservoir Sedimentation

The quantity and location of sediment in-fill was approximately calculated during this Phase I Study. The size and extent of the reservoir preclude the use of any reasonably cost-effective means of controlling and preventing this loose sediment from running into the river system during drawdown. Subsequent water level fluctuations would continue the process of "washing" the sediment from the reservoir slopes and erosion of the thick deposits at the mouths of the tributaries, resulting in long-term turbidity and water quality issues. Future studies should evaluate the long-term environmental impacts to the river system and estimate the duration of the turbidity effects.

9.3.2 Tributary Sedimentation

Sediment deposition within the tributary channels due to backwater from the John Day Reservoir has significantly changed the geometry of several of the tributary streams. To ensure the continuous passage of migrating adult fish in these tributaries, modifications to the current channel geometry are required. The required modifications were based on design channels developed to transport the incoming sediment loads and pass adult fish. To

determine the channel design requirements for sediment transport, the Copeland Method (1994) was used. The newly designed channel was then input into the HEC-RAS model to determine channel hydraulics for fish passage.

9.3.3 Stable Channel Design

Fish passage requirements determine the need for channel modifications. For the four main tributaries that pose a barrier to fish, a stable channel design was developed on the basis of incoming sediment loads, bed material size distributions, and channel-forming discharge. Estimates of channel width and slope for the four main tributaries were developed using the two-year flood event. Design channel configurations are itemized in Table 54. Stable channel cross sections and profiles with water surface elevations for the four major tributaries are shown in the Sediment Section of the Engineering Technical Appendix. Design channels were developed based on a trapezoidal cross section with 2h:1v side slopes. All the design channels contain a low flow channel, either a V-shaped or a trapezoid-shaped notch, to allow for fish passage under the lowest average flow conditions.

Table 54. Design Channel Configurations

Tributary	Bottom Width (ft)	Side Slope (h:v)	Channel Slope (ft/mile)
Willow Creek	65	2:1	0.004
Umatilla River	195	2:1	0.005
Rock Creek	67	2:1	0.0086

9.3.3.1 John Day River

A stable channel design for fish passage on the John Day River was not developed. At locations of potential barriers, the channel slope becomes the limiting factor in the hydraulics. A design that would reduce the channel slope could not be made due to observed upstream bedrock control at RM 4.5, as shown in topographic maps and river profiles. Also, the relatively narrow confines of the valley walls would not allow introduction of meanders to reduce the existing channel slope. In addition, a comparison of thalweg profiles shows no noticeable change in channel profile between pre-and post-dam conditions.

Cross sections of concern for fish passage were checked against pre-dam (1955) cross sections to determine what changes in channel geometry might have occurred that would affect fish passage. It was determined that no such significant changes had occurred. A selected cross section location showing pre- and post-dam geometry is presented in Figure 10. When the same fish flows used in the post-dam geometry model were run in the pre-dam model, similar locations showed potential blockages to fish. It was concluded that sedimentation in the channel has not introduced additional fish passage concerns. Therefore, dredging on the John Day River is not recommended.

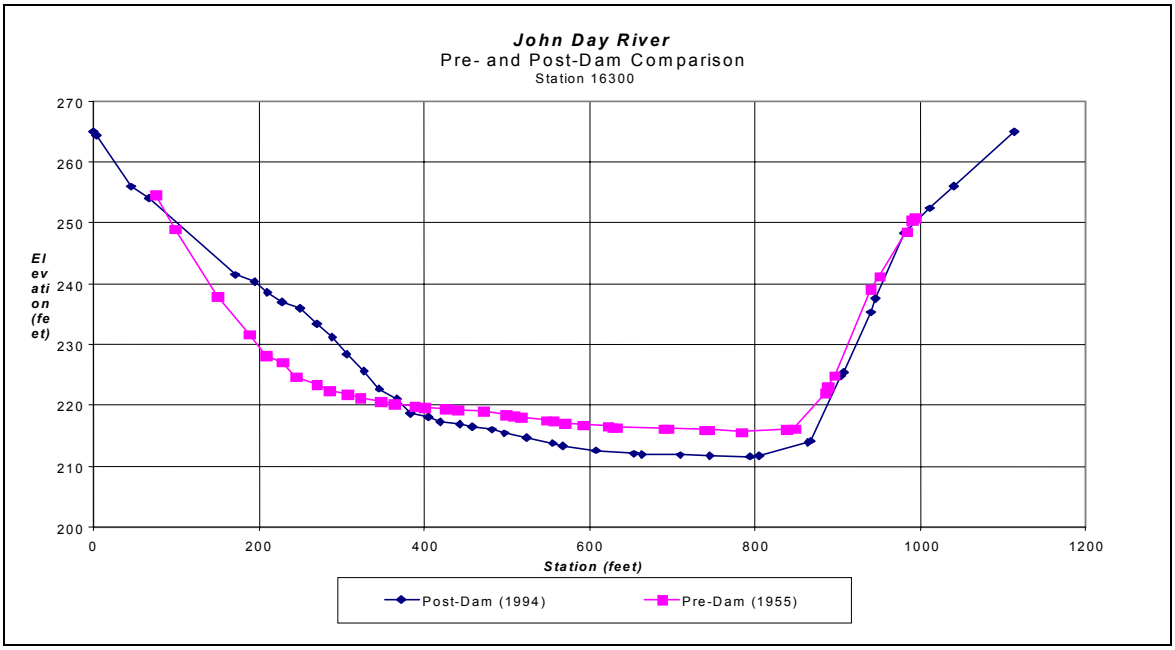


Figure 10. Selected Cross Section Comparison of John Day River (Location Determined To Be Potential Barrier to Fish Passage in Hydraulic Models)

9.3.3.2 Willow Creek

Willow Creek has a significant amount of sediment deposition within the backwater of the John Day Reservoir. Some locations contain as much as 40 feet of deposition, but typically average 20 feet. A design channel was developed to transport the existing incoming bed material load. The slope and geometry of new channel is similar to the channel that existed prior to construction of the John Day Dam.

Considerable sediment will be exposed under the proposed drawdown conditions. This newly exposed sediment will be subject to erosion from precipitation, overland flow, and channel processes. Due to the significant depth of sediment removal necessary to incorporate the design channel, localized erosion is expected to contribute substantial amounts of sediment to the channel. The largest amount will be contributed during the first few years after the drawdown takes place, but erosion should gradually diminish as vegetative cover increases and local sediment supplies decrease. Erosion control measures and channel maintenance will be necessary to maintain fish passage on Willow Creek. Figure 11 is a selected cross section for Willow Creek showing pre-dam, post-dam, and design channel geometry.

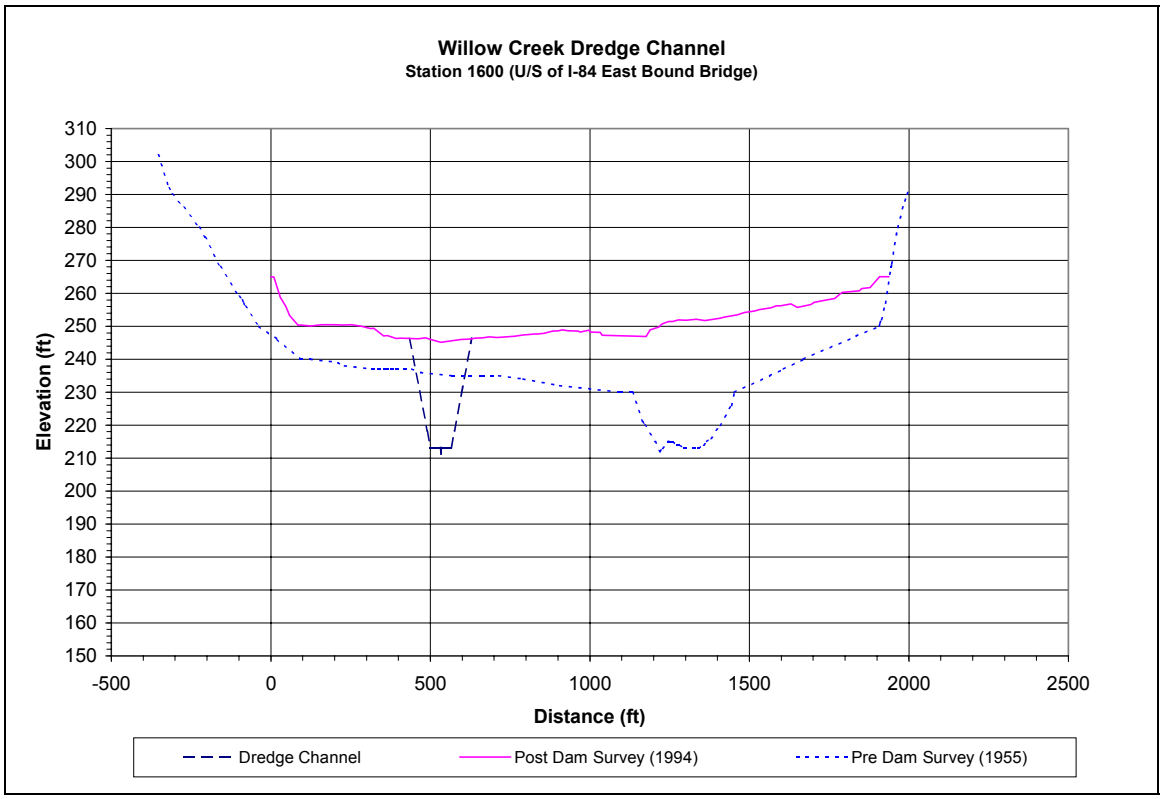


Figure 11. Selected Pre-Dam, Post-Dam, and Design Channel Cross Sections for Willow Creek

9.3.3.3 Umatilla River

The Umatilla River is controlled by bedrock at approximately RM 2. Above this location is the Three Mile Falls diversion dam, which has a hydraulic height of 23 feet and a crest length of 915 feet. This dam, together with numerous other storage and diversion dams within the Umatilla Basin, has effectively cut off the supply of bed material to the mouth of the Umatilla River. This observation is supported by the relatively minor amount of sediment accumulation in the channel between 1955 and 1994. Modifications to the current channel are minor, and typically provide for a low flow channel to allow for fish passage during the lowest average flows. Figure 12 is a selected cross section showing the current channel and design channel geometry.

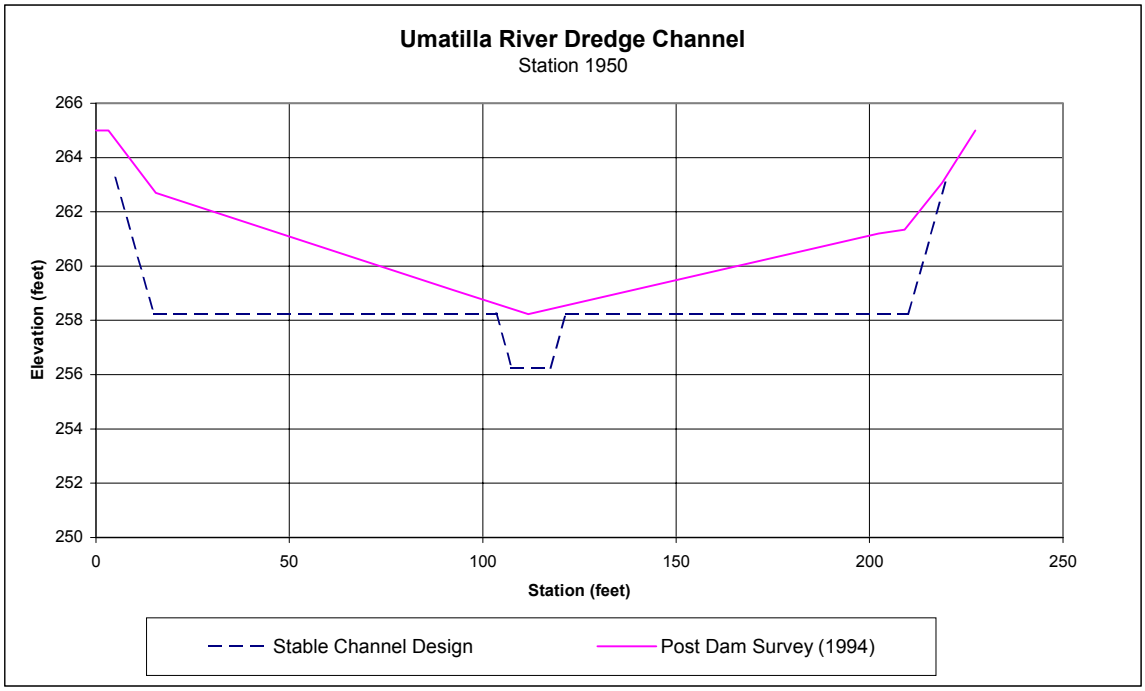


Figure 12. Selected Post-Dam and Design Channel Cross Sections for the Umatilla River

9.3.3.4 Rock Creek

Modifications to the outlet of Rock Creek will be necessary to incorporate the stable channel design that will provide for fish passage. A new outlet located along the centerline of the channel is recommended, as shown in Figure 13. The outlet would be cut through the existing road bed fill and spanned by a new highway (SR-14) bridge and railroad (BNSF) bridge. The new channel alignment would closely approximate pre-dam conditions and allow for sediment transport beyond the current outlet location.

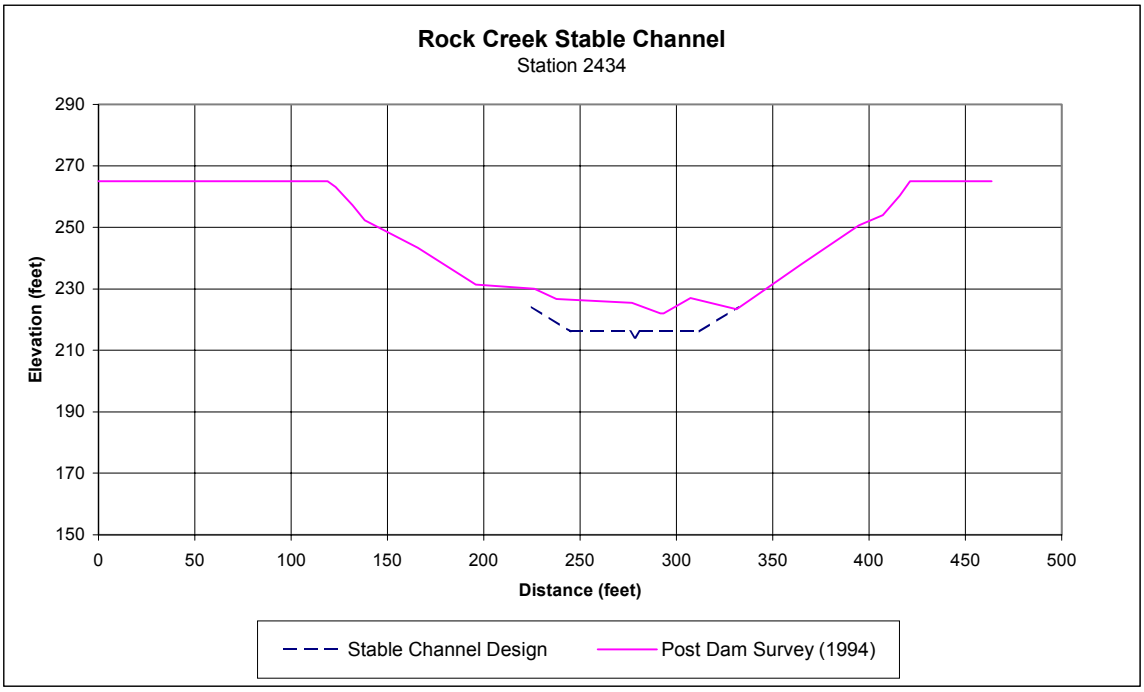


Figure 13. Selected Post-Dam and Design Channel Cross Sections for Rock Creek

9.3.3.5 Wood Gulch

Wood Gulch is a gravel and cobble bed stream. It is the only other tributary to the John Day Reservoir known to support salmonids. However, no data are available to determine requirements for fish passage. Some dredging of the delta may be required initially to open the stream to fish passage. However, it is also likely that the channel will quickly adjust to the new conditions and maintain itself. It is unlikely that continued maintenance will be required.

9.3.4 Dredging Requirements

Initial dredging of Willow Creek, Umatilla River, Rock Creek, and Wood Gulch would be required to open the channel to adult fish passage under drawdown conditions. Initial dredging is defined as the amount of dredging required to provide for fish passage. After initial dredging is completed and drawdown takes place, the channel will begin to readjust itself to the new hydraulic and sediment transport conditions. As this adjustment takes place, annual maintenance dredging may be required to maintain the design channel. The amount

of maintenance required will depend on the ability of the channel to transport the incoming sediment load. In some cases, that sediment load will be increased by local bank erosion from newly exposed sediments. Bank stability measures located at select locations would reduce the amount of required maintenance dredging.

9.3.4.1 Initial Dredging

The stable channel cross sections were overlaid on the existing cross sections to measure the amount (in square feet) of sediment to be removed. This was done for each cross section for which data were available. The average end area method was used to determine the volume of sediment required to be removed. Dredge quantities are "in-place" volumes. This means that no adjustments have been made to the quantities to account for changes in density, which is commonly referred to as "bulking." Dredge quantities are listed in Table 55.

Cross-section data for Willow Creek do not extend far enough upstream to enable the entire dredge quantity to be computed. The additional dredge quantity was estimated using average end area method between the most upstream cross section and the intersection of the backwater with the channel.

Table 55.
Initial Dredging Quantities

Tributary	Dredge Quantity (cubic yards)	
	Spillway	Natural
John Day	0	0
Willow Creek	468,380	1,051,760
Umatilla River	41,770	41,770
Rock Creek*	53,430	377,280
Wood Gulch	Unknown (no data)	Unknown (no data)

* Quantities exclude roadbed fill removal.

9.3.4.2 Maintenance Dredging

The John Day River does not require maintenance dredging. The Umatilla River is not expected to require maintenance dredging because its sediment transport capacity of under spillway free flow and natural river drawdown conditions exceeds the incoming sediment load. This will maintain the dredge channel or possibly cause additional degradation.

The stable channels designed for Willow Creek and Rock Creek are designed to transport the incoming sediment load. The dredged channels will be highly entrenched within the existing sediments, which will be subject to high erosion rates the first several years after drawdown occurs. Consequently, maintenance dredging quantities for natural river conditions were assumed to equal the incoming sediment load to account for channel migration and side slope erosion. Maintenance dredging quantities for the four major tributaries are summarized in Table 56. Again, these quantities do not account for bulking.

Table 56. Average Annual Maintenance Dredging Quantities		
Tributary	**Dredge Quantity (cubic yards)**	
	Spillway	**Natural**
John Day	0	0
Willow Creek	70,000	106,000
Umatilla River	0	0
Rock Creek	6,000	19,000
Wood Gulch	Unknown (no data)	Unknown (no data)

9.3.4.3 Dredge Spoil Disposal

An assumed disposal depth of 15 feet and a bulking factor of 1.5 were used to estimate the areal extent of the dredge disposal. The volume of dredge material determined for initial and maintenance dredging was increased by a factor of 1.5 to account for bulking. The bulked volume was then divided by the assumed disposal depth of 15 feet to estimate the extent of the disposal area. Disposal areas are summarized Table 57.

Table 57. Dredge Spoil Disposal Area				
	Disposal Area			
	Spillway Alternative		**Natural River Alternative**	
Tributary	**(ft^2)**	**(acres)**	**(ft^2)**	**(acres)**
Initial Dredging				
John Day	0	0	0	0
Willow Creek	1,265,000	29.0	2,840,000	65.2
Umatilla River	113,000	2.6	113,000	2.6
Rock Creek	144,000	3.3	1,019,000	23.4
Wood Gulch	Unknown	Unknown	Unknown	Unknown
Maintenance Dredging				
John Day	0	0	0	0
Willow Creek	189,000	4.3	286,000	6.6
Umatilla River	0	0	0	0
Rock Creek	16,200	0.4	51,300	1.2
Wood Gulch	Unknown	Unknown	Unknown	Unknown

9.4 Navigation Modifications

9.4.1 Modifications for Commercial Ports and Marinas

Commercial ports and marinas would be impacted by the effects of the proposed drawdown alternatives, and potential modification measures were evaluated as part of this Phase I Study. In most cases, discussion centered on relocation of facilities closer to the proposed

river channel. All facility managers indicated, however, that simple relocation would not be sufficient to recover a substantial percentage of the revenue and employment that would be lost by drawdown.

Post-drawdown port commerce would be impractical for the following reasons:

- It would cost several million dollars to relocate the port's facilities and resume operations. A detailed estimate of mitigation costs is provided in the Economics Technical Appendix.
- Because of the large cargo volumes that can be transported by barge, the ports and barge lines currently can ship commodities for a much lower cost than other modes of transportation. Under the pre-dam channel configuration, barge capacities would be much smaller. As a result, it would be more expensive to ship by barge than by truck or rail.
- Even with a redesigned 14-foot channel, towboats would have to increase horsepower and steering capabilities because of the higher current velocities and sharper channel bends. Also, it would require more time and fuel to navigate the river. Safety would be a major issue for barge traffic as it moves from slack water or canal waterways to open river navigation. These factors would result in increased transportation costs, reducing the profit margins of all parties currently involved. However, the profit margin for rail transportation and trucking companies would potentially increase.

Most farms in the area would be negatively affected by higher transportation costs. Farms are the ports' largest clients, and many of the ports could not operate without their business.

The directors of all the evaluated sites provided cost estimates for relocating their facilities. For some sites, the costs of other potential mitigation alternatives were also included. This information is explained below and summarized in the Navigation Section of the Economics Technical Appendix. Most of the facility cost estimates provided were for original construction costs with year of construction. These costs were then adjusted to present-day values using *Engineering News-Record* cost indices.

9.4.1.1 Port of Arlington, Oregon

The main facility at the Port of Arlington is the Cargill grain elevator. Cargill did not provide data on construction cost or year, so a value of $4 million was estimated for the grain elevator, based on a comparison with other similar facilities in the project area. The total cost to replace the port and marina facilities at Arlington would be approximately $5.3 million, not including infrastructure or removal of existing structures. Roughly 350,000 cubic yards of sediment and rock would have to be removed to create a similar marina. Under both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than it would for existing conditions. Under either drawdown scenario, port management believes that the facility would have to close and that relocation would not be a feasible alternative. The port director also thought it would be impractical to rebuild the waterfront park because of the greater distance between the town and the river after drawdown.

9.4.1.2 Port of Roosevelt, Washington

Construction of facilities and infrastructure at the Port of Roosevelt would cost an estimated $6 million, not including removal costs. The port director estimates that due to increased

transportation costs around 25 to 30 percent of the port's business would be lost under the spillway drawdown scenario, and that all business would be lost under a natural river conditions scenario. For both drawdown scenarios, the relocated port must accommodate greater fluctuations in reservoir elevation than for existing conditions. Facilities exist at the port for loading eight rail cars per day; however, they have not been used for more than 10 years due to the availability of less expensive barge transportation. Port management suggested that these facilities could be converted to load 50-car unit trains at an estimated cost of $1 million to $4 million. The port director stated that it might be economically feasible to operate the port after a relocation or rail conversion, but it would be at a minimal profit.

9.4.1.3 Boardman Park and Marina, Oregon

The total cost to relocate Boardman Park and Marina was estimated to be $10 million, including infrastructure and dredging. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Park management believes that 50 percent of the users would not return, even if the park were relocated; therefore, relocation alone would not be a feasible alternative. It was suggested that some other attraction would be needed in order to draw tourists to the park. Possibilities put forth by park management were an indoor swimming pool and an 18-hole golf course.

9.4.1.4 Port of Morrow, Oregon

The cost to replace facilities located at the Port of Morrow was estimated to be $30.3 million, including infrastructure. Approximately 1.2 million cubic yards of rock and sediment would have to be removed to create equivalent access channels, slips, and a turning basin. This estimate does not include the cost of removing existing facilities. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. The port director predicted that, even after relocation, the port would lose most of its grain contracts under the spillway drawdown condition and all of its grain contracts under the natural river condition.

9.4.1.5 Hogue-Warner Grain Elevator, Irrigon, Oregon

The value of the Hogue-Warner Grain Elevator facilities is estimated to be $17.5 million. As discussed earlier, however, the Hogue-Warner grain elevator would not have to be completely replaced. The facility could be modified to operate under either drawdown condition at an estimated cost of $250,000. For both drawdown conditions, the relocated grain elevator must accommodate greater fluctuations in pool elevation than for existing conditions. The Morrow County Grain Growers estimate that 40 percent of the grain elevator's business would be lost if the channel is returned to its pre-dam configuration, and 20 percent would be lost if a 14-foot channel is maintained. Another option discussed by management was conversion to a rail facility at a cost of $5 to $8 million.

9.4.1.6 Irrigon Park and Marina

Accurate figures on the original cost of constructing Irrigon Park and Marina could not be obtained, but the port director estimated that replacement would cost $5 million. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. Park officials predicted that 50 percent of the tourism

would be lost even with relocation. However, relocation would not be economically feasible due to the relatively small amount of income generated by the facility.

9.4.1.7 Umatilla Park and Marina

The value of the Umatilla Park and Marina was estimated to be approximately $2 million. As discussed earlier, this facility would not require relocation. However, an estimated 13,000 cubic yards of dredging and rock blasting would be necessary. For both drawdown conditions, the relocated port must accommodate greater fluctuations in pool elevation than for existing conditions. The park director predicted that 50 percent of tourism would be lost under either drawdown condition. Due to the relatively small amount of dredging required, it would be feasible to dredge and maintain the operational status of the marina.

9.4.2 Modifications for the Columbia River Navigation Channel

Four different channel designs were analyzed, including the pre-dam channel design, the existing channel design, a revised navigation channel design, and a channel design based on input from the towboat operators. Table 58 summarizes the channel design parameters for both drawdown conditions. The parameters include depth and width, with advanced maintenance dredging shown in parenthesis in the second column. Channel alignments and profiles are included in the Navigation Section of the Economics Technical Appendix.

All design work was based on guidance from USACE's EM 1110-2-1611, *Layout and Design of Shallow-Draft Waterways*. The limiting design condition for depth was assumed to be the 99 percent, 5-day exceedance daily flow of 80,000 cfs. The limiting design condition for channel velocities was assumed to be the median 5-day exceedance daily flow of 200,000 cfs. Channel alignments, widths, and depths were input into the commercial software program ArcInfo and used in conjunction with the Digital Terrain Model. Water surface profiles were estimated from the HEC-RAS step-backwater hydraulic analysis.

9.4.2.1 Pre-dam Channel Design

Prior to construction of John Day Dam, barge traffic along the river was achieved by means of a narrow, winding, 150-foot-wide by 7-foot-deep navigation channel. Passage through this channel was made extremely difficult and dangerous by the presence of strong currents, shallow rock formations, boulders, and stretches of shallow-water rapids. In addition, the channel was only wide enough to allow for one-way barge traffic, and towboat captains had to coordinate their crossings. Barge capacities ranged from 700 to 1,000 tons compared to 3,500 to 4,250 tons per barge today. Also, only two barges per tow were possible, compared with 4 to 4.5 barges per tow today. Although this design would require the least amount of dredging, it would not provide a practical solution for the commercial shipping industry. Smaller volumes and greater travel times would increase the cost of barge shipping for all commodities.

Table 58. Channel Design Parameters		
Channel Design	**Depth (ft)**	**Width (ft)**
Natural River Drawdown		
Pre-dam	7	150
Existing	14 (+2)	250
Revised	14 (+2)	165, 260[a]
Towboaters' Input	14 (+2)	260, 350[b]
Spillway Drawdown		
Pre-dam	7	150, 250[c]
Existing	14 (+2)	250
Revised	14 (+2)	165, 260
Towboaters' Input	14 (+2)	260, 350

a. 165-foot width for one-way traffic; 260-foot width for two-way traffic.

b. 260-foot width for the entire length of channel, except for a 350-foot-wide stretch from Arlington to Boardman.

c. 250-foot width from John Day Dam to approximately RM 263; 150-foot width from RM 263 to McNary Dam.

Glen Comstock of Foss Maritime and Dan Craemer of Port of Morrow provided information identifying the pre-dam navigation channel alignment. Both men are former towboat captains who navigated this stretch of the Columbia River between John Day and McNary Dams for many years prior to construction of John Day Dam. In addition, they provided valuable input for both drawdown conditions. For the natural river drawdown, their suggested alignment was used as the basis for design of the entire project length. For the spillway drawdown scenario, the depth created by the slack-water pool would be sufficient to maintain the existing 14-foot-deep by 250-foot-wide channel from John Day Dam upstream to about RM 263. This alignment for the spillway drawdown condition would extend from RM 263 upstream to McNary Dam located at approximately RM 291, and it would be based on the same alignment delineated for the natural river condition. The Navigation Section of the Engineering Technical Appendix details the variable dredging effort required for each of the four separate channel designs for the two basic drawdown conditions.

A constant width of 150 feet and a depth of seven feet are required for the pre-dam channel design. No advanced maintenance dredging was included in this analysis as it was not included in the original channel design. Therefore, all material dredged under this design was assumed to be sedimentary. The dredged material was assumed to be 80 percent silt to 20 percent sand and gravel from John Day Dam upstream for a distance of five miles, and 20 percent silt to 80 percent sand and gravel for the rest of the upstream channel.

9.4.2.2 Existing Channel Alignment

The existing navigation channel was designed and implemented after John Day Reservoir was filled. A constant width of 250 feet and a depth of 14 feet were used. An additional 2 feet of advance maintenance dredging was incorporated into the design, bringing the total dredging depth to 16 feet.

Under both drawdown conditions, the channel would cross over dry land and several stretches of extremely shallow water. Thus, the alignment was altered slightly in some reaches to produce a more feasible alignment that would bypass the dry land and shallow water areas. However, at nearly 12 million cubic yards of dredging and blasting, this alignment remains the most impractical design of the four channel designs.

9.4.2.3 Revised Channel Design

Using USGS bathymetric charts for a flow rate of 156,000 cfs, a revised channel alignment was chosen. The goal was to design a channel that would require the least amount of dredging possible, while still maintaining an easily navigable waterway. Channel width was calculated assuming a total barge tow width of 85 feet and a total barge tow length of 650 feet.

A minimum channel width of 260 feet is required for two-way traffic in straight segments for the barge tow dimensions specified above. After discussions with barge line operators, it was decided that two-way traffic is not imperative along the entire length of the channel. To minimize dredging in shallower areas, it would be possible to narrow the channel to 165 feet wide, which is the minimum necessary for one-way traffic. A wider channel would likely be required in areas where the current is swift or the bottom is rocky. Channel width may also be increased in bends.

9.4.2.4 Revised Channel Design Based on Input from Towboat Operators

Based on conversations with towboat operators, a few additional considerations were added to the revised channel design. Many towboat operators stated that the stretch of river between Arlington and Boardman is consistently subjected to extremely high wind speeds and shifting wind directions. The towboat operators' suggestion that this stretch of channel be widened to 350 feet was incorporated into the revised channel design. They also requested that the entire channel be designed for two-way traffic, although it would not be absolutely necessary. Therefore, the width in the straight segments is kept at a constant 260 feet except for the 350-foot-wide section between Arlington and Boardman. The width in bends varies from 260 to 400 feet.

Channel Dredging Requirements

USGS provided surface bed material gradation, but no detailed information on the riverbed substratum was available. Based on comparisons of the 1935 and 1994 Digital Terrain Models and on conversations with river users (including port and park directors, towboat operators, and local residents), it was assumed that solid rock lies beneath the riverbed sedimentary layer. Much of the finer sediment now in place would be washed away by natural current action once the water surface was lowered and river velocities increased. To determine dredging quantities for specific materials, it was assumed that within the channel template the following ratios would be present for all designs except pre-dam:

- From John Day Dam (RM 215.6) upstream to RM 221: 30 percent silt, 70 percent rock
- RM 221 to 256: 10 percent silt, 90 percent rock
- RM 256 to 291: 10 percent sand/gravel, 90 percent rock

The "rock" portion may include a large quantity of cobbles and boulders. A more detailed analysis, including extensive sediment borings, will be necessary to ascertain more accurately the quantities and types of materials to be dredged.

9.4.2.5 Initial Dredging

Based on the assumption that most of the channel excavation would be through rock, the channel banks were designed to be vertical. Dredging quantities were determined by overlaying the channel designs with their respective cross-section templates in the 1994 Digital Terrain Model. Table 59 lists quantities of material to be dredged for each of the four channel designs for both drawdown conditions.

The pre-dam configuration would require the least amount of dredging, and the existing channel would require the most. It is estimated that nearly 12 million cubic yards would need to be dredged. Profiles of the water surface, channel bottom, and river bottom, along with areas to be dredged, are presented in the Navigation Section of the Engineering Technical Appendix.

Table 59.
Initial Dredging Requirements

Design	Dredging Volume (cubic yards)
Natural River Drawdown	
Pre-Dam	91,600
Existing	11,945,600
Revised	3,051,600
Revised with Towboaters' Input	4,459,800
Spillway Drawdown	
Pre-Dam	25,400
Existing	3,736,800
Revised	1,501,700
Revised with Towboaters' Input	1,794,800

9.4.2.6 Maintenance Dredging

Maintenance dredging requirements were also investigated. Little or no maintenance dredging of consequence will be required under any of the four channel designs, for the following reasons:

- Little evidence of significant sedimentation was observed.
- Increased channel velocities will prevent suspended sediments from settling.

Most sediment within the main channel of the Columbia River will settle upstream from McNary Dam, where the velocities are low. As a result, the sediment budget for the project length will come almost entirely from runoff and tributaries below McNary Dam.

Although only small amounts of sedimentation would occur in the main channel, minor quantities of gravel, boulders, and rock fragments would be expected to unravel from

adjacent banklines and surrounding areas. These materials would likely accumulate over time and could require periodic removal. Further analysis will be required in a Phase II Study to more accurately determine the need for maintenance dredging.

Quantities of material to be dredged were estimated in order to determine the feasibility of each of the channel designs. The pre-dam configuration would require the least amount of excavation, approximately 25,380 cubic yards for the spillway drawdown condition and 92,000 cubic yards for the natural river drawdown condition. The existing channel would require the most dredging, about 3.7 million cubic yards for the spillway drawdown condition and 12 million cubic yards for the natural river drawdown condition. The most practical design is the revised design. It would require approximately 1.5 million cubic yards of excavation under the spillway drawdown condition and three million cubic yards under a natural river drawdown condition.

9.4.2.7 Disposal Site Requirements

Upland disposal area capacity requirements were determined for each dredging reach. To calculate the area needed, a 15-foot disposal dike height was assumed. Bulking factors were applied based on the percentage of material dredged, using a factor of 1.2 for sand, 1.55 for silt, and 1.75 for rock. Table 60 lists the approximate area required for each of the four designs for both drawdown conditions.

Table 60.
Approximate Disposal Site Areas Required for Initial Dredging

Design	Area (acres)
Natural River Drawdown	
Pre-Dam	5
Existing	850
Revised	220
Revised with Towboaters' Input	320
Spillway Drawdown	
Pre-Dam	2
Existing	260
Revised	110
Revised with Towboaters' Input	130

Navigation Modification

Without dredging, the water surface elevation within the channel would drop below levels required for navigation throughout much of the river. Ports and marinas currently in operation would be left with no way to load barges, even if a main navigation channel existed.

Measures could be taken to contend with some impacts caused by the proposed drawdown. The main navigation channel could be redesigned and dredged to accommodate the barges in use today. In addition, ports and marinas could be relocated closer to the water. However,

large quantities of rock and gravel would have to be removed. Dredging and relocation of facilities could only be accomplished at great cost and over a significant period of time. Many port directors stated that relocation of their port facilities is not feasible due to the associated high costs. In addition, the following issues would still require consideration.

- Higher current velocities and sharper turns would make navigation less safe, less efficient, more time-consuming, and, as a result, more expensive.

Some reaches of the Columbia River consist of wide, shallow rapids. During periods of low flow, it may not be possible, without dredging, to maintain a 14-foot channel through some of these shallower areas, unless all flow could be diverted into the channel.

Navigation through the John Day Reservoir is essential for all navigation interests upstream from McNary Dam.

Several studies of the impacts of a modal shift in commodities shipping from barge to truck or rail have been conducted and are summarized in the Navigation Section of the Engineering Technical Appendix.

The results presented in this investigation are based on a number of assumptions. It is possible that profitable navigation could be achieved and maintained along the John Day Reservoir after the proposed drawdown, but a more comprehensive and thorough analysis is required.

9.5 Transportation and Shoreline Infrastructure Modifications

9.5.1 Bridges

Two bridges would need to be modified, the SR-14 and BNSF Railway bridges over Rock Creek. Prior to the initial filling of the John Day Reservoir, the railway and road embankment was rerouted across Rock Creek and completely blocked the original Rock Creek channel. A new channel was blasted through bedrock several hundred feet east of the original channel. Both bridges are currently set in bedrock, with the channel bottom also consisting of a bedrock sill. Following drawdown, this bedrock sill would block fish passage. The thalweg of the channel would need to be lowered. Furthermore, to achieve a stable channel for Rock Creek, the bridges would have to be longer in order to achieve the required channel width. To provide fish passage, dredging the original channel and breaking through the existing embankment is recommended. This approach would require building two new bridges over the opening in the abutment to carry SR-14 and BNSF track.

9.5.1.1 Natural River Condition

For the natural river condition, the new highway and railroad bridges must be 460 feet long to accommodate the stable channel design. The thalweg would have to be lowered to elevation 202. In addition to the two new bridges, this design would require the removal of 299,357 cubic yards of embankment fill.

9.5.1.2 Spillway Drawdown Condition

For the spillway drawdown condition, the new highway and railroad bridges would need to be 330 feet long to accommodate the stable channel design. The thalweg would have to be lowered to elevation 234.8. In addition to the two new bridges, this design would require the removal of 118,152 cubic yards of embankment fill.

9.5.2 Culverts

9.5.2.1 Perched Culverts

A total of nine culverts would be perched after drawdown. They are (1) the box culvert at the Blalock Canyon boat launch, (2) the box culvert at Jones Canyon, and (3) a group of seven culverts near RM 267. To drain the stagnant water that would be trapped upstream, these culverts would need to be replaced with culverts that are low enough to empty the entire pond and pass inflows. The requirement for these will be virtually the same for both the natural river and spillway drawdown conditions. The only difference is that the culverts for the natural river condition would have to extend to a lower elevation to reach the post-drawdown water surface than would the culverts for the spillway drawdown condition.

9.5.2.1 Specific Sites

Blalock Canyon Boat Launch. Add a 48-inch-diameter, 100-foot-long corrugated metal pipe that has an inlet as low as the pond bottom. This modification will drain the water ponded behind the existing box culvert.

Jones Canyon Railroad Culvert. Add a 48-inch-diameter, 100-foot-long corrugated metal pipe that has an inlet at the same elevation as the pond bottom. This modification will drain the water behind the existing culvert.

Backwater Pond Culverts near RM 267. Replace existing culverts. Seven culverts drain backwater ponds behind I-84 and the UPRR embankment along a stretch of river near RM 267. Three 36-inch-diameter culverts, about 1,000 feet apart, connect ponds on either side of I-84. Three 48-inch-diameter culverts and one set of two 60-inch culverts connect the pond behind the railroad embankment with the reservoir. They, too, are approximately 1,000 feet apart. One 100-foot-long, eight-foot-diameter corrugated metal pipe would replace all the culverts in the railroad embankment. A 200-foot-long, eight-foot-diameter corrugated metal pipe would replace all the culverts in the I-84 embankment. The inlets of the eight-foot corrugated metal pipes should be low enough to allow the ponds to completely drain.

9.5.3 Other Culverts

Approximately 240 culverts spill directly onto embankments. Three different designs are proposed. For culverts less than or equal to two feet in diameter, Class 4 riprap would extend down from the culvert to the drawn-down water surface. It is assumed that no riprap is currently in place; the slope is 2V:1H; the flow from the culvert expands at a 4:1 ratio; and the thickness of the riprap to be installed is five feet (or twice the median riprap size).

Culverts more than two feet and less than or equal to four feet in diameter, 48-inch-diameter, semicircular corrugated downspouts would be placed from the culvert outlet and extending to the drawn-down water surface. It is assumed that the slope is 2V:1H.

Culverts four feet or more in diameter, grouted Class 4 riprap would be placed from the culvert to a point where the flow has expanded to a flow-per-unit width less than 8.7 cfs per foot. Class 4 riprap, without grout, would be placed from that point to the water surface. Again, it was assumed that no riprap is currently in place; the slope is 2V:1H; flow from the culvert expands at a 4:1 ratio; the thickness of the riprap blanket is five feet; and the porosity of the riprap is 0.5 (the grouted riprap is about 50 percent riprap and 50 percent grout).

9.6 Irrigation Modifications

Two alternatives were investigated for providing irrigation if a drawdown were implemented. The two alternatives included (1) pump modifications, and (2) constructing irrigation canals in combination with pump modifications. The following sections provide the detail for the two irrigation modifications.

9.6.1 Pump Stations

All pump stations will require new intakes with fish screens to deliver water to existing pump stations, and most will require new low lift pumps (with fish screens) to the lowered reservoir to deliver water to existing pump stations. Proposed modifications at each of the pump stations are detailed in the Irrigation Section of the Engineering Technical Appendix.

9.6.1.1 Pump Station Quantities and Costs

Pump station quantities and costs were based on the following.

Low lift pumps. Pumps to deliver water from lowered pool to existing pump station, varying between 25 hp and 850 hp.

Fish screens (twin wedge-wire). Cylindrical steel wedge-wire screens located on intake pipes (diameter of screen varies).

Cofferdam and dewatering. Cofferdam and dewatering requirements to install discharge pipe from low lift pumps to existing pump station.

Intake pipe or pipes. Steel pipe (diameter of pipe varies) to deliver water to low lift pump station or for those stations requiring intake pipe extensions.

Pump caisson and manifold pipe. Steel pipe (diameter of pipe varies) required for low lift pump stations. Each caisson would contain one pump.

Discharge pipe or pipes. Steel pipe (diameter of pipe varies) from low lift pump to existing pump station.

Inlet structure at existing pump station. Modification of existing inlet structure (construction of weir box) at existing pump station.

Electrical. Electrical and mechanical hookups for low lift pumps. Electrical transmission line and transformers for low lift pumps.

Land Changes. Access road to low lift pump station. Land acquisition for low lift pump station and discharge lines.

9.6.1.2 Operation and Maintenance

An increase in O&M will be required for the following:

- Operation of the new low lift pump stations
- Operation of the existing pumps at a higher pumping head
- Maintenance associated with the intake structure and fish screens (removal of sediment from drawdown)

9.6.2 Irrigation Canals

A canal option is included as an alternative for providing water to irrigators affected by drawdown. Proposed Oregon and Washington routes and system design information was obtained from the *Feasibility of Irrigation Canal Along the Columbia River in Oregon,* (November 1992) and from *Feasibility of Irrigation Canal Along the John Day Pool in Washington* (March 1993).

9.6.2.1 Irrigation Canals in Washington

A major pump station would lift water from the McNary pool to a canal along the Washington shore for approximately 42 miles and deliver water as far west as Harris Farms (located at RM 240.8). For estimating purposes, a design capacity of 1,639 cfs was derived from the report mentioned above (this amount was selected based on existing pump station capacities and accounting for evaporation losses and unknowns). A pump station would also be required to lift water from The Dalles pool to a canal extending along the Washington shore for approximately 1.5 miles and deliver water to Goldendale Aluminum (located at RM 216.9). Existing pump stations would be relocated to the canals.

Table 61. **Canal Design Features**
• Pumps are required to pump water from the Columbia River pump stations (McNary and The Dalles pools) into the canals. The Oregon Canal Pump Station would consist of 20 pumps, each 1,500 hp and 44,600 gpm. The Washington Canal from McNary pool would consist of 16 pumps, each 1,500 hp and 46,000 gpm. The Dalles pool would consist of 4 pumps, each 400 hp and 5,300 gpm.
• Fish screens (twin wedge-wire): Located on intake pipes to the Columbia River pump stations.
• Intake pipes: Steel pipe to deliver water to the Columbia River pump stations. For estimating purposes, one intake would be provided for two pumps.
• Pump caisson and manifold pipes: Steel pipe required for the Columbia River pump stations. Each caisson would contain one pump.
• Discharge pipeline to convey water from the Columbia River pump stations to the canals.
• Electrical and mechanical hookups for all pumps.
• Electrical transmission line and transformers to the Columbia River pump stations and to the relocated pump stations along the canals.
• Excavation and fill to form the canal section.
• Concrete lining (3-inch thickness) for the canals.
• Security fence along both sides of the canals, around the Columbia River pump stations, and around the relocated pump stations.
• Bridges required at road crossings (22-feet wide).
• Canal check structures required for each relocated pump station.
• Relocated irrigation pump stations (use existing pumps) including check and pressure relief valve assemblies.
• Regulating reservoirs.
• Automation and control systems for full automation of the Columbia River pump stations and pump stations along the canals.
• Restoration of original pump station sites to a more natural state.
• Siphon crossings of the Umatilla River, railroad, highways, creeks, Four Mile Canyon, and Wood Gulch.
• Land acquisition for the Columbia River pump stations, canals, and relocated pump stations.

9.6.2.2 Irrigation Canal in Oregon

A major pump station would lift water from the McNary pool to a canal extending along the Oregon shore for approximately 37 miles and deliver water as far west as Willow Creek (located near RM 252.8). For estimating purposes, a design capacity of 1,988 cfs was used from the report cited above (this amount was selected based on existing pump station capacities and accounting for evaporation losses and unknowns).

Canal design features are listed in Table 61. See the Irrigation Section of Engineering Technical Appendix for the canal routes and sketch layouts.

9.7 Water Supply Modifications

9.7.1 Municipal Water Supply: Canal Recovery Alternative

If a canal option is chosen as a feasible and economical alternative for the irrigation pump station modifications, then the canals could also supply current water users if all affected users are able to draw from the canals. Users would need to locate pumps at the canal, run pipeline to their existing water supply or distribution lines, and provide for water treatment. Other issues might include acquisition of property for canal or pipeline supply alignments; access right-of-ways; easements for secondary canals, pipelines, and electrical lines; and siting of pumps or booster pumps.

Table 62 and Table 63 list the primary and alternative options, respectively, together with their associated requirements, costs, and feasibility.

Table 62. **Water Supply Primary Options: New Intakes and Replacement, and Deepening Wells**	
New Water Intakes in Reservoir	
Required Items	Install new pumps and pipelines, or construct access benches into the pool and install intakes, pumps, and pipeline Provide treatment facilities for bacteria, chemicals, and minerals Install new distribution system, if required Provide for heating and cooling of treated water (for fish hatcheries) Install new holding tanks or holding ponds Acquire additional lands
Costs	Capital investment costs include land acquisition, intakes, turbine pumps, treatment plant, heating and cooling systems, holding tanks. Future costs include additional electricity payments; maintenance of new pumps, intakes, and treatment facility; cleaning of holding tanks or ponds.
Feasibility	Most likely alternative for users with high water quantities.
Replacement of Wells or Siting of Well Intakes at Lower Elevation in Existing Well	
Required Items	Drill, develop well, install well screen, and install new pump.
Costs	Capital costs for drilling and developing new wells, for drilling existing wells deeper, for installing new pumps, or for modifying existing pump.
Feasibility	Most likely alternative for small to moderate users.
Deepening of Existing Wells	
Required Items	Remove existing pump or well column Drill to deeper interval for water production Install well screen Develop well Install new pump or well column
Costs	Capital costs include drilling to deeper elevations, installing and developing wells, new pumps or extended pump columns, and any electrical control changes Future costs include additional electricity payments
Feasibility	Only likely for small users who can use alternative water supplies until deeper wells are completed.

Table 63. **Water Supply Alternative Options: Canal, Import, Combined Sources, and Buyout**	
Intakes from Proposed Water Canal and Associated Treatment	
Required Items	Purchase land or property for siting pipelines and treatment facility Install booster pumps, distribution pumps, and pipelines Provide for treatment of pool water for bacteria, chemicals, and minerals Install new distribution system, if required Provide for heating and cooling of treated water as applicable Install new holding tanks or holding ponds
Costs	Capital investment for the canal for lands (partial or graduated portion of canal), intakes, pumps, treatment plant, distribution system, heating and cooling systems, holding tanks. Future costs include additional electricity payments, maintenance of new pumps and intakes and treatment facility, and cleaning of holding tanks or ponds.
Feasibility	Only likely if the canals are chosen for the irrigation pump stations, but alternative is more costly than other alternatives due to land acquisition for pipelines to the canal location from the existing user location.
Importation of Water from Other Municipal Entities	
Required Items	Lands and property Pipeline Treatment as required Truck, rail, or barge transportation New holding tanks or holding ponds
Costs	Capital investment costs include the treatment plant, distribution system, heating and cooling systems, holding tanks or ponds, lands, easements, and rights-of-way. Future costs include additional electricity payments, maintenance of new pumps and pipeline, and treatment facility, cleaning of holding tanks or ponds.
Feasibility	For small users, this may be cost-effective, but the dependence on others would not likely make this a favorable choice to users.
New Combined Water Source (other than wells or pumps) and Distribution (must be combined with canal or other water transport source)	
Required Items	Lands and rights-of-way New reservoir (away from pool area) Treatment system Distribution system and pipelines New holding tanks or holding ponds
Costs	Capital investment costs include land required for reservoir area, treatment system and plant, distribution system, and holding tanks or ponds. Future costs include additional electricity payments, maintenance of new pumps and pipeline, and treatment facility.
Feasibility	Not likely due to land acquisition costs and dependence on using Canals.

9.7.2 Private Wells

9.7.2.1 Water Supply Alternatives

For owners of shallow wells, one alternative is to drill a deeper well to place the well screen in the horizon below where the new reservoir level will operate. A drop of approximately 40 feet in reservoir height would adversely affect any shallow well. Developing deeper wells above the basalt aquifer is one option to mitigate the drop in reservoir level.

Use of water from the basalt aquifer in Oregon in the Boardman-Umatilla-Hermiston region is regulated by the Oregon Water Resources Department (OWRD). Because of past overuse of the aquifer, OWRD halted additional drilling and withdrawal from the aquifer. Therefore, drilling deeper wells into the basalt aquifer is not an option for those with shallow wells seeking to use the basalt aquifer as an alternative source.

A measure of the effectiveness of the existing water supply system under the drawdown conditions will be whether the alternative will supply the current quantity and quality of water at the proposed reservoir levels.

Table 64 presents the options for recovering water supply capacity.

Table 64. **Options for Recovering Water Supply Capacity**	
Construct new water well	
Required Items	Drill one well to deeper elevation than original well. Install new well screens, develop the well, pump test the well, reinstall pump and controls, or replace if required due to greater depth.
Costs	Capital investment costs include new well or deepened well, casing, well screens, and new pump Future costs include additional electricity payments.
Feasibility	Most likely alternative for domestic users.
Purchase water from municipality or commercial source	
Required Items	Delivery system
Costs	Capital investment costs for new pipeline Future costs include increased water costs
Feasibility	Higher costs than constructing new water well due to potentially higher unit cost of water.

9.7.3 Summary

Owners of water supplies may have to choose among limited recovery methods. The economics of the choices may determine which choice may be viable. Primary recovery choices for system replacement are listed in Table 65.

Table 65. Water Supply Modifications Summary Table				
Existing System	**Alternative 1 Replacement**	**Alternative 2 Replacement**	**Alternative 3 Replacement**	**Alternative 4 Replacement**
Ranney Well Collector	New pumps and intake, or canals	Canals or new pumps and intakes	New pumps and intakes, or canals	Canals or new pumps and intakes
Large Alluvial Well	New pumps and intake or canals	Canals or new pumps and intakes	New pumps and intakes, or canals	Canals or new pumps and intakes
Basalt/Alluvial Well	Adjust lower intake screens, or adjust pump	Adjust lower intake screens, or adjust pump	Adjust lower intake screens, or adjust pump	Adjust lower intake screens, or adjust pump
Basalt Well	Adjust or resize pump	Adjust or resize pump	Adjust or resize pump	Adjust or resize pump
Surface Collection	New pumps and intake or canals	Canals	New pumps and intake or canals	Canals
Private Domestic Well – Alluvial	New well or purchase water from others	New well or purchase water from others	New well or purchase water from others	New well or purchase water from others
Private Domestic Well – Basalt	Adjust or resize pump, or new well	Adjust or resize pump, or new well	Adjust or resize pump, or new well	Adjust or resize pump, or new well

9.8 Recreation Modifications

9.8.1 Recreation Sites

9.8.1.1 Railroad Island Park

Plates 32 and 33 show a natural-shaped area that could be excavated to provide an area for boat ramps and docks. Access to this location would be across the dry lake bed and through the culvert/tunnel under the BNSF railroad. If one of the spillway crest alternatives is selected, the new location for the boat ramp and docks would be approximately 3,000 feet from the existing boat ramp. Also, there could be a possible congestion problem due to barge traffic through the lock at John Day Dam. If a natural river alternative is selected, the location of the boat ramp and docks would be approximately 3,450 feet from the existing boat ramp. The riverbanks in this area are steep (16 percent; USACE, 1955), so any new roads would require excavation and grading to reach the suggested alternatives. Note: both of these suggested alternatives will require further engineering and archeological study to evaluate their feasibility. Since this site was officially closed in the 1980s, no replacement of facilities should be considered; however, the proposed treaty-fishing site would be relocated.

9.8.1.2 Le Page Park (OR), RM 217

All the river access facilities included in this study will need to be relocated, but the level of facility relocation depends on the drawdown alternative. If a spillway crest alternative is selected, the swimming beach could be relocated with some excavation, contouring, and placing of sand. The future beach area would be approximately half the size of the existing beach. The boat docks for both the public and Tribal fishermen could be relocated farther out into the John Day riverbank while the ramps would be extended (see Plate 34). If a natural river alternative is selected, the ramp and boat docks could be relocated to a site on

the Columbia River approximately 2,400 feet from the existing boat ramps (see Plate 35). Floating breakwaters coupled with a rock groin, or a series of rock-filled breakwaters could be used to create short-term moorage facilities at the ramp. Due to the swift currents expected, it is doubtful that the swimming beach can be relocated to the main section of the Columbia River. However, it may be possible to relocate the swimming beach to the backwater area created at the confluence of the John Day and Columbia Rivers. Excavation, some contouring, and sand placement should create a safe swimming environment. Relocating the ramp and docks into the Columbia River would require building an access road, but known archeological sites in the area may limit the available right-of-way.

9.8.1.3 Albert Philippi Park (OR), John Day RM 3 5

Under the spillway crest alternatives, the backwater effect from the Columbia River will just extend to the downstream end of the park (see Plate 36). Therefore, with excavation and relocation of the existing boat docks, river access can be maintained. However, any sediment carried by the John Day River will start to drop out at the beginning of the backwater pool and cause a long-term maintenance problem in the area of the docks.

Under the natural river alternatives, river access will be limited to jetboats. As shown in Plate 37, there will be no backwater effect from the Columbia River, so the temporary docks at this site would have to be removed. Because of expected currents in the river, existing swimming beaches would be difficult to recreate for any of the four alternatives. Due to increased river velocities and the reduction or elimination of the backwater pool caused by the drawdown, the current sediment problem should be eliminated or significantly reduced.

9.8.1.4 Rock Creek (WA), RM 229

As stated earlier, there will be no river access to Rock Creek Park. However, under the spillway crest alternative, there appears to be a large, land-protected inlet approximately 1,000 feet from the current access tunnel (under the BNSF railroad). Excavation of the area and relocation of the ramp and boat docks, this inlet could be used (see Plate 38). If the natural river alternative is selected, the closest river access from the railroad access tunnel is approximately 2,300 feet (see Plate 39). Depending on further investigation, there should be a small shallow inlet formed by this drawdown alternative that could be deepened by excavation and then used for a ramp and boat dock. Either alternative would require building an access road to the relocated site, so other engineering and archeological considerations need to be investigated. The natural river bottom in this area has a one percent slope (USACE, 1955), so a road could easily be built. Both alternatives may also require groins and a floating breakwater or a rock-filled breakwater to provide safe boat launching and short-term moorage facilities. With some excavation, contouring, and sand fill, it should be possible to construct a swimming beach for either alternative. As in the boat launching facilities, groins and a floating breakwater or a rock-filled breakwater may be needed to provide a safe swimming area.

9.8.1.5 Blalock Canyon Boat Ramp (OR), RM 233 5

The closest river access is located approximately 1,200 feet from the current boat ramp using the spillway crest alternative, or 2,500 feet under the natural river alternative. With the spillway crest alternative (see Plate 40), there is some protected river access, so river velocities could be low enough to launch boats, although a groin or other structure may still

be required. With the natural river alternative (see Plate 41), there is no protected access, so river velocities would require a structure (a groin or equivalent) be built so boats could be launched safely. River access may be possible through the box culvert, but due to the steep slopes of the riverbanks in the general area (25 percent grade, USACE 1995) extensive excavation and grading would be required to locate a road past the railroad grade. Beyond the fill for the railroad, the banks of the Columbia River become very flat (<1 percent slope), so a road could easily be built to either alternate site. According to a 1955 survey by USACE, a road extended from the highway to the river. The survey also shows a structure that could be a boat ramp. Each alternative will require further engineering and archeological study before any alternative relocation can be considered with confidence. Although there is occasional recreational use of the boat ramp, the primary use of the site is as a harbor of refuge. Therefore, abandoning the site should also be considered in any future analysis.

9.8.1.6 Roosevelt Park (WA), RM 241

As indicated in Plate 42, it may be possible to relocate the park ramp, docks, and treaty-fishing facilities to the Columbia River approximately 1,500 feet from the current boat ramp for the spillway alternative. Due to river velocities and wind-wave action, a groin and floating breakwater or a rock breakwater may be needed to provide safe river access. Some excavation may be needed in the general area of the ramp and docks to provide enough draft for boats. With further excavation, a swimming beach could be provided, but since the beach would be located on the Columbia River, some type of breakwater would be necessary.

Under the natural river drawdown option (see Plate 43), there is a long inlet of water that extends up toward Roosevelt Park. With excavation, it may be possible to create a marina with enough draft for a boat ramp and dock that is located approximately 3,000 feet from the current boat ramp. A swimming beach, but this would require more excavation, some contouring, and placement of sand fill. Both alternatives will require a road to be built out to the suggested sites. Based on a 1955 survey by the USACE, there appears to be a road that may extend to the proposed sites. Consequently, further engineering investigation and archeological analysis will be required at this site.

9.8.1.7 Arlington Marina (OR), RM 241

As shown in Plates 42 and 43, it may be possible to relocate the ramp and boat docks out in the Columbia River. This area would be located on the outside of a curve in the Columbia River, and therefore the current could to be very strong. Therefore, a rock breakwater would be needed to provide protection for high channel velocities and wind-wave action. A road (approximately 2,300 feet in length from the existing boat ramp) through the existing marina could provide access to the new site. Another alternative is to excavate the marina. In the marina, the average bottom elevation is 225 (at the docks). To provide a 10-foot water depth at the docks would require increasing the depth of the marina by 50 feet (for the natural river alternative) and 17 feet (for the spillway crest alternative). Also, the banks of the marina along the island/jetty where the grain elevator is located may need to be sloped back to provide the room necessary for this excavation. This would require moving the island/jetty to farther out into the river to keep the current size of the grain load facility constant. Therefore, due to the extent of the excavation required, moving the marina out into the river may be the most viable alternative.

Based on recent borings taken in the marina, the bottom is composed of medium dense alluviums consisting of fill (basalt cobbles and boulders), and thick layers of sandy gravel, cobbles, and boulders interspersed with thin layers of sandy silt. No bedrock was encountered. Any excavation or road building may also encounter a rail yard that was flooded by John Day Reservoir. This infrastructure could be a potential environmental problem, so it would need more investigation, in addition to further engineering analysis.

9.8.1.8 Earl Snell Park, Arlington (OR), RM 241

The park is central to the city. The embayment could be excavated to provide very limited swimming at the higher flows of Alternatives 1, 2, or 4, but the higher water surface level would only be temporary. Any excavation may encounter sections of the old town of Arlington that was flooded by the reservoir. This infrastructure could be a potential environmental problem.

Another option would be to create a small dam across the narrowest part of the waterway entrance to the park (in-between the I-84 and the UP railroad bridges). Columbia River water could be pumped in to maintain the water level and water quality of the impounded lake. Since there are no ramp facilities located in the existing park, river access should not be an issue.

9.8.1.9 Quesnel Park (Threemile Canyon) (OR), RM 255

One possible replacement measure is moving the facilities to the river side of Threemile Island. A road from the existing site could be built from the new location. Using the spillway crest alternative, the ramp would be 2,800 feet the current ramp (see Plate 44). This location would require a groin and floating breakwater or a rock breakwater to provide a safe area for boat launching due to river currents and possible wind-wave action. The natural river alternative would place the ramp 3,000 feet from the current ramp (see Plate 45). In this case, some excavation may be required to provide adequate depths for launching or mooring a boat.

Another replacement option would be to move the recreation site approximately 1 mile upstream from Threemile Island (see Plate 44 or 45). With some excavation, it may be possible to provide a more protected boat launching and moorage facility. Before the John Day Reservoir was created, a road existed (USACE survey, 1955), so it should be possible to provide access to either of the proposed relocation sites. However, on the river side of Threemile Island, the slope of the riverbank exceeds 12 percent. According to USACE's 1955 survey, there is a road to the relocation site 1 mile upstream from Threemile Island. In fact, the site was the location of a ferry crossing, which may indicate that it has natural protection from the river. Finally, as with all of the other sites, any road, ramp, or docks would need to be evaluated for engineering judgment and archeological concerns.

9.8.1.10 Crow Butte (WA), RM 262

For all alternatives, the boat ramp could be relocated to an area along the south bank of Crow Butte and an access road extended from existing roads in the park. Since this location would be on the main section of the Columbia River, groins and a floating breakwater or a rock breakwater may be needed to provide safe boat launching facilities and to provide protection from wind-wave action (see Plate 46 or 47). The same would be true for a swimming beach. However, due to river velocities construction of a safe swimming area may be difficult, so it

would be a candidate for elimination at this location. Both would require some excavation, and contouring, while the swimming beach would also require sand fill. The side slopes of the river in this area of Crow Butte exceed 35 percent (USACE, 1955), so an access road to this site would be difficult to build.

Another option would be to place the facilities somewhere near the inlet that is between Crow Butte and the mainland (see Plates 46 and 47), or approximately 7,000 feet from the current boat ramp. According to interviews, an old road bed and railroad bed that extended from Crow Butte out into this area were in use prior to the filling of the John Day Reservoir. The existence of the old beds was verified during a 1955 survey by USACE.

The irrigation pump intake will need to be relocated so that the park grounds can be irrigated until other sources are found.

9.8.1.11 Boardman Park and Marina (OR), RM 269

As indicated in Plate 48 or 49, there is a naturally shaped inlet about 700 feet in front of the existing marina. Depths are very low, but it may be possible to excavate to create a new marina. However, the excavation and contouring required to provide the same level of facilities (size and depth availability) that is currently available could be very extensive. A groin and floating breakwater or a rock breakwater may be needed to shield against wind-wave action. With excavation, contouring, sand fill, and some type of breakwater for protection from river currents, a swimming beach could also be built in this area. A road would need to be built from the current boat ramp (approximately 2,000 feet in length), and utilities would be routed to the new marina. Based on aerial photographs taken by USACE in its 1955 survey, the approach to the suggested site is very flat and appears to be over farm land that existed before John Day Reservoir was filled.

Another option is to excavate the existing marina. The average bottom elevation in the dock area is 250, so the marina would need to be excavated by 39 feet to provide the necessary draft for larger boats. The existing rock breakwater would also need to be moved farther out into the river to provide room for the side slopes created by the excavation. Therefore, due to the extent of the excavation, moving the marina may be the most viable alternative. The park manager has suggested abandoning the swimming beach because access to water will still be available and unless water quality can be improved, swimming will remain a low public activity. Further engineering and archeological evaluations will be required to determine if the potential sites are viable.

9.8.1.12 Irrigon Park and Marina (OR), RM 282

The marina could be located farther out into the river (see Plates 50 and 51), which would require a rock breakwater to protect against wind-wave action. An earlier study found that a series of groins and a floating backwater were not practicable for this area due to the wind-wave action. In addition to the rock breakwater, would be necessary to provide the same level of services as is currently available. A large excavation would also be required to reestablish an area with adequate depth for swimming. Once the excavation is complete, the wave action that is causing the current bank erosion would continue, so a rock breakwater would also be required to protect the swimming beach.

The other option is to excavate the existing marina. Assuming a 10-foot depth, the marina would need to be excavated to elevation 226. This would require a 26-foot excavation. In

addition, the current rock breakwater would need to be moved to provide the room necessary for the required side slopes created by the excavation. Therefore, the most viable alternative may be to relocate the marina out into the river. No matter which areas are selected, further engineering and archeological evaluations will be required to determine if these sites are practical.

9.8.1.13 Umatilla Marina Park (OR), RM 290

Keeping the marina requires deepening the bottom to elevation 238.5 for clearance of 11.5 feet at 75,000 cfs (an excavation of 14.5 feet). This will provide adequate depth for deep draft vessels. Total depth for the entrance will be 12.5 feet, or elevation 237.5 (an excavation of 15.5 feet) to provide for wave and bottom clearance for larger ships using the marina. In addition, the existing rock breakwaters may have to be moved to provide the room necessary for the required side slopes created by any excavation.

Another option entails constructing a floating breakwater structure outside the marina with rubble mound breakwater on the upstream side for wind/wave protection. To provide the same area as the existing marina, the current rock breakwater/jetty would need to be removed and the area excavated to provide the proper depth. This alternative would place the marina very close to the proposed navigation channel (see Plate 52 or 53), so there could be a safety issue due to barge traffic.

Therefore, excavation could be the most viable alternative, since all of the current park facilities would be least affected by excavation. Restoration of the swimming beach would require a large excavation, contouring, and placement of sand to achieve a maximum water depth of seven feet. The current swimming beach has little use due to poor water quality, sedimentation buildup, and lack of maintenance. Therefore, the swimming beach may be a viable candidate for abandonment.

9.8.1.14 Plymouth Park (WA), RM 289

The ramp and boat docks could be relocated out into the main river channel approximately 1,000 feet from the current boat ramp (see Plate 52 and 53). This relocation may require groins and a floating breakwater or a rock breakwater to protect against river velocities and wind-wave action. The swimming area will also need to be relocated to the river, but it may not be practicable because of the previously mentioned velocities. Due to the shallow nature of the river in this area after drawdown, excavation would be required to provide the area and draft needed for boat launching and docking facilities. An engineering and archeological study will need to be performed to evaluate any proposed relocation. From examining USACE's 1955 survey, a road could easily be built to the relocated facilities.

9.8.1.15 Nugent Park (OR), Umatilla RM 1

Given the extensive rock excavation that would be required to mitigate the boat ramp and fishing structure to maintain existing use at drawdown, combined with the proximity of boat launching facilities at Umatilla Marina Park, it is proposed that this site not be mitigated. However, coordination with the National Park Service, the administrator of Land and Water Conservation Fund projects, will be necessary. Relocating the fishing structure to a site downstream of the park has not been evaluated for this Phase 1 Study.

9.8.2 Technical Requirements

9.8.2.1 Pile Installation

Without first performing an engineering investigation, pile installation conditions are unknown. However, new piles would be of similar material and design as those that currently exist at each site.

9.8.2.2 Boat Ramp Design

Depending on the drawdown alternative and relocation area selected for each site, the boat ramps will require either relocation or extension. See the attachments for details showing a typical ramp design [where is this material?].

9.8.2.3 Dock Design

Segments will be 20 feet in length, with widths and materials being consistent with docks used for the new treaty-fishing access sites. New docks would be constructed of concrete and sized to match existing facility docks. Design of concrete docks will conform to Oregon State Marine Board requirements. See the Recreation section of the Engineering Technical Appendix for typical gangway and dock details. Where new dock segments are added, piles will be required and installed. Minimum draft and buffer requirements are as follows:

- Marina entrance channels must have sufficient depth to accommodate the deepest draft vessels currently moored plus three feet (currently 10 feet required).
- Marina interior depths must be two feet deeper than the deepest draft vessel currently moored.
- Standard handling dock area depths must be a minimum of four feet. Because these are not permanently moored boats, it is assumed that the two-foot buffer is not required.
- Four types of docks are found at the recreation sites. They are defined as follows:
- Handling dock: dock adjacent to a boat ramp for the purpose of temporarily tying up launched boats for loading of passengers, etc.
- Courtesy dock: dock separated from a boat ramp but connected to land by gangway or anchor block
- Floating dock: dock that is not connected to land and not adjacent to a boat ramp
- Moorage dock: dock that is intended for long-term moorage

9.8.2.4 Excavation

Any in-river excavation required would have to be done during the in-water work period in the John Day Reservoir. Cofferdams with dewatering could be used to allow excavation to continue beyond the in-water work period. Irrigon and Umatilla Marina Parks are the two marinas that will require extensive excavation to provide for deeper-draft vessels. However, excavation can be expected at all sites depending on the drawdown and relocation alternative selected. General excavation methods for in-water work would involve barge-mounted equipment and bottom dump barges to haul excess materials for disposal. Dredging would not be the preferred method because cobbles and boulder-sized materials would be removed. Excavation equipment would include cranes with buckets, drag line, and chisels if needed, or

large backhoes with the required reach length to the projected bottom of the marinas. Disposal areas have not been identified. If excavation were to occur in existing basin/ramp areas, piles for docks would be removed and replaced. All docks suitable for reuse should be removed or protected to avoid damage during excavation. Piles associated with docks outside the excavation area should be protected and preserved. Silt fence barriers would be used as required for controlling turbidity during in-water excavation.

9.8.2.5 Swimming Beach Design

All swimming beaches would require some excavation to provide maximum water depths of seven feet during the normal July/August flow of 200,000 cfs. During the minimum flow periods in late August/September, the swimming areas will be designed to maintain a minimum water depth of four feet. Disposal of excavated material would be in-water if appropriate areas are available. If in-water disposal areas are not adequate to handle all disposal required, upland disposal will be used. Upland disposal site availability was discussed with lessees during the team site reconnaissance, but final disposal locations will be fully coordinated prior to completion of construction documents and award of any construction contract requiring excavation and disposal. A two-foot-deep sand cover would be required for all newly excavated areas in the swim beaches. It is assumed all swim beaches would be relocated if feasible. Beach designs would meet the minimum requirements specified in EM 1110-2-410.

9.9 Utilities Modifications

Seven utilities along and/or crossing the reservoir may be affected; they are an electrical utility, a gas pipeline, and five sanitary sewer outfalls. Exposure of utilities may result in required relocation of utilities. Increased velocity will increase scour, requiring riprap protection for pipelines. Sanitary sewer outfalls will be exposed, resulting in NPDES permit violations. Outfall pipes will require extensions into the lowered river level.

Impacts and modifications to the electrical utility crossing, gas pipeline crossing, and the Umatilla sanitary sewer outfall remain the same for each alternative. Modifications to the sanitary sewer outfalls for Boardman, Arlington, Roosevelt, and Goldendale Aluminum change under each alternative.

9.9.1 Operation and Maintenance

Additional O&M will be required for increased monitoring of the utility modifications following drawdown. The increased monitoring is estimated to extend over a five-year period at a cost of $10,000 per year.

Section 10. Economics

10.1 Introduction

The objective of the John Day drawdown economic analysis was to quantify the costs and benefits associated with operating John Day Dam at spillway crest or natural river levels. Seven primary areas of economic impact were addressed in the Phase I Study.

- Flood control
- Hydropower
- Recreation
- Navigation
- Water supply
- Commercial fishing
- Implementation Costs

In general, the level of detail for each impact is limited to available information. For some impacts, such as hydropower, considerable data exist as a result of the Lower Snake drawdown studies. Other impacts, such as recreation, are more difficult to assess and have a relatively wide range of uncertainty.

Each impact is addressed from three different perspectives. The Federal or national view considers the net effects to the nation. The regional perspective identifies gains and losses to specific subregions in terms of income and employment. The third perspective presents some of the possible social impacts on local communities and individuals.

10.2 National Economic Development

National Economic Development (NED) analyses are concerned with the economic efficiency of the nation. Thus, economic gains achieved by one region, community, or individual at the expense of another party do not represent an increase in the national economy. The results of the NED analysis should be taken as a general estimate of the magnitude of each impact. They should not be taken as a mitigation or compensation plan. NED costs associated with drawdown are included in the analysis regardless of who bears those costs or enjoys the benefits. For example, there is no federal obligation to construct new power plants if John Day hydropower production is eliminated. The analysis predicts supply and demand of electricity and assumes that new generating capacity will be built as needed. The costs of that new capacity are included in the NED analysis, but the incidence of the costs is irrelevant. The following sections present a brief overview of the NED analysis for each of the areas of impact.

10.2.1 Flood Control NED Evaluation

The John Day Dam and its reservoir, provide the only flood control storage space on the Lower Columbia River. The John Day Project has been operated for flood control since 1969. The project contains approximately 500,000 acre-feet of flood storage capacity. This

is a relatively small amount of total storage capacity compared to some upper Columbia River projects. Despite its limited storage capacity, the John Day Project's proximity to the Portland metropolitan area makes it valued for its ability to provide water management.

USACE's *Flood Control Operating Plan* for the Columbia River considers John Day a Category IV reservoir, similar to Arrow and Grand Coulee on the Columbia River in Canada and Washington, respectively. The operating plan states that Category IV reservoirs are operated with variable releases, primarily for flood control on the lower Columbia. Outflows from these projects have a relatively brief time of travel (two days or less) to the lower Columbia flood area, and the projects' have sufficient flexibility to permit variable releases on a day-to-day forecast basis. These reservoirs provide the final major storage regulation of the flood control system and are used primarily to maintain the desired controlled flows in the lower Columbia and at the same time provide local flood protection. The use of John Day storage capacity is occasionally limited by other operating goals, such as irrigation or fish and wildlife considerations.

For both the spillway crest and the natural river drawdown alternatives, the structural costs of providing the existing level of flood control at John Day have been estimated. The structural costs of providing flood control are far greater than the estimated damages prevented.

This study relied on the Portland District's Annual Flood Damages Prevented calculation, which is reported annually to Congress. The calculation most likely underestimates John Day's flood control benefits because John Day flood control is only credited if unregulated flows on the lower Columbia overtop the area's levee system. Another concern about using the Flood Damages Prevented calculations is that they do not account for other benefits of this storage capacity, such as augmenting flows for environmental and transportation purposes. Since 1969, the storage capacity associated with the John Day Project is credited with preventing annual flood damages between zero and $4.3 million (unadjusted). The project is credited with preventing cumulative damages of $28.5 million (adjusted 1998 dollars) for an average annual value of $950,000 a year.

Given that the costs associated with maintaining flood control at John Day are substantially greater than the damages prevented, most areas of impact have not been addressed in significant detail with regard to the changes in reservoir elevation associated with flood control. For the purposes of the NED analysis, there is a $1 million average annual impact for both the spillway crest and the natural river drawdown alternatives. This is a simplifying assumption that has been made for the purposes of this analysis; it does not represent a decision regarding the future of flood control.

10.2.2 Hydropower NED Evaluation

Hydropower impacts were measured by modeling the future supply and demand of energy. From an NED perspective, a reduction of John Day hydropower production will lead to the use of more expensive energy in the region, and new power plants will be constructed. The hydropower studies also address increased transmission costs and changes in air quality.

Two different approaches were undertaken to estimate the net system economic effects associated with the impacts to hydropower production in the Pacific Northwest: a) system production cost approach, and b) market price approach. System transmission effects and costs and ancillary costs were also analyzed.

10.2.2.1 System Production Costs Analysis

The economic effects presented in this section are based on the system production costs as defined by BPA and USACE production cost models.

The terminology used here refers to variable and fixed costs, which correspond to energy and capacity, respectively. Energy is defined as the power (capacity) that does work over a time period. Electrical energy consumed is usually measured in kilowatt-hours (kWh), megawatt-hours (MWh), or annual average megawatts (aMW). Capacity is defined as the maximum amount of power that can be delivered by a generating station. Electrical capacity is usually measured in kilowatts (kWs) or megawatts (MWs). In terms of system production costs, variable costs are the costs associated with meeting the energy requirements. They fluctuate in relation to the level of energy produced and represent the per-unit cost of energy generation. Fixed costs are the costs associated with providing the generation capacity and do not vary with the level of energy production. The fixed costs represent the annualized cost of constructing the new capacity.

Variable Production Costs

The variable production costs of thermal-based energy generation mainly include the fuel costs and, to a lesser extent, other variable operating costs (e.g., consumables required to keep the machinery working). If energy is transmitted between market regions, the costs associated with this transmission are also included in the variable production costs. Variable costs increase by an estimated $142.3 million with drawdown to natural river level.

Fixed Production Costs

For either of the production cost models to meet the loads projected over time, new generating facilities must be constructed. With each alternative, a different quantity of new thermal-based generating facilities will be needed to account for the varying amounts of hydropower production.

It was estimated that 20,220 aMW of new generating capacity would be built in the PNW and PSW with the baseline condition by the year 2020. With Alternatives 1 and 2, an additional 460 MW would have to be added by year 2020. With Alternatives 3 and 4, an estimated 960 MW would have to be added by year 2020.

It is assumed that this new capacity would be provided from natural gas-fired, combined-cycle combustion turbine plants at a cost of approximately $601 per kW and an average plant size of 250 MW.

Total System Production Costs

The increase in annual fixed costs and variable costs for the two natural river alternatives was $91 million and $142 million, respectively. The total system production cost for the natural river alternatives ranged from $207 million to $233 million. The increase in annual fixed costs and variable costs for the two spillway alternatives was $44 million and $74 million, respectively. The total system production cost for each of the spillway alternatives is $18 million.

10.2.2.2 Market Price Analysis

The electric industry is moving rapidly toward a more competitive market, but it is currently in a transition period that mixes wholesale pricing at marginal costs with most retail pricing based on average costs, together with established contracts that may or may not reflect either of these approaches. For these reasons, this report provides results from the two approaches of system production costing discussed in the previous section and the market pricing discussed in this section.

A comparison of estimated net economic effect for the natural river and spillway alternatives to the baseline condition for year 2020 indicates an annual cost increase of $201 million to $222 million and $100 million to $111 million, respectively.

10.2.2.3 System Transmission Effects

The analysis of power system impacts up to this point assumed that transmission reliability and service would remain the same under all study alternatives. The purpose of this section is to discuss the costs associated with maintaining transmission reliability with the different power analysis scenarios.

To compute the incremental costs associated with transmission impacts of John Day Dam drawdown combined with the breaching of the Lower Snake River projects, it is first necessary to determine the transmission cost impacts associated only with the breaching of the Lower Snake River projects. Based on the Lower Snake River study, the average annual transmission impact costs for breaching the four Snake River dams would be $21.9 million to $28.1 million at the 6.875 percent discount rate.

The drawdown of John Day Dam and/or breaching of the four Lower Snake dams renders the powerhouses inoperable, thereby altering the configuration of power generation facilities in the PNW transmission grid that feeds into the Northwest transmission grid. Since the transmission grid was originally constructed in combination with the generation system, and because they interact electrically, loss of generation will affect the transmission system's ability to move bulk power and serve regional loads.

The incremental costs of John Day drawdown combined with the breaching of the Lower Snake River dams was computed by subtracting the transmission costs estimated in the Lower Snake River study ($21.9 million to $28.1 million) from the overall annual costs for the drawdown of both the Snake river and John Day Reservoir ($23.5 million to $36.5 million). Therefore, the incremental costs associated with adding John Day drawdown to the Lower Snake River dam breaching are $1.6 million to $8.4 million.

The unanswered question is: What are the transmission system economic impact costs related to just the drawdown of John Day without the breaching of the Snake River dams? This question was not answered for this Phase I Study due to the limited scope of the analysis. At an absolute minimum, the incremental costs discussed above could be used to estimate an extreme lower limit of the transmission-related impacts. However, it is the opinion of system operators that the impacts to the transmission system of drawing down John Day to the natural river level would be similar to the impacts associated with breaching the Lower Snake River dams. Many of the same types of transmission facility improvements would be necessary with the drawdown of John Day as with the removal of the four Lower Snake River dams. However, no studies have been completed to confirm this hypothesis.

For this reason, the transmission impacts for the natural river alternatives were assumed to be the same as those estimated for breaching the Lower Snake River dams. The range of impacts would be between $21.9 million and $28.1 million. No studies were done to estimate the economic costs of transmission system impacts for drawdown to spillway crest. However, to account for the likely costs that would occur, it was assumed that the costs would range between the lowest incremental costs discussed in the preceding paragraph and the lowest of the costs for the Lower Snake River breaching transmission impacts. That is, it was assumed that drawing down the John Day Dam to the spillway crest level would have economic costs associated with transmission impacts between $1.6 million and $21.9 million.

10.2.2.4 Ancillary Services Effects

Power suppliers are now charging for many of the ancillary services that in the past were generally provided without charge by the entities owning the transmission facilities. Since these services are a necessary element of a safe and reliable power system, the loss of these services represents economic costs that are to be accounted for.

The John Day hydropower plant is used for Automatic Generation Control (AGC). Small, but very frequent changes in generation are necessary to perform this function. Hydroelectric projects, with stored water as their fuel, are extremely flexible and very useful for this purpose. If John Day Reservoir were drawn down, its contribution to this system would have to be spread over the remaining projects or replaced from other sources. BPA relies on AGC from John Day about 100 percent of the time at a level of about 100 MW. The average annual value was estimated to be $7.7 million.

John Day Dam is also used to provide part of the required reserves for the Federal power system. Reserves are expected to be "on-call" in the event of emergency loss of generating resources in the system. The market values of these reserve services vary throughout the year. In the high-demand winter months, it was assumed that BPA would have to purchase power from the market at a value of $31/MW-month to create reserve margin on the system. During the rest of the year, it was assumed BPA would sell this reserve at the average monthly market prices. The annual net economic cost associated with the loss of these reserves with John Day Reservoir drawn down to the natural river level or the spillway level was estimated to be $15.3 million. The total ancillary economic effects for the four drawdown alternatives are therefore estimated at $23 million.

10.2.2.5 Summary of Hydropower Net Economic Effects

The net economic effects represent the most likely point at which estimates of economic effects are most comparable to economic impacts identified elsewhere in the analysis.

The total net economic effects are listed in Table 66 for the medium economic forecast condition. This table combines the system costs computed with the two study approaches of system production costs and market price estimates with the transmission reliability effects and the ancillary services.

Table 66. Summary of Annual Net Economic Effects ($ million)		
	Spillway Crest	**Natural River**
System Costs		
Low	$101.2	$202.9
High	$116.7	$230.8
Transmission Reliability Costs		
Low	$1.6	$21.9
High	$21.9	$28.1
Ancillary Services Costs	$23	$23
Average Total Costs	$144	$265

10.2.3 Recreation NED Evaluation

From a national perspective, economic effects to recreation are measured as the change in willingness to pay for the recreation experience with and without John Day drawn down. Proxies for willingness to pay were estimated based on adjusting survey data gathered for the Lower Snake River Draw Down Study to anticipated conditions on John Day Reservoir. Seventeen current recreation sites along the John Day Reservoir were evaluated to assess the costs required to make them usable for recreation with a drawdown to spillway crest. In addition these seventeen sites were evaluated for changes in recreation opportunities, use, and quality as part of the willingness to pay proxy for both a drawdown to spillway crest and a drawdown to natural river level.

10.2.3.1 Modification Costs for Recreation Facilities – Spillway Crest Drawdown

Modifications to maintain recreation access with drawdown are proposed at 13 of the 17 sites. Modification costs were not developed for four recreation sites (Phillipi Park, Nugent Park, Sundale Park and Alderdale Park) because of concerns with future use or the high economic costs to dredge to the recreation sites. The cost estimates that were developed reflect drawdown to spillway crest. The total costs to modify the recreation facilities for a spillway crest drawdown is $21,685,000. Modification costs were not estimated for drawdown to natural river level but would be expected to be higher. Table 67 summarizes the modification measures and cost estimates for each recreation site.

Table 67. Modification Measures and Costs for Recreation Facilities – Spillway Crest Drawdown		
Recreation Site	**Modification Measures**	**Preliminary Cost Estimate**
Railroad Island Park, WA	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, and modification of access roads	$525,703
Le Page Park, OR	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of replacement swim beaches, and modification of access roads	$835,297
Phillippi Park, OR	No modification measures	
Rock Creek Park, WA	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of a replacement swim beach, and modification of access roads	$1,323,876
Sundale Park, WA	No modification measures	
Roosevelt Park, WA	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of a replacement swim beach, and modification of access roads	$668,752
Blalock Canyon Boat Ramp, OR	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, and modification of access roads	$525,532
Arlington Marina, OR	Extension of boat ramps, placement of riprap along boat ramp, and marina dredging	$7,301,577
Earl Snell Park, OR	Creation of a replacement swim beach	$143,050
Threemile Canyon Park, OR	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, and modification of access roads	$525,532
Alderdale Park, WA	No modification measures	
Crow Butte State Park, WA	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of a replacement swim beach, and modification of access roads	$996,283
Boardman Park, OR	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of a replacement swim beach, modification of access roads, and marina dredging	$2,380,777
Irrigon Park, OR	Extension of boat ramps, relocation of docks, placement of riprap along boat ramp, creation of a replacement swim beach, modification of access roads, and marina dredging	$2,059,470
Nugent Park, OR	No modification measures	
Plymouth Park, WA	Extension of boat ramps, relocation of docks, placement of rip rap along boat ramp, creation of a replacement swim beach, and modification of access roads	$668,752
Umatilla Park, OR	Extension of boat ramps, relocation of docks, placement of rip rap along boat ramp, creation of a replacement swim beach, modification of access roads, and marina dredging	$3,730,370
TOTAL		**$21,685,000**

10.2.3.2 Existing Recreation Use and Value

Visitation records indicate that over a 10-year period, 1989 through 1998, more than 25 million visitors used the recreation facilities provided in the John Day Reservoir. The

average attendance in this period was over 2.5 million visitors a year. The high use of the recreation facilities along the reservoir indicates the economic utility of the sites.

The percentages of participation in each of the 10 main recreation categories (listed in order of participation) at the John Day Reservoir are presented in Table 68. For this analysis the percent participation figures were normalized to indicate the relative contribution of demand for each activity to total recreation participation.

Table 68. Percent of Visitor Participation by Activity, John Day Reservoir, 1991

Activity	Percent Participation	Normalized
Boating	33.0 %	19.60 %
Fishing	31.7 %	18.82 %
Picnicking	25.2 %	14.96 %
Sightseeing	15.6 %	9.26 %
Swimming	14.5 %	8.61 %
Camping	12.0 %	7.13 %
Water-skiing	9.9 %	5.88 %
Hunting	6.7 %	3.98 %
Windsurfing	5.0 %	2.97 %
Other	14.8 %	8.79 %
Total*	168.4 %	100.00 %

*Total is greater than 100% because visitors participate in more than one activity.

Fishing activities account for approximately 19 percent of visitations, and non-fishing activities account for approximately 81 percent of visitations. Of the fishing activity, fishing for resident species such as walleye account for the majority of fishing recreation in the reservoir.

In the Lower Snake River study, a Travel Cost Method (TCM) Survey was applied to estimate the willingness to pay (WTP) for existing recreation opportunities. The Snake River survey findings reported the average net WTP for reservoir fishing as $22.48 per visit, and the average net WTP of non-fishing reservoir recreation as $45.19 per visit. These WTP proxies were used in combination with the 10-year average visitation demand to the average annual baseline recreation values for John Day Reservoir shown in Table 69.

Table 69.
Average Annual Baseline Recreation Value of John Day Pool Reservoir Recreation

Activity	Visitation Demand by Activity	WTP Values	Estimated Annual Baseline Recreation Value
Reservoir Fishing Activities	477,847	$22.48	$10,742,000
Reservoir Non-Fishing Activities	2,061,193	$45.19	$93,145,000
Total	2,539,040	-	$103,987,000

10.2.3.3 Future Without-Project Recreation Use

Based on earlier studies, fishing and non-fishing recreation on John Day Reservoir is expected to grow at approximately a 1.02 and 1.65 percent average annual rate, respectively. These average growth rates were applied to the baseline average annual visitation to estimate future recreation use without drawdown over the 100-year period of analysis. To calculate the value of this recreation, the WTP values shown in Table 68 were applied to the projected future recreation. The average annual value of this recreation was computed as $148,898,800 using the 100-year period of analysis and the Federal discount rate of 6.875 percent and is summarized in Table 70.

Table 70.

Without Project Reservoir Recreation Value, John Day Reservoir

Format	Activity	Value
Present Value	Fishing Recreation	$195,376,000
	Non-Fishing Recreation	$1,892,457,000
	Total	$2,087,833,000
Average Annual Equivalent Value	Fishing Recreation	$13,934,000
	Non-Fishing Recreation	$134,964,000
	Total	$148,898,000

Note: Based on conservative growth numbers.

10.2.3.4 Future With-Project Recreation Use

Lowering the John Day operating pool will have significant effects on recreation visitation levels, as well as on the types of recreation use that take place on the river. Though this analysis assumes that boat launch ramps will be extended to reach the river at most sites; the types of recreation use will change as the reservoir is drawn down from a slack-water pool to a free-flowing river channel. Current slack-water recreation users would possibly move to other currently less attractive areas, possibly incurring higher costs in terms of travel time and distance to recreation areas providing similar slack-water amenities. The cumulative economic impact of reduced opportunities for slack-water recreation on the John Day Reservoir will be offset to some degree by increased opportunities for free-flowing natural river recreation activities. This section describes the estimated recreation impacts associated with the two primary alternatives.

No recreation estimates were developed for the impact of drawdown to spillway crest or natural river level with flood control maintained. If the reach is operated for flood storage, it is anticipated that the impact would be negative for recreation opportunity and value.

Drawdown to Spillway Crest

The impacts of drawdown to spillway crest were estimated by applying a predicted 20 percent reduction in reservoir recreation demand to the same WTP values in the without-project analysis. The 20 percent reduction in demand can be attributed to a variety of

impacts, including reductions in resident fish habitat quantity and productivity, boating areas, number of access sites, number of backwater sites, and aesthetic quality. The impacts of drawdown to spillway crest are summarized in Table 71.

Table 71.

Estimated Recreation Impacts of Drawdown to Spillway Crest

Format	Activity	Value Without Drawdown	Value With Drawdown	Change in Value
Present Value	Fishing	$195,375,000	$156,300,000	-$39,075,000
	Non-Fishing	$1,892,457,000	$1,513,966,000	-$378,491,000
	Total	$2,087,833,000	$1,670,266,000	-$417,567,000
Average Annual Equivalent	Fishing	$13,934,000	$11,147,000	-$2,787,000
	Non-Fishing	$134, 964,000	$107,971,000	-$26,993,000
	Total	148,898,000	$119,118,000	-$29,780,000

Drawdown to Natural River Level

Drawdown of John Day Reservoir to natural river level is expected to result in significant changes in recreation demand and value. Motor boating, swimming, water skiing, and windsurfing activities are expected to decline significantly as conditions change to more fast moving water activities. Fishing, non-motorized boating, picnicking, sightseeing, camping, hunting, and other activities are expected to see small increases over current conditions. It is estimated that an increase in total river recreation trips would come in part from more distant areas, such as Portland, Seattle, and California. The visitation estimates have been adjusted by suitability factors that approximate the time necessary after drawdown for the natural system to recover and recreation demand to materialize. WTP values ($33.35 fishing and $55.29 non-fishing) were taken from the Lower Snake River Drawdown Study for the natural river condition. Non-fishing WTP values were adjusted to $50.24 to take into account likely slower river velocities on John Day Reservoir. Table 72 shows an increase in the value of fishing recreation and a decline in the value of non-fishing opportunities provided with drawdown to natural river level. This translates to an average annual net loss in recreation value of -$2,429,000 as shown below.

Table 72.
Estimated Recreation Impacts of Drawdown to Natural River Level, John Day Reservoir

Format	Activity	Value Without Drawdown	Value With Drawdown	Change in Value
Present Value	Fishing	$195,375,000	$279,806,000	$84,431,000
	Non-Fishing	$1,892,457,000	$1,773,976,000	-$118,481,000
	Total	$2,087,833,000	$2,053,782,000	-$34,050,000
Average Annual Equivalent	Fishing	$13,934,000	$19,955,000	$6,021,000
	Non-Fishing	$134,964,000	$126,514,000	-$8,450,000
	Total	$148,898,000	$146,469,000	-$2,429,000

10.3.2.5 Recreation Economics Conclusions

All alternatives were found to have a net negative economic effect. This effect included the facility modification costs and the losses in recreation value over the period of analysis. Positive effects were found for recreational fishing with the natural river drawdown alternative. These positive effects were offset by negative impacts on non-fishing recreation activities.

10.2.4 Navigation NED Evaluation

Between the mouth of the Willamette River near Portland, Oregon, and the mouth of the Clearwater River near Lewiston, Idaho, there are more than 80 major docks used for loading/unloading barges. There are approximately 185 barges operating on the river, most of them specialized for a single cargo. Primary cargoes are grain, petroleum, chemicals, wood chips, logs, and containerized goods such as farm and paper products. In an average year, roughly 8 to 10 million tons of commodities are shipped through the navigation lock at the John Day Dam.

A drawdown of the John Day Dam to either spillway crest or natural river conditions would close a 70-mile stretch of the Columbia-Snake River System (CSRS) to commercial navigation. This closure would end the current practice of barging commodities on the river, as nearly all of the commodities shipped on the CSRS pass through the John Day Reservoir. Reservoir closure would force producers throughout Idaho, Montana, North Dakota, Oregon, and Washington to seek alternative modes and routes for shipping their commodities to export facilities on the Lower Columbia River.

10.2.4.1 Methodology

This navigation analysis captures the increased transportation costs of a drawdown through a comparison of the total costs of shipping goods through John Day Lock under existing conditions to the total cost of shipping the same quantity of goods without the option of shipping by barge. The navigation analysis that is the focus of this chapter, quantifies the loss in economic efficiency resulting from a change in the most efficient (current) mode of transportation, to other modes. Data from the Lower Snake Drawdown Study was utilized where it was relevant.

Study Assumptions and Constraints

This Phase I Study is based on numerous assumptions and constraints that are specific to this navigation analysis. While summarized in this main report, these assumptions and constraints are detailed in the technical appendices that accompany it. The navigation economics analysis was based on the following project assumptions and constraints:

- For the purposes of the economic analysis, it has been assumed that all navigation would end. While it is physically possible to dredge a navigation channel under both drawdown scenarios, little information exists regarding the costs and risks associated with navigating under increased river velocities. Given these uncertainties, the NED impact associated with navigation was measured as the cost of transporting good by alternative means.

- Commodities currently being shipped on the Columbia and Snake Rivers would continue to travel from their current origins to their current destinations. No losses in production quantities or alterations in final shipping destinations are assumed.
- Projected quantities of commodities being shipped are estimated through year 2022, then held constant through the end period of the analysis in 2112.
- No costs resulting from a loss of competition were calculated in this analysis. More realistically, the loss of barge service would reduce the number of potential transportation providers and could result in less competitive or even monopolistic pricing strategies by the remaining transportation providers. Any costs associated with this loss of competition are assumed to be transfer payments from producers to transportation providers, and therefore are not NED costs.
- Costs for increasing the capacity of roads and shipping terminals, including export facilities and inland rail facilities, have not been included in this analysis. For the Snake River drawdown analysis, such costs were assumed to be paid through increased revenues and/or taxes generated by the increased volumes. This assumes that the states will collect taxes to cover the full cost of truck use and that the opportunity for increased business will be profitable enough to warrant investment in elevators and rail facilities by providers of these services.

10.2.4.2 Commodities

The major commodities moving through John Day Lock are wheat and barley, and petroleum. These two commodities make-up over 50 percent of the tonnage moving through the reservoir. Wheat and barley is shipped from many ports on the Columbia and Snake Rivers. This downbound tonnage is destined for export houses on the lower Columbia River. Petroleum moves upbound predominately from Portland to the Tri-Cities. Other significant commodities using John Day Lock include chemicals, logs, and containerized cargo. The historical average tonnage of four years (1994-1997) moving through John Day Lock was used as the base for commodity projections. This base was adjusted based on discussions with barge companies who anticipated increases in petroleum and decreases in chemical shipments. These adjustments are described in more detail in the technical appendix. Table 73 below shows the calculated base commodity figures.

Table 73. Base Commodity Figures (1,000 tons)

Commodity	Total
Chemicals	122
Empty Containers	149
Metals	10
Other Food and Farm Products	99
Petroleum and Related Products	2,964
Soil, Sand, Gravel, Rock, and Stone	24
Wheat and Barley	5,314
Wood Chips and Logs	1,002
Wood Products	56
All Other	213
TOTAL	**9,953**

10.2.4.3 Commodity Projections

Commodity projections for John Day were estimated using information from the Lower Snake River Drawdown Study. Commodity projections were calculated for the years 2002, 2007, 2012, 2017, and 2022. Total barged tonnage over this period is expected to grow from 11.3 million tons in 2002 to 13.3 million tons in 2022. This is an average annual growth rate of 0.8 percent over the twenty year period. Table 74 below shows the commodity projections.

Table 74.
Projections for Analyzed Commodities

Projection Year	Goods Shipped on the Snake River (1,000 tons)	Goods Loaded or Unloaded between John Day Dam and Ice Harbor Dam (1,000 tons)
2002	4,631	6,682
2007	4,818	7,016
2012	4,866	8,348
2017	5,048	7,630
2022	5,228	8,041

10.2.4.4 Costs of Drawdown Alternatives

The closure of the John Day Reservoir would force producers and manufacturers to find alternative routes and modes for shipping goods. For most commodities, this would mean a switch to either truck or a combination of truck and rail transport. For a number of reasons, the current practice of shipping goods on the river by barge is the most efficient means of transporting many commodities. The loss of this efficiency, by forcing a switch to truck and rail, constitutes a cost under NED guidelines. This cost does not consider the increased rates that producers and manufacturers might have to deal with as a result of reduced competition, nor does it capture the cost of infrastructure improvements required to shift to new modes. Therefore, the costs described in this section should not be construed as being the total costs that the region would face, but as an analysis of economic efficiency on a national scale.

The cost of transporting grain from the county of origin to export elevators on the lower Columbia River was estimated using the Reebie Associates modal costing models. Transportation costs were developed for the base condition and elimination of navigation through John Day Lock. Other commodities besides grain were traced and costed only from their river origin as opposed to their county of origin. The cost calculations used for this analysis are the product of the predicted tonnages and the average cost per ton.

Projected Costs

The projected costs of shipping commodities following drawdown are shown in Table 75.

Table 75.
Total Increase in Costs of Shipping Goods (total cost under drawdown - Total Base costs)

Projection Year	Average Projected Cost Increase ($1000)
2002	84,594
2007	88,513
2012	95,091
2017	93,014
2022	95,102

Average Annual Costs of Drawdown Scenario

The average annual cost of shipping Columbia and Snake River goods, under existing conditions and the drawdown scenario is shown in Table 76. The average annual cost under drawdown conditions is estimated to be between $237 million and $281 million per year. This amounts to a net impact ranging from $83 million to $104 million per year. These costs were annualized using the 6.875 percent Federal discount rate and a 100-year period of analysis.

Table 76.
Average Annual Costs ($1000)

	Existing Condition	Drawdown Scenario	Increased Costs
Low	$153,703	$237,067	$83,365
Mid	$166,316	$260,938	$94,621
High	$178,459	$281,547	$103,089

10.2.4.5 Other Navigation Issues

Because of the limited scope of this analysis and the restrictions inherent in using NED criteria, it is important to address topics that could not be captured in the main body of the analysis but are of importance. These topics discussed below include areas of uncertainty, potential costs that could not be adequately captured, and costs which, while significant, are not considered NED costs.

Navy Reactor Compartment Shipments

Permanent elimination of navigation through the John Day Reservoir for reactor compartment shipments would stop the Navy's disposal of decommissioned nuclear powered ships. River transportation is the only feasible means of transporting the reactor compartment packages because of their large size and weight.

Crop Selection and Production

Evidence suggests that increased transportation costs under drawdown conditions could cause some producers to select different crops or to cease production entirely. Other evidence suggests that cost increases would be capitalized into agricultural land values, but the overall production of grain and other commodities would remain relatively constant.

Destination Changes

Another potential outcome of a John Day drawdown could be a shift in the quantities of goods being shipped to downstream export elevators. An increase in transportation costs could cause producers to select another destination for their goods.

Rates

Concerns over competitiveness are associated with concerns about increases in rates faced by producers. Current rates for shipment by rail could provide an estimate of the rate increase to producers. However, changes in the system of collection and export via rail could make rail more cost-efficient and allow rates to be lowered. Countering this increased efficiency would be the tremendous capital cost of upgrading facilities in the short term, as well as the long-term loss in competition.

Rail Capacity, Reliability, and Competitiveness

The cost estimates provided in this study are based almost entirely on the assumption that goods currently being shipped on the river will be forced onto rail lines. This potential outcome raises some serious questions about capacity, reliability, competitiveness, and rates. For many of the region's producers, rail service is not currently considered to be a viable transportation mode; in many cases, commodities are driven many miles from elevators having rail access to be loaded onto barges and shipped on the river.

The underlying economic cause of this problem with rail service is twofold. On the one hand, rail carriers can make higher profits by using their cars to ship commodities longer distances. On the other hand, the areas that typically send goods to the CSRS have not invested in consolidated and higher speed loading facilities, particularly for grain, that are becoming the norm in other regions. Because shipping by barge is so cost-competitive with shipping by rail or truck, areas near the river system have little incentive to pursue transport modes other than barging. For those areas that border the area of influence of the CSRS, the quantities of goods are small enough that they are often overlooked by rail carriers during periods of high demand for rail cars. With a relatively small quantity of grain at stake, and strong competition from the barge service providers, there has been little incentive to modernize rail facilities. As a result, rail service in the region has declined.

The discussion of capacity has three components: the mainline facilities of Class I railroads; on short-line railroads; and facilities for loading and unloading commodities. Assuming a roughly equal distribution of shipments throughout the year, it appears that mainline capacity would be available to meet the needs of increased shipments. Short-line railroads would probably vary widely in their ability to handle significant tonnages of additional cargo.

Capacity at loading and unloading facilities served by rail is an area of significant concern. In numerous areas, sidings and leads serving these facilities have not been maintained, and many would need to be replaced. In addition, many of the loading facilities are designed to

handle small numbers of cars and have neither the speed nor capacity to handle traffic by today's standards. In addition to being small, the collection system for commodities is dispersed over a large area. This lack of centralization would decrease the competitiveness of these facilities for limited rail cars.

Capacity is also a concern at unloading facilities, particularly for wheat and barley. Approximately 45 percent of the grain exported from the Lower Columbia is shipped by barge. Therefore, shipping all of the grain by rail would therefore nearly double the quantities that elevators would have to handle by a single mode. Some elevators are significantly constrained by space and/or have limited rail access. Many of the facilities are located in or near developed metropolitan areas, further restricting staging and storage capacity.

Concerns over reliability arise from the fact that many of the commodities shipped on the CSRS are based on time-sensitive export demands. Rail cars may be unavailable in areas served by the CSRS. Without reliability, producers have serious concerns about their ability to fulfill their contracts and to ship their goods profitably.

The loss of barge service raises concerns over shipping choices that producers would have under drawdown conditions. Currently, two Class I railroads BNSF and UPRR serve much of the area of influence of the CSRS. A short-line railroad, Camas Prairie Railnet, serves both of these major railroads from eastern Washington and western Idaho. However, large portions of the Columbia-Snake region are served by essentially one railroad. These areas would have little recourse if rates were increased, and they could face significant regional costs.

10.2.5 Water Supply and Irrigation NED Evaluation

Approximately 180,000 acres of land are irrigated from the John Day Reservoir. To measure the impact of drawdown to irrigators, two solutions for maintaining the water supply were formulated. One solution would be modification of the existing pumps to draw water out of John Day Reservoir after drawdown. This solution could result in a one-season loss of irrigation, which would be extremely costly. Another solution would be construction of two canals, one on each side of the river, which would draw water out of the McNary reservoir. While this second measure is more costly than the pump modification solution, it does not have an associated risk of a one-season loss of irrigation. The canal option is used as the midpoint estimate of the NED water supply impacts. The identification of a physically feasible solution does not necessarily indicate that all farms would be capable of bearing this cost; however, a detailed farm income analysis was outside the scope of this study.

10.2.5.1 Water Supply and Irrigation Land Use

The study area lies eastward of the Cascade Mountains, which block moisture from Pacific storms. As a result, the climate is semiarid and there is little natural vegetation. The geography of the region is primarily rolling plains and low hills that are transected by the Columbia River. At the river, elevations range from about 100 to 300 feet. Agriculture and open space are the dominant land uses. Lands at higher elevations and farther from the river are suitable for dry land grains and irrigated crops. Lands irrigated from the reservoir are bench lands adjacent to the reservoir. All of these lands that are used for growing crops are irrigated.

10.2.5.2 Agricultural Use

The economic importance of agriculture is assessed in the context of the five counties in Washington and Oregon that would be directly affected by drawdown of the John Day Reservoir.

As shown in Table 77, the study area in Oregon accounts for only about 6 percent of the total number of Oregon farms, but it accounts for about 19 percent of the land in farms, about 12 percent of the irrigated land, and about 14 percent of the market value of agricultural products sold. At the same time, the area accounts for only 2.4 percent of the state's population.

On the Washington side of the river, a similar situation exists, but it is less pronounced. There the study area accounts for about 5.5 percent of all farms, about 8.0 percent of the land in farms, about 10 percent of the irrigated land, and about 7.0 percent of the value of agricultural products sold. These data suggest a significant concentration of irrigated agriculture in the study area. This is especially true in Gilliam County in Oregon, where there were only 29 irrigated farms in 1997.

Table 77.
Selected Agricultural Data for Affected Oregon and Washington Sites, 1992 and 1997

Data Type	Year	Oregon	Washington
Number of Farms (all farms)	1997	2,074	1,608
	1992	1,962	1,636
Land in all Farms (acres)	1997	3,206,051	1,200,635
	1992	3,351,957	1,330,009
No. of Irrigated Farms	1997	1,192	1,077
	1992	1,145	1,078
Irrigated Land (acres)	1997	227,662	173,493
	1992	221,521	164,437
Market Value Product (Total Sales - $1,000)	1997	415,258	333,761
	1992	297,858	247,877

Source: 1997 Census of Agriculture -- Highlights of Agriculture: 1997 and 1992. www.nass.usda.gov/research/

Agricultural Production

In 1994, there was a combined total of about 182,000 acres in production—Oregon (89,700 acres), and Washington (92,300 acres). The combined value of production, based on estimated acreage and production for 2000 and average prices for 1998, amounts to an approximate total of $324.6 million Oregon—$111.3 million, and Washington—$213.3 million.

The order of importance of crops grown in the study area in Oregon, in terms of acres of production, are alfalfa, potatoes, all wheat, and field and sweet corn. These four crops account for over 80 percent of the total acreage and value of production. The total production value of all crops is $111,270,000.

The order of importance of crops grown in the study area in Washington, in terms of acres of production, is field and sweet corn, potatoes, alfalfa, and all wheat. These four crops account for about 66 percent of the total acreage and 40 percent of the value of production. The total production value of all crops is $213,267,000.

Agricultural Net Income

A detailed analysis of net income was not prepared for this study. However, based on information obtained from several of the irrigators and from engineering and economic consultants in the study area who work for irrigators in both Oregon and Washington, net income to farming is estimated to be in the range of from $250 to $350 per acre. This estimate is representative of the average for the study area and would not be valid for any one crop. Crops with the highest net income at present are potatoes and vineyards. A number of the crops that are used in rotation with potatoes, such as field corn and wheat, currently have negative net incomes.

Value of Land and Investments in Perennial Crops

The value of irrigated land and investments in perennial crops was determined to establish a basis for determination of the significance of the cost of alternative water supply options. Estimates of these values were developed in consultations with representatives of the irrigators and financial institutions that serve farmers in the study area. Based on this information, a range of values from a low of about $921 million to a high of $1.2 billion was developed, as shown in Table 78.

Table 78.

Estimated Value of Land and Investment in Perennial Crops on Farms Irrigated from the John Day Reservoir

		Value/Cost ($)	
Cost Item	**Acres**	**Low**	**High**
Value of Land	182,103	637,359,450	819,462,150
Investment in Perennial Crops	40,501	283,507,000	405,010,000
Total Value of Land and Perennials		920,866,450	1,224,472,150

Changes in Land Use and Crop Production Since 1994

Since 1994, approximately 27,000 acres of cropland (about 24,000 acres in Oregon and 3,000 acres in Washington) have been or are in the process of being converted from cultivation of traditional farm crops to the cultivation of hybrid poplars as a source of wood chips for pulp.

The combined total acreage of the hybrid plantation amounts to about 32,000 acres. On the basis of the annual sustained production estimate of 8.2 bone-dry tons per acre and an expected range of prices for wood chips from $50 to $100 per bone-dry ton, the gross annual value of production of wood chips ranges from $13 million to $26 million.

10.2.5.3 Municipal and Industrial Water Use

Municipal and industrial water users in the study area include local communities, fish hatcheries, a school district, and an aluminum mill. In addition, a number of relatively small,

publicly owned and privately owned wells draw from the unconfined aquifer that may be supplied by the Columbia River/John Day Reservoir.

In addition to the usual residential and commercial uses typical of communities that are the size of those in the study area, the major uses are for food processing and for providing cooling for electrical power generation and industrial processes.

10.2.5.4 Costs to Modify Agricultural Water Supply Systems

Irrigation Water Impacts

Irrigators face two sources of drawdown impacts. The first is the cost of new irrigation delivery systems. The second is the potential for interruption in water availability during construction of new pump stations and/or intake pipe extension to the new level of the river following drawdown.

Irrigation Water Supply Options

Two options were considered for providing water for irrigation after drawdown. In terms of the first cost, the least-cost alternative is to relocate the existing pumps to the new level of the river. Where necessary, new pumps would be installed to achieve the same capacity as the stations now provide. The more expensive alternative is to construct canals from McNary Dam to the John Day study area. A canal would be constructed on both sides of the river. These canals would extend far enough down river to provide water to all of the existing farms. This option includes relocation of existing pump stations to the canals to provide water service to existing farms.

Total First Cost of Water Supply Options

Estimated costs for the pump relocation and canal construction options include all of the costs related directly to their respective implementation. Increased operating costs are not included. Details of the cost estimates are explained in detail in the Water Supply Section of the Economics Technical Appendix. On the basis of construction costs alone, the pump relocation option appears to be least costly. However, this is without consideration of impacts to irrigators and the costs that they would incur. These costs must be added to the construction cost to obtain an estimate of the total cost of each option.

The canals could be constructed prior to drawdown so that water service would not be interrupted. Therefore, this alternative has no additional costs due to its impacts to irrigators. This is not the case, however, with the pump relocation plan. This cannot be implemented until the reservoir has been drawn down. In the case of the spillway crest alternatives, plans are to complete drawdown from November through February. Following drawdown, cofferdams would be constructed and dewatered to allow for relocation of the pump stations.

With construction beginning in March, at the earliest, it would not be possible to complete the modifications prior to the start of the growing season. Therefore, irrigators would lose crop production for at least one season, and those irrigators with perennial crops would probably suffer a total loss. These costs must be added to the cost of the pump relocation plan. The only difference between the total cost of the spillway crest drawdown and natural river drawdown alternatives is the difference in the actual implementation cost, amounting to $2 million. Ranges of costs are shown because of uncertainties about the actual losses associated with net income from farming and the investment in perennial crops.

Assumptions used to develop the ranges of costs and the derivation of the ranges of costs are provided in the Irrigation Section of the Economics Technical Appendix.

Summary of First Costs and Annual Capital and O&M Costs of Irrigation Water Supply Options

To determine whether it would be theoretically possible for farmers to bear the costs of the irrigation water supply options, the first costs of the alternatives (including construction costs and costs to irrigators) were converted to annual costs. Since farmers would be required to pay the costs, annual costs were computed using terms currently available to farmers. In addition, the increase in pumping costs associated with the higher lift required with drawdown was included, as follows:

- Interest rate-7 percent
- Loan repayment period-30 years
- Increase in pumping costs with spillway crest drawdown (30-foot increase in lift)
    - Low--$4.00 per acre
    - High--$5.00 per acre
- Increase in pumping costs with natural river drawdown (60-foot increase in lift)
    - Low--$8.00 per acre
    - High--$10.00 per acre

O&M costs could increase slightly with drawdown, especially if turbidity increased significantly. This could cause excessive wear of pump impellers and other equipment. However, insufficient information was developed for this Phase I Study to determine whether O&M costs would actually increase. Therefore, O&M costs are assumed to remain at approximately the levels associated with the existing pump stations.

Annual costs for the pump relocation alternative were computed with and without implementation impacts to irrigators for both drawdown scenarios. Annual costs are listed in Table 79.

The potential range of impacts is quite wide. Due to the scope of this study, it is inappropriate to assume that all engineering concerns related to the pump modification plan will be overcome. While the canal option also has implementation issues, it is still a reasonable midpoint estimate of the range of potential impacts, resulting in an average annual NED impact of $26,600,000. This estimate is based on a first cost of $373,000,000 annualized over 50 years at an interest rate of 6.875 percent. Uncertainty and risk factors are discussed in the Economics Technical Appendix.

Table 79.

Estimate of Net Income Impacts for Alternative Irrigation Water Delivery Systems, With and Without Implementation Impacts to Irrigators

	Pump Relocation Alternative (with implementation impacts to farmers)		Pump Relocation Alternative (without implementation impacts to farmers)		Canal Alternative [a]	
	Low ($)	**High ($)**	**Low ($)**	**High ($)**	**Low ($)**	**High ($)**
Spillway Crest Drawdown						
Construction Cost	237,000,000	237,000,000	237,000,000	237,000,000	373,000,000	373,000,000
Loss of Production	374,600,000	532,500,000				
Total First Cost	611,600,000	769,500,000			373,000,000	373,000,000
Annual Cost of Construction	49,286,644	62,011,238	19,098,978	19,098,978		
Annual Increased Cost of Pumping	728,412	910,515	728,412	910,515		
Total Annual Cost[b]	50,015,056	62,921,753	19,827,390	20,009,493	30,058,729	30,058,729
Annual Cost per Acre	275	346	109	110	165	165
Natural River Drawdown						
Construction Cost[c]	239,000,000	239,000,000	239,000,000	239,000,000	373,000,000	373,000,000
Cost to Irrigators	374,600,000	532,500,000				
Total First Cost	613,600,000	771,500,000			373,000,000	373,000,000
Annual Cost of Construction	49,447,817	62,172,410	19,260,150	19,260,150		
Annual Increased Cost of Pumping	1,456,824	1,821,030	1,456,824	1,821,030		
Total Annual Cost	50,904,641	63,993,440	20,716,974	21,081,180	30,058,729	30,058,729
Annual Cost per Acre	280	351	114	116	165	165

a. There may be a savings in pumping costs if the canal feed pump stations are located in the McNary pool, as is assumed in the current cost estimate for the canal. These savings, however, were not estimated because of the uncertainty about possible removal of McNary Dam.

b. O&M costs are assumed to remain the same as for the existing pump stations.

c. Construction costs include relocation of pumps.

10.2.5.5 Cost to Modify Municipal and Industrial Water Supply Systems

As with the irrigators who pump water directly or indirectly from the John Day Reservoir, municipal and industrial water users face two potential sources of drawdown impacts: (1) interruption of water supply at the quantity and quality currently provided by existing

systems, and (2) the cost of modifications to existing system or construction of new systems. Ranney well systems appear to be most vulnerable to drawdown.

To avoid potential reductions in the supply of water, it would be necessary to modify existing systems or construct new systems prior to drawdown. There is no way of knowing, however, whether the modifications would adequately address drawdown impacts until the drawdown is actually implemented. This creates a degree of risk and uncertainty that must be addressed prior to drawdown to ensure adequate water supplies to water-dependent industries, especially food processing.

Estimated costs of proposed modifications and new systems are summarized in Table 80. Costs are identical for both the spillway crest alternatives and the natural river alternatives. Cost detail is available in the Water Supply Section of the Economics Technical Appendix.

Table 80.
Municipal and Industrial Water Supply Impacts

First Cost	$110,000,000
Annualized First Cost	$8,750,000
Additional Annual O&M	$ 8,800,000
Total Average Annual Costs	$17,550,000

10.2.6 Commercial Fishing

The economic valuation of changes in anadromous fish stock harvests due to reservoir drawdown relies on available methods and data. Economic valuation is a method for measuring the benefits received by those who fish and the value they place on fishing.

Estimates of the net economic value (NEV) of commercial and recreational anadromous fishing are derived from available studies and procedures developed by various fish management agencies, such as the Oregon Department of Fish and Wildlife (ODFW), Pacific Fishery Management Council (PFMC) , and the NMFS. Evaluations of commercial fisheries use ex-vessel (the price the fishermen receive at the dock for their catch) value of the fish as a proxy indicator for the actual value. Seventy percent of ex-vessel revenue is used as an indicator of net value. The remaining 30 percent represents the additional expenses of harvesting and primary processing. Evaluations of recreational fisheries evaluation use a benefit-transfer approach for an angler day value. The basis of a benefit-transfer approach is that other similar situations for fishing experiences are correctly evaluated and are directly comparable to another situation. Changes in recreational opportunities have also been evaluated using data from previous studies to assign a value to an angler-day.

NEV estimates for anadromous fish harvesting are based on a per-fish value for commercial fishing, and a per-angler-day value for recreational fishing. The NEV estimates used in the Phase I Study represent general values; specific uses in selected areas may change these values.

10.2.6.1 Harvest Distribution Assumptions

The forecast of fish available for harvest in the ocean and in the Columbia River is distributed to user groups within constraints presented by international understandings and

tribal treaty agreements. Historical harvest distribution patterns were used as a base and then modified for future resource management regimes.

There are three basic or migration patterns for the Columbia River Basin salmon: north-turning fish (fall chinook), south-turning fish (coho), and fish that tend to migrate in either direction. Steelhead tend to scatter and migrate as far as Russian waters. Harvest rates by geographic area depend on migration patterns and historical fishing patterns, as well as on international and historic treaties and management policies. In terms of the distributional criteria, it is assumed that future harvests will reflect recent historical catches in both the ocean and terminal fisheries where these fish migrate.

The anadromous fish forecasting analysis results in a fairly large share of summer steelhead destined to the Snake River watershed escaping fisheries and returning to hatcheries as surplus. This surplus is used for food fish, egg, and carcass sales. There may be fishery management opportunities that would convert these sales to harvest opportunities; however, the drastic changes to management regimes necessary to take advantage of such opportunities were not included in the analysis.

10.2.6.2 Historical Anadromous Fish Production in the John Day

John Day Dam construction started in 1958, and the reservoir reached operating levels in 1968. Records indicate that 30,000 adult fall chinook salmon spawned in the area prior to construction of the dam. In 1978, Oregon and Washington, USACE, and other federal agencies reached agreement on chinook mitigation due for the John Day Project. The agreed-upon mitigation was for 30,000 adult fall chinook spawners and the harvest associated with the annual production of the lost spawning habitat. Annual hatchery production mitigates for losses in spawning habitat caused by construction and operation of John Day Dam.

10.2.6.3 Harvest Forecast

Harvest forecast methods use passage models to characterize fish survival through the hydrosystem. The passage model results are then incorporated into life-cycle models to characterize the effect of water management actions on adult population levels. The effects were used as the basis for extending the analysis to represent all wild and hatchery origin stocks. The methods and forecast results are detailed in the following two sections, which concern the effects of passage improvements and habitat improvements in the John Day Reservoir.

10.2.6.4 Passage Improvement

To produce impact estimates of John Day Dam actions on adult population levels, the PATH analysis was simplified to produce mean equilibrium harvest and spawner levels under a range of hypotheses. This simplification arises from the assumption that actions taken at the John Day Project will not affect survivals in other life stages (e.g., ocean survival or egg-to-smolt survival) with the result that these survivals will cancel each other out when two actions are being compared.

The equilibrium measure of adult population is the level at which the spawning recruits of a brood are exactly sufficient to replace their parental brood. With typical salmon life-cycle models, in the absence of environmental variations and a constant harvest rate, the equilibrium population level is a stable point that a stock approaches over time. That is,

equilibrium is a measure of the number of fish a habitat can maintain under a specific set of management actions, including hydrosystem operations and fisheries regulations.

The amount of time required for anadromous fish to reach equilibrium may differ, depending on physical conditions, fishery management, and other factors. An undefined time period may be needed to return riverbed conditions to acceptable spawning habitat. After initial drawdown, the river will cut through soft sediments relatively quickly and create a surface layer of appropriate spawning gravels, but it may take a large flood to scour the streambed deep enough to clear embedded fine materials. Similarly, at current commercial fish harvest rates, a span of many generations may be required to achieve spawning levels approaching full capacity. Following the geomorphologic changes due to drawdown, it may take 10 years to reestablish a macroinvertebrate community sufficient to support rearing fall chinook. Given the suggested ranges for geomorphologic changes, macroinvertebrate changes, and demographic responses, the time period to recovery was assumed to be 30 years for the purpose of economic calculations.

Modeling assumptions were required to estimate the near-term changes between existing conditions and Year 30 equilibrium levels. For wild anadromous fish stocks, a Logistic Growth Curve was applied to Year 0 starting values and Year 30 equilibrium levels. For hatchery stocks, the rate of change in survival rates for the first generation of wild stocks (Year 0 existing conditions and estimated Year 5 equilibrium levels) was applied to current survival rates for hatchery-origin anadromous fish. Hatchery production is assumed to be constant, so typical spawner-recruit relationships do not apply.

It was necessary to expand the provided index wild stocks from the upper Columbia River and Snake River to represent all other significant wild stocks affected by the John Day Dam alterations. Because the actions intended to increase wild anadromous fish survival would increase hatchery fish survival as well, it was necessary to add all affected hatchery origin stocks.

10.2.6.5 John Day Dam Reservoir Area Habitat Improvement

The potential effects on spawning adult salmonids from improved habitat resulting from John Day Dam water management actions were reviewed. The review describes the effects of various drawdown alternatives on spawning salmonid fishes as follows:

- Evaluating the species known, both historically and currently, to use the John Day Dam reach for spawning
- Evaluating the timing and duration of reservoir spawning
- Estimating the potential change in the quantity and quality of spawning habitat conditions
- Estimating the increased capacity of the reach to produce salmonid fishes under alternative operating scenarios

Drawdown to natural river is anticipated to provide an approximate 8- to 10-fold increase in the fall chinook spawning capacity in the John Day reach compared to current levels of spawning. Drawdown to spill crest is expected to achieve perhaps 50 to 75 percent of the benefit achieved under natural river conditions. Table 81 lists the projected number of spawners and fish available for ocean and terminal fisheries harvest. The existing reservoir spawning is only for fall chinook salmon. The drawdown to spillway crest or natural river

levels is also assumed to benefit only fall chinook, which make extensive use of large mainstem rivers for spawning.

Table 81.

Adult Fish Available to Terminal Fisheries Resulting from Increased Habitat Capacity in the John Day Reservoir

					Fish Available to fishery	
	Spawner Capacity	**Smolt Yield (100 smolts/spawner)**	**Hydro System Survival**	**Potential Adult Returns**	**Terminal**	**Ocean**
Existing Conditions	5,500	550,000	314,500	10,700	5,200	1,819
Natural River	55,000	5,500,000	3,790,000	129,000	74,000	21,930
Spillway Crest	31,100	3,110,000	1,960,000	66,600	35,500	11,322

Note: Potential adult returns are ocean escapement.
Sources: Willis (1999) and Phase I Study.

If the equilibrium spawning population size required to replace itself is subtracted from the predicted total run size annually entering the Columbia River from additional John Day-generated smolts, approximately 35,500 and 74,000 adults, respectively would be available to an annual terminal fishery. In comparison, existing hatchery production for John Day could produce, under optimum conditions, as many as 144,000 fall chinook salmon for interception at terminal fisheries. Removal of available adults at these levels equates to very high harvest rates that can not be sustained under natural production conditions. Presumably, hatchery production in mitigation for inundation of the John Day reach would be decreased as natural production was restored, and would ultimately be replaced by restored natural production.

Policies for abandoning hatchery production are unknown; therefore, existing hatchery output is assumed to be constant. Under poor ocean conditions and high harvest rates, the modeled adult returns would be insufficient to replace the spawning population. Consequently, the economic valuation results should be considered as very liberal estimates of benefits to terminal fisheries from fall chinook originating in the John Day Reservoir.

Fall chinook are the only anadromous fish species considered in this study that have a significant ocean fishery in addition to terminal fisheries. Interception rates vary with abundance levels, fishery management plans, and harvest allocations dictated by international and Native American treaties.

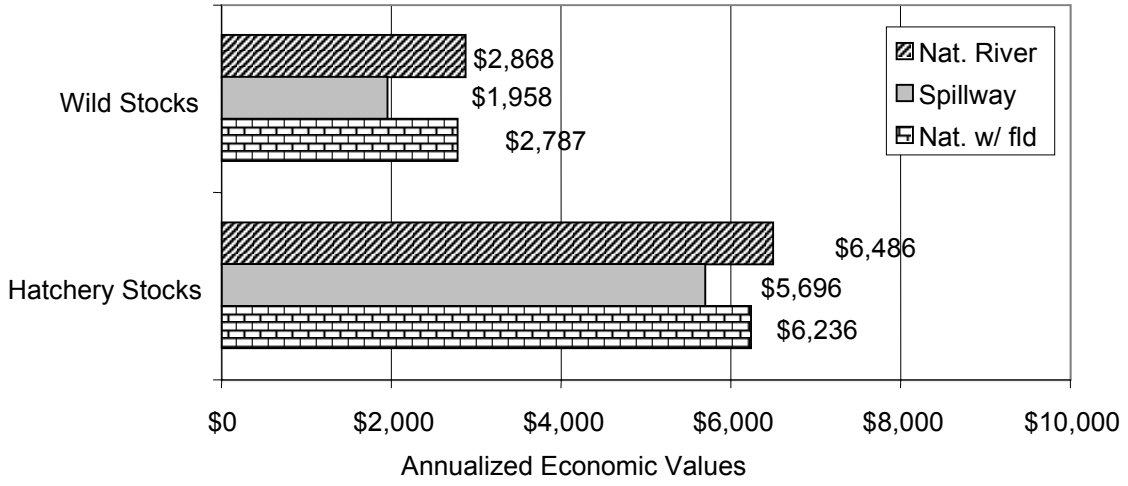
10.2.6.6 Economic Value Forecast

Economic values for commercial fisheries are modeled as a direct calculation between distributed harvests and unit values in the geographic area where the harvest occurs. The economic values for recreational fisheries are similar, except that predicted success rates (angler days per fish) are a factor and the economic value is per-angler day.

The changes in annualized economic values from increased anadromous fish harvest resulting from John Day Dam water management alternatives are listed in Table 82. Changes in annualized economic values by stock origin are shown in figure 14.

Table 82. Annualized Economic Values from Increases in Anadromous Fish			
	Natural River Alternative without Flood Control	**Spillway Alternative without Flood Control**	**Natural River with Flood Control**
John Day Alternatives with Snake River Drawdown			
Commercial	$3,284,000	$2,452,000	$3,204,000
Recreational	$6,070,000	$5,203,000	$5,820,000
Total	$9,354,000	$7,655,000	$9,024,000
John Day Alternatives without Snake River Drawdown			
Total	$740,000	$30,000	$800,000

Figure 14. Changed Annualized Economic Values by Stock Origin for John Day Alternatives and Snake River Drawdown



Note: Economic values are expressed as average annual equivalent values in thousands of 1998 dollars using a 6-7/8% discount rate.
Source: Phase I Study.

There is sensitivity of changed annualized economic values for a schedule of altering the John Day Dam and four lower Snake River dams. The benefits of a John Day drawdown are sensitive to the status of the four lower Snake River dams, meaning that benefit associated with the combination of drawdown of both the John Day dam and the four lower Snake dams is greater than the sum of either two actions taken alone. Drawdown to natural river levels at John Day results in an average annual commercial fishing benefit of $800,000, but, when done in conjunction with a drawdown of the four lower Snake dams, the incremental benefit associated with drawing down the John Day dam increases to $2.7 million. Table 83 is a comparison of three schedule combinations.

The synergy between these two actions may be attributable to the effects of smolt passage survival rates when determining total adult returns at maximum sustained yields. Altering John Day Dam is assumed to curtail smolt transportation. If survival-modeling assumptions

emphasize effectiveness of transportation, then alterations are ineffective. Because the stocks negatively affected by curtailing transportation outnumber those that are unaffected, the resulting economic valuations will be negative. However, fall chinook produced from improved habitat will always be considered a drawdown benefit and ameliorate the plusses and minuses resulting from transportation effects.

Table 83.

Changed Annualized Economic Values Based on Three Schedule Combinations

	Annualized difference Between Actions		
	Natural River Less Base Case	**Spillway Crest Less Base Case**	**Natural River With flood Control Less Base Case**
John Day Dam drawdown and breaching of four lower Snake River dams occur in tandem	9.35	7.66	9.02
John Day Dam drawdown without breaching of four lower Snake River dams	0.80	-0.03	0.74
Four lower Snake River dams breached without John Day Dam alterations	6.63	6.63	6.63

Notes:
1. Economic values are expressed as average annual equivalent values in thousands of 1998 dollars using a 6-7/8% discount rate.
2. The case of breaching the four lower Snake River dams without altering the John Day Dam is shown for comparison purposes. This estimate may be different than those in other current studies, such as the *Lower Snake River Juvenile Salmon Migration Feasibility Study*, due to different methods and assumptions. Different methods and data have been used in this study, so the resulting estimate should not be used for evaluation of other study results.
3. The benefits shown in this report can generally be characterized as high-end estimates, using assumptions that tend to maximize the potential benefit of a drawdown of the John Day pool.

10.2.7 Implementation Costs

The implementation costs are essentially all other costs associated with implementation that are not covered in any of the six previous impact categories. The majority of the costs occur at the dam, but there are also substantial costs associated with management of cultural resources, road and railroad repair associated with drawdown and bank stabilization efforts.

10.2.8 NED Cost Summary

The following tables summarize the NED costs associated with each drawdown alternative.

Table 84.
NED Cost Summary
Alternative 1. Spillway Crest Drawdown w/o Flood Control

Feature	First Costs	Economic Cost[a]
Dam/Spillway	$ 317,015,082	$ 372,200,000
Navigation Lock	$ 288,443,736	$ 0 [b]
McNary (Fish & Navigation)	$ 25,162,524	$ 29,500,000
Bank Protection	$ 386,037,504	$ 362,100,000
Navigation w/ Existing Fleet Tow Boater's Design (Dredging)	$ 520,616,430	$ 0 [b]
Irrigation Canal w/ Pump Modifications	$ 385,992,099	$ 425,000,000
Hydropower	$ 0	$ 0
Impacts (Roads & RxR)	$ 248,302,242	$ 211,500,000
Cultural Management	$ 71,535,645	$ 84,000,000
Cultural Mitigation	$ 21,214,000	$ 21,200,000
Relocation of Treaty Fishing Access Sites	$ 33,164,271	$ 33,200,000
Recreation	$ 28,287,054	$ 26,500,000
Erosion Seeding/Habitat Restoration	$ 57,854,763	$ 49,300,000
Municipal & Industrial Water Supply	$ 114,450,327	$ 122,000,000
Bridge & Culverts	$ 311,283,648	$ 282,700,000
Utilities	$ 20,469,024	$ 19,800,000
Total First Costs		**$ 2,039,000,000**
Annual First Costs		**$ 135,300,000**

Other Economic Impacts	Economic Impact
Navigation	$ 94,621,000
Hydropower	$ 144,000,000
Recreation	$ 29,780,000
Flood Damages	$ 950,000
Commercial Fishing	$ (2,001,000)
Total Other Economic Impacts	**$ 267,350,000**
Total First Costs and Other Economic Impacts	**$ 402,650,000**

a. Economic costs are calculated by taking the present value of the first costs.

b. Impacts related to navigation have been calculated as the costs of alternate means of transportation (rail), rather than the costs associated with dredging a channel and maintaining navigation.

Table 85.
NED Cost Summary
Alternative 2. Spillway Crest Drawdown with Flood Control

Feature	First Costs	Economic Cost[a]
Dam/Spillway	$ 329,444,300	$ 412,400,000
Navigation Lock	$ 288,303,648	$ 0 [b]
McNary (Fish & Navigation)	$ 24,843,536	$ 29,200,000
Bank Protection	$ 381,143,665	$ 357,500,000
Navigation w/ Existing Fleet (Dredging)	$ 514,016,520	$ 0 [b]
Irrigation Canal w/ Pump Modifications	$ 381,098,836	$ 419,600,000
Hydropower	$ 0	$ 0
Impacts (Roads & RxR)	$ 245,154,488	$ 208,800,000
Cultural Management	$ 70,628,780	$ 82,900,000
Cultural Mitigation	$ 22,069,000	$ 22,100,000
Relocation of Treaty Fishing Access Sites	$ 32,743,844	$ 32,700,000
Recreation	$ 27,928,456	$ 26,200,000
Erosion Seeding/Habitat Restoration	$ 57,121,332	$ 48,700,000
Municipal & Industrial Water Supply	$ 112,999,428	$ 120,500,000
Bridge & Culverts	$ 307,337,472	$ 279,100,000
Utilities	$ 20,209,536	$ 19,600,000
Total First Costs		**$ 2,059,300,000**
Annual First Costs		**$ 136,700,000**

Other Economic Impacts	Economic Impact
Navigation	$ 94,621,000
Hydropower	$ 144,000,000
Recreation	$ 29,780,000
Flood Damages	$ 0
Commercial Fishing	$ (2,001,000)
Total Other Economic Impacts	**$ 266,400,000**
Total First Costs and Other Economic Impacts	**$ 403,100,000**

a. Economic costs are calculated by taking the present value of the first costs.

b. Impacts related to navigation have been calculated as the costs of alternate means of transportation (rail), rather than the costs associated with dredging a channel and maintaining navigation.

Table 86.
NED Cost Summary
Alternative 3. Natural River Drawdown w/o Flood Control

Feature	First Costs	Economic Cost [a]
Dam/Spillway	$ 1,136,465,100	$ 1,334,100,000
Navigation Lock	$ 254,825,920	$ 0 [b]
McNary (Fish & Navigation)	$ 25,078,192	$ 29,400,000
Bank Protection	$ 310,899,041	$ 291,600,000
Navigation w/ Existing Fleet Tow Boater's Design(Dredging)	$ 920,623,340	$ 0 [b]
Irrigation Canals w/ Pump Modifications	$ 388,006,972	$ 427,200,000
Hydropower	$ 0	$ 0
Impacts (Roads & RxR)	$ 250,093,092	$ 213,000,000
Cultural Management	$ 108,078,596	$ 126,900,000
Cultural Mitigation	$ 29,973,000	$ 30,000,000
Relocation of Treaty Fishing Access Sites	$ 33,337,388	$ 33,300,000
Recreation	$ 29,011,656	$ 27,200,000
Erosion Seeding/Habitat Restoration	$ 78,123,340	$ 66,500,000
Municipal & Industrial Water Supply	$ 115,116,504	$ 122,700,000
Bridge & Culverts	$ 394,299,071	$ 358,100,000
Utilities	$ 19,981,404	$ 19,400,000
Total First Costs		**$ 3,079,400,000**
Annual First Costs		**$ 204,300,000**

Other Economic Impacts	Economic Impact
Navigation	$ 94,621,000
Hydropower	$ 265,000,000
Recreation	$ 2,429,000
Flood Damages	$ 950,000
Commercial Fishing	$ (3,518,000)
Total Other Economic Impacts	**$ 359,482,000**
Total First Costs and Other Economic Impacts	**$ 563,782,000**

a. Economic costs are calculated by taking the present value of the first costs.

b. Impacts related to navigation have been calculated as the costs of alternate means of transportation (rail), rather than the costs associated with dredging a channel and maintaining navigation.

Table 87. NED Cost Summary Alternative 4. Natural River Drawdown with Flood Control		
Feature	First Costs	Economic Cost [a]
Dam/Spillway	$ 1,902,934,992	$ 2,622,500,000
Navigation Lock	$ 903,651,600	$ 0 [b]
McNary (Fish & Navigation)	$ 25,902,336	$ 30,400,000
Bank Protection	$ 659,330,182	$ 618,400,000
Navigation w/ Existing Fleet (Dredging)	$ 950,673,360	$ 0 [b]
Irrigation Canal w/ Pump Modifications	$ 400,671,888	$ 441,100,000
Hydropower	$ 0	$ 0
Impacts (Roads & RxR)	$ 257,880,528	$ 219,700,000
Cultural Management	$ 111,606,384	$ 131,000,000
Cultural Mitigation	$ 29,977,000	$ 30,000,000
Relocation of Treaty Fishing Access Sites	$ 34,425,552	$ 34,400,000
Recreation	$ 29,958,624	$ 28,100,000
Erosion Seeding/Habitat Restoration	$ 80,673,360	$ 68,700,000
Municipal & Industrial Water Supply	$ 118,874,016	$ 126,700,000
Bridge & Culverts	$ 407,168,714	$ 369,800,000
Utilities	$ 20,640,576	$ 20,000,000
Total First Costs		**$ 4,740,800,000**
Annual First Costs		**$ 314,600,000**
Other Economic Impacts		Economic Impact
Navigation		$ 94,621,000
Hydropower		$ 265,000,000
Recreation		$ 2,429,000
Flood Damages		$ 0
Commercial Fishing		$ (3,421,000)
Total Other Economic Impacts		**$ 358,629,000**
Total First Costs and Other Economic Impacts		**$ 673,229,000**

a. Economic costs are calculated by taking the present value of the first costs.

b. Impacts related to navigation have been calculated as the costs of alternate means of transportation (rail), rather than the costs associated with dredging a channel and maintaining navigation.

10.3 Regional Economic Analysis

Changes in water management resulting from drawdown of the John Day Dam Reservoir will affect industries that depend on Columbia River flow passing through the reservoir, which in turn will affect business activities throughout the Pacific Northwest. The effects may be negative for some elements and positive for others. For example, a change in power generation from hydroelectric to fossil fuel would likely increase consumer energy costs, potentially reducing consumption of other goods and services in the region. The change in power source would have an initial negative effect on regional income and employment, but

this would be offset by jobs related to the construction and operation of replacement fossil fuel plants. A set of regional input-output models was used to translate changes in final demand for certain goods and services into total (direct, indirect, and induced) impacts to regional economies.

The first step in the economic analysis is to identify the economic sectors most likely to be affected by water management changes. Next, the effects are expressed as direct changes in final demand for the output of those sectors (Table 88 and 89). Finally, the total impacts of the changes in demand, including indirect and induced effects, are calculated using the input-output models. The results of the analysis under the proposed management drawdown are reported in terms of changes in employment and personal income in the study regions (Table 90 and 91).

The projections of overall employment impacts depend on assumptions about the response by the irrigated agriculture sector to John Day Dam drawdown. Assuming that irrigated agriculture cannot adjust and production in all the existing acreage ceases, a total of 14.81 thousand regional jobs across all affected sectors may be lost (Table 92 and 93). In the short run (one to 10 years), a total of 11.49 thousand jobs may be gained, primarily in the construction and railroad industries. Under the assumption that impacts to irrigated agriculture would be lessened by construction of an adjacent water delivery canal, a total of 5.54 thousand jobs may be lost in all sectors. In the short run, 11.49 thousand jobs may be added to the region; in the long run, 2.61 thousand jobs may be gained, mainly in the railroad and fishing industries.

Table 88. John Day Dam Drawdown Study: Changes in Final Demand by Sector: Natural River Drawdown Alternative ($ in millions)

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commer-cial Fishing	Recreation	
													Fishing	Other Recreation
1	Power (87% of Snake River = 6 plants)			($51.9)	($94.1)	$150.0 [c] $10.0 [d]					$26.8			
2	Transportation				($12.2)			($77.5)	($49.0)	$153.2				
3	Water Supply	Agriculture (without canal construction)	($324.6)			$75.0 [e]								
		Agriculture (with canal construction)			($24.57)	$75.0 [e]								
		Municipal and Industrial (with canal construction)			($4.0)	$12.6	$4.0							
4	Anadromous Fish											$17.9 [f]		
5	Recreation (in 10th year)												$6.9	$39.1
6	Implementation and Avoidance			$656 [g]										

Notes:
a. Impacts for the lower Snake River dam natural river alternative have been calculated separately and will be in addition to the John Day drawdown impacts.
b. Power plant construction and operating costs are per plant.
c. Each year for 6 years.
d. Transmission for 1 year.
e. Canal construction over 5 years.
f. After 30 years.
g. Divided between households, wholesale trade, construction and government (from 1-5 years).

Table 89. John Day Dam Drawdown Study: Changes in Final Demand by Sector: Spillway Crest Drawdown Alternative ($ in millions) [a]

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commer-cial Fishing	Recreation	
													Fishing	Other Recreation
1	Power (87% of Snake River = 6 plants)			($26.5)	($42.9)	$150.0 [d] $5.0 [e]					$26.8			
2	Transportation				($12.2)			($77.5)	($49.0)	$153.2				
3	Water Supply	Agriculture (without canal construction)	($324.6)											
		Agriculture (with canal construction)			($24.57)	$75.0 [f]								
		Municipal and Industrial (with canal construction)			($4.0)	$12.6	$4.0							
4	Anadromous Fish											$13.9 [g]		
5	Recreation (in tenth year)												($0.5)	($4.7)
6	Implementation and Avoidance			$440 [i]										

Notes:
a. Impacts for the spillway crest alternative will not be affected by flood control.
b. Impacts for the lower Snake River dam natural river alternative have been calculated separately and will be in addition to the John Day drawdown impacts.
c. Power plant construction and operating costs are per plant.
d. Each year for 3 years.
e. Transmission for 1 year.
f. Canal construction over 5 years.
g. Commercial fishing after 30 years.
h. Divided between households, wholesale trade, construction, and government.

Table 90. John Day Dam Drawdown Study: Income and Employment Impacts: Natural River Drawdown Alternative ($ in millions)

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plant Operating Costs (per plant)	Commer-cial Fishing	Recreation	
													Fishing	Other Recreation
1	Power (87% of Snake River = 6 plants)			($71.8) -739 jobs	($130.1) -1,334 jobs	$113.2 3,027 jobs					$7.9 292 jobs			
2	Transportation				($15.4) -128 jobs			($43.2) 1,834 jobs	($25.2) -770 jobs	$40.0 2,330 jobs				
3	Water Supply	Agriculture (without canal construction)	($350.5) -9,276 jobs											
		Agriculture (with canal construction)			($31) -257 jobs	$52.4 [d] 1,395 jobs								
		M&I (with canal construction)			($3.8) -31 jobs	$8.7 232 jobs [e]	$1 61 jobs							
4	Anadromous Fish											$26.5 [f] 717 jobs		
5	Recreation (in tenth year)												$1.75 71 jobs	$10.5 496 jobs
6	Implementation and Avoidance					$125.4 4,957 jobs [g]								

Notes:
a. Impacts for the lower Snake River dam natural river alternative have been calculated separately and will be in addition to the John Day drawdown impacts.
b. Power plant construction and operating costs are per plant.
c. For 5 years.
d. For one year.
e. After 30 years.
f. For 1.5 years.

Table 91. John Day Dam Drawdown Study: Income and Employment Impacts: Spillway Crest Drawdown Alternative ($ in millions)

	Impact Type		Agriculture Production	Commercial and Industrial Consump. Effect	Household Personal Consump. Effect	Construction Each Year	Local Govt.	Truck Industry	Barge Industry	Railroad Industry	Power Plants Operating Costs (per plant)	Commer-cial Fishing	Recreation	
													Fishing	Other Recreation
1	Power (51% of natural river alternative = 3 plants)			($36.6) -377 jobs	($66.4) -680 jobs	$109 2,906 jobs					$7.9 299 jobs			
2	Transportation				($15.4) -128 jobs			($43.2) -1,834 jobs	($25.2) -770 jobs	$40.0 2,330 jobs				
3	Water Supply	Agriculture (without canal construction)	($350.5) -9,276 jobs											
		Agriculture (with canal construction)			($31) -257 jobs	$52.4 [d] 1,395 jobs								
		M&I (with canal construction)			($3.8) -31 jobs	$8.7 232 jobs [e]	$1 61 jobs							
4	Anadromous Fish											$20.6 [f] 557 jobs		
5	Recreation (in tenth year)												($0.12) -5 jobs	($1.3) -59 jobs
6	Implementation and Avoidance					$91.1 3,568 jobs								

Notes:
a. Impacts for the spillway crest drawdown alternative will not be affected by flood control.
b. Impacts for the lower Snake River dam natural river alternative have been calculated separately and will be in addition to the John Day drawdown impacts.
c. Power plant construction and operating costs are per plant.
d. For 5 years.
e. For 1 year.
f. After 30 years.

Table 92. John Day Dam Drawdown Study: Total Employment Impacts: Natural River Drawdown Alternative by Industrial Sector, Over 100 Years

Impact Type	Negative Job Impacts 100 90 80 70 60 50 40 30 20 10 0	Positive Job Impacts 0 10 20 30 40 50 60 70 80 90 100
1. Power	2,073 jobs [Commercial and household consumption effects] >----------<	292 jobs [Power Plant Operation] >----------< 3,027 jobs [Construction] >-----<
2. Transportation 4 Year Average	128 jobs [Household consumption] >----------< 1,834 jobs [Truck industry] >----------< 770 jobs [Barge industry] >----------<	1,370 jobs [Railroad industry] >----------<
3. Water Supply without Canal Construction 3. Water Supply with Canal Construction 3. Water Supply–Municipal and Industrial	9,276 jobs [Agriculture] >----------< 257 jobs [Household consumption] >----------< 31 jobs [Consumption] >----------<	1,395 jobs [Construction] >-----< 232 jobs [Construction] >--< 61 jobs [Local government] >----------<
4. Anadromous Fish		717 jobs [Fisheries] >----------<
5. Recreation in Tenth Year		567 jobs [Recreation] >----------<
6. Implementation and Avoidance	443 jobs [Operations] >----------<	5,400 jobs [Construction] >---<

Notes: a. Time frame for the Water Supply-Agriculture Sector Scenario 1: in the first 10 years, a loss of 14,812 jobs and a gain of 11,485 jobs between project years 30 to 100,a gain of 2,610 jobs..
b. Time frame for Scenario 2: in the first 10 years, a loss of 5,535 jobs and a gain of 11,485 jobs; between project years 30 to 100, a gain of 2,610 jobs.

Table 93. John Day Dam Drawdown Study: Total Employment Impacts: Spillway Crest Drawdown Alternative by Industrial Sector, Over 100 Years

Impact Type	Negative Job Impacts 100 90 80 70 60 50 40 30 20 10 0	Positive Job Impacts 0 10 20 30 40 50 60 70 80 90 100
1. Power	1,057 jobs [Commercial and household consumption effects] >----------<	299 jobs [Power Plant Operation] >----------< 2,906 jobs [Construction] >-----<
2. Transportation Four Year Average	128 jobs [Household consumption] >----------< 1,834 jobs [Truck industry] >----------< 770 jobs [Barge industry] >----------<	1,370 jobs [Railroad industry] >----------<
3. Water Supply without Canal Construction 3. Water Supply with Canal Construction 3. Water Supply–Municipal and Industrial	9,276 jobs [Agriculture] >----------< 257 jobs [Household consumption] >----------< 31 jobs [Consumption] >----------<	1,395 jobs [Construction] >-----< 232 jobs [Construction] >--< 61 jobs [Local government] >----------<
4. Anadromous Fish		557 jobs [Fisheries] >----------<
5. Recreation in Tenth Year	65 jobs [Recreation] >----------<	
6. Implementation and Avoidance	443 jobs [Operations] >----------<	3,568 jobs [Construction] >---<

Notes: a. Time frame for the Water Supply-Agriculture Sector Scenario 1: in the first 10 years, a loss of 13,418 jobs and a gain of 8,137 jobs; between project years 30 to 100 a gain of 1,866 jobs.
b. Time frame for Scenario 2: in the first 10 years, a loss of 4,585 jobs and a gain of 9,532 jobs; between project years 30 to 100 a gain of 1,866 jobs.

10.4 Other Social Effects

The social analysis presents some of the possible impacts to local communities and individuals. A change in power rates, for example, would have an effect on many people in the region, but low-income individuals would experience a greater impact because power expenditures are likely to be a greater proportion of their income. An important aspect of the social analysis is the incidence of costs. The impacts associated with drawdown can either be diluted to the widest possible population (the federal taxpayer) or those impacts can fall completely on the smallest possible population. Decisions regarding the incidence of costs are outside the scope of the Phase I Study, but, for the purposes of the social analysis, most impacts are assumed to be borne locally rather than at a national level.

10.4.1 Purpose

This section of the report is an overview of the types of economic and social effects that should be carefully examined to determine the impacts of the John Day drawdown. While quantitative information is provided where possible, this report is primarily intended to identify the qualitative impact of changes caused by drawdown. Estimates of economic impact are necessarily vague at this stage of the process, and that makes determination of the social impacts even more problematic. In addition, drawdown would not occur until about 2013, and much could change between now and then. Further, the impact is likely to be affected by the decision made regarding the four dams on the Snake River. Hence, some consideration of these alternatives is necessary. Tribal impacts are discussed in the Cultural/Tribal Technical Appendix and are not covered extensively in this analysis.

10.4.2 Geographic Scope

The geographic scope is focused on the area most directly affected by changes in the John Day Reservoir. Previous studies have identified the area around the reservoir as the "downriver" area associated with the analysis of the Snake River dams. For consistency with those earlier analyses, the same geographic area was identified for this study. The impacts to be discussed are more concentrated than this area would suggest, but the benefits of consistency with previous studies argue for the larger area. The downriver area is defined as the area below the Snake River dams, encompassing both McNary and John Day Dams. The alternatives under consideration will affect McNary operations, but the changes being considered largely relate to the Snake River dams and the John Day Dam. Therefore, most of the impact discussion is focused on the areas around the John Day Reservoir.

The downriver area consists of Benton, Franklin, Klickitat, and Skamania Counties in Washington, and Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties in Oregon. While impacts to other areas would occur, the effects are likely to have been captured in the analysis of the Snake River dams. In particular, regional effects would be quantitatively different from those associated with the Snake River analysis, but they should not be qualitatively different. However, the targeted effects of the change in operation of the John Day Dam would result in impacts that are considerably more focused on this area.

10.4.3 Study Area Overview

The economic effects of the John Day Dam drawdown will be most concentrated in the area adjacent to and immediately upriver from the dam. This region consists of large areas that are primarily agriculture and natural-resource-oriented, together with one major urban

concentration, the Tri-Cities area, and several smaller urban concentrations. While there may be some regional effects from drawdown, they would tend to be minor relative to any of the affected state economies. The three states likely to be affected—Idaho, Oregon, and Washington—have had similar experiences with divergent forces affecting urban and rural economies. Each state has a major urban area that has undergone significant growth in high-tech industries, while rural areas have largely continued to rely on their traditional industries. For example, an analysis of high-tech employment in Oregon revealed that several of the counties in the mid-Columbia area have no employment related to high-tech industries.

Due to the strength of the high-tech sectors and the forecasts for their continued growth, the impacts of drawdown on the overall economies of the three states would be hard to identify. Impacts that should be considered are more focused. At the state level, three possibilities have been identified. The first is the possibility that downriver navigation would be affected by changes in water flow, thus affecting the Port of Portland primarily and the shippers who use the port secondarily. The second possibility is the impact of increased electric power costs and potential flood damage. These impacts are likely to be small for the state as a whole, but they may affect certain groups or areas disproportionately. Third, the benefits or costs of changes in recreational possibilities are likely to accrue significantly within the region's urban areas, since the Columbia Gorge is a major recreation destination for urbanites in the region. Most of the remainder of the discussion focuses on the more direct impacts expected in the region adjacent to the dam and its reservoir.

The Oregon side of the river is relatively more homogenous with respect to rural vs. urban character than the Washington side is. In this regard, it is useful to consider the description of the economy developed by the Oregon Department of Labor, which identifies this area as regions 9 and 12 for the state. The following is taken from the department's regional analyses.

Region 9 counties consist of Gilliam, Hood River, Sherman, Wasco, and Wheeler. This region is located in the north-central portion of Oregon. The Columbia River borders the northern part of the region. Based on 1996 population estimates, this region contains the three least-populous counties in the state: Gilliam (1,900), Sherman (1,900), and Wheeler (1,600). The combined total for these three, 5,400, is less than the population of the next smallest county, Wallowa (7,250). By comparison, the other two counties are Hood River (19,000) and Wasco (22,500). The largest cities in the region, unsurprisingly, are located in these same two counties: Hood River (population 5,110) in the county of the same name, and The Dalles (11,460) in Wasco.

The region boasts a number of scenic attractions, which, in addition to the Columbia River and Columbia Gorge, include the John Day fossil beds, Mount Hood, and national forest areas. The Columbia River Highway, completed approximately 80 years ago, was the Northwest's first paved highway. Beginning with the completion in 1937 of Bonneville Dam, much of the state's electricity and water for irrigation have been supplied by the area's hydroelectric projects, including The Dalles and John Day Dams. Recreation has been a growing source of employment in the region, particularly windsurfing. Hunting and fishing opportunities are also plentiful, along with other outdoor recreation attractions.

In 1996, non-farm payroll employment in the region was 18,400, an increase of 4,600 jobs over the past 20 years. Nearly 75 percent of these new jobs have been in trade and service industries.

Region 12 consists of two counties, Morrow and Umatilla, located in the northeast portion of Oregon and bordered on the north by the Columbia River and Washington state. A major portion of the region, particularly in Umatilla County, consists of national forests, specifically the Umatilla, Wallowa, and Whitman National Forests.

Umatilla (1996 population—65,500) is the more populous county of the two. Morrow 's comparable population was 9,000. Umatilla's largest cities are Pendleton (15,900) and Hermiston (11,050). Boardman (2,580) is the largest city in Morrow County.

Umatilla County has become a major center for wholesale and retail trade, employing 5,480 in this industry group in 1996. Its services sector, at 4,580 jobs in the same year, is also healthy and substantial. In Morrow County, government represents the largest work force (790 in 1996), with food and related products manufacturing (620) coming in second.

10.4.4 County Profiles

State employment division data were used to provide some general information on each of the counties included in the study area. This information is largely taken from public files of the employment divisions of Oregon and Washington and from the Oregon Blue Book. It is intended as a general overview of the counties in the identified area, and not all counties or all industries in each county would be negatively affected by the changes in dam operations. Detailed community profiles are located in the Economics Technical Appendix.

10.4.4.1 Benton and Franklin Counties, Washington

The Tri-Cities region is an agricultural center with a related food processing industry. Agri-chemical industry along the banks of the Columbia River near Kennewick is also a major component of the region's economy.

While the Hanford facilities are an important factor in the regional economy and are largely insulated from any changes that might occur as a result of dam operations, agriculture is still an important factor in the region's economy. The level of dependence on irrigation and the effects of dam drawdown are likely to be noticed even in Benton county, which is among the least agriculture-dependent of the counties in the region.

Direct agricultural employment in 1990 amounted to 8,728 workers, and another 3,294 were employed in the food processing industry. In total, agriculture and related employment in the Tri-Cities reached 12,869, not that far removed from the number employed by Hanford.

Unemployment in Benton and Franklin Counties is two-tiered. In Franklin County, the percentage of unemployed is consistently larger than in Benton County, and the difference has widened in recent years. The gap between the two can largely be explained by the seasonality of the agricultural work that predominates in Franklin County and the stability of Hanford employment in Benton County. Additionally, the share of Franklin's total employment devoted to agriculture has increased far more than Benton's in the recent past.

10.4.4.2 Klickitat County, Washington

The agricultural pattern in the county's central valley is based on the rotation of soft winter wheat and alfalfa hay crops, with cattle as the balancing factor. Agricultural patterns vary in the county's western and eastern extremes where soil composition and climates differ. Logging and lumber are also important industries.

Klickitat County maintains a relative balance between agriculture, livestock, food processing, and government, and some aluminum reduction, fishing, logging and lumber production. Klickitat County's economy has long been associated with traditional, resource-based industries, such as farming, logging and timber operations, and, more recently, aluminum production. Although these industries have been, and still are, the backbone of the county's prosperity, they are also the prime culprits in its higher than average unemployment rate. Farming employment is seasonal, as are logging and timber production. Aluminum industry employment depends on cheap electricity and is subject to a volatile market that can render production unprofitable overnight.

This industrial base is quite a bit different than that of the state as a whole. Manufacturing is much stronger in the county, trade and services are much weaker, and government employment is markedly higher.

In recent years, migration has been a strong factor in the population growth, but from 1980 to 1990 the county actually had a migratory net loss. While the natural population increase (births minus deaths) was 1,085, net migration resulted in a minus 291 (i.e., that many more people left the county than came to the county). From 1990-93, though, there has been strong in-migration. The natural increase during these 3 years was estimated at 248, while the migratory net was pegged at a positive 636.

Klickitat County's economy has a number of advantages and disadvantages. High unemployment is the greatest concern, but at present it is considerably lower than it has been in the past. Manufacturing employment is currently stagnant; the timber industry is at a standstill, and the immediate outlook for the aluminum industry is simply unknown. But there is ample room for development in the services and trade industries, and a nascent tourist industry could provide a boost to the economy. Finally, the stable and large government presence adds solidity to the employment base.

10.4.4.3 Skamania County, Washington

Fishing, logging, and lumber were major industries in Skamania County. In 1986, the U.S. Congress proposed and President Reagan signed legislation designating the Columbia River Gorge as a National Scenic Area. The act imposes land use and development controls on the area and is intended to preserve the Gorge for future generations. Tourism plays an ever-increasing role in the county's economy. Additionally, roughly 80 percent of the county's land mass is part of the Gifford Pinchot National Forest, with its mountains, mineral hot springs, ancient lava beds, and, of course, Mount St. Helens, all of which are tourist destinations.

Today, Skamania County's economy is based largely on federal employment—especially management of national forests and of fish and wildlife—with the balance distributed among logging and lumber, tourism and recreation, and light manufacturing.

10.4.4.4 Gilliam County, Oregon

Gilliam County is in the heart of the Columbia Basin wheat area. The economy is based mainly on agriculture, with an average farm size of about 4,200 acres. Wheat, barley, and beef cattle are the principal products. The largest individual employers in the county are two subsidiaries of Waste Management Inc.—Chemical Waste Management of the Northwest and Oregon Waste Systems, Inc., a regional state-of-the-art solid waste landfill.

With elevations of over 3,000 feet near Condon in the southern part of the county and 285 feet at Arlington, 38 miles north, the county offers a variety of climates and atmosphere. Hunting, fishing, and tourism are important secondary industries. Two major rivers, the John Day and the Columbia, traverse the area, as does I-84. State Highway 19 connects the county's major cities and serves as gateway to the John Day Valley.

10.4.4.5 Hood River County, Oregon

Agriculture, timber, lumber, and recreation are the major sources of revenue and industry in Hood River County. Fruit grown in the fertile valley is of exceptional quality, and the county leads the world in Anjou pear production. There are more than 14,000 acres of commercial orchards, which grow pears, apples, cherries, and peaches. The county also contains two ports and two boat basins (one serving local barge traffic), a steel boat manufacturing firm, and Mid-Columbia yachting interests. Windsurfing on the Columbia River is a popular sport and attracts windsurfers from all over the world.

10.4.4.6 Morrow County, Oregon

Morrow County contains more than one million acres of gently rolling plains and broad plateaus. This rich agricultural land can be roughly divided into three occupational zones: increasing amounts of irrigation farming in the north; vast fields of wheat yielding to cattle and sheep ranches in the center; and timber products in the south. Food processing and recreation are also important sectors. With the advent of center-pivot irrigation technology, Morrow County became one of Oregon's fastest growing areas in terms of population, personal income, and agricultural and industrial development. The Port of Morrow serves as a gateway to Pacific Northwest and Pacific Rim markets.

10.4.4.7 Sherman County, Oregon

The county is a wheat-growing area with miles of waving grain on rolling hills of wind-blown glacial silt. The total absence of timber in the county exemplifies the true meaning of the "wide open spaces of the West." Its pastoral landscape provides spectacular views of canyons and rivers, with mountains silhouetted in the distance. Recreation abounds on the rivers, from the famous and scenic fly-fishing and whitewater-rafting on the Deschutes River to water-skiing, windsurfing, boating, fishing, and rafting on the John Day and Columbia Rivers.

10.4.4.8 Umatilla County, Oregon

Irrigation has been key to economic diversification and growth in the county, most recently in the Hermiston area, where the desert now yields lush watermelons and other products. Tourism is also increasingly important, particularly related to the Pendleton Roundup. In addition to agriculture and tourism, food processing, forest products, manufacturing, and recreation, aggregate production and power generation are important components of the economy.

10.4.4.9 Wasco County, Oregon

The county economy is largely oriented toward agriculture, forest products, manufacturing, electric power, aluminum processing, and transportation.

10.4.5 Socio-Demographic Characteristics

Many of the counties described above are sparsely populated. The heavy reliance on agriculture tends to generate higher levels of unemployment, due to the its seasonal nature, and lower average earnings. This can be seen clearly in Table 94, where the median income for Benton County, with Hanford and related activities, is almost 50 percent higher than the other counties in the region. Poverty rates vary substantially, from a low of 7 percent in Gilliam County to a high of over 18 percent in Franklin. Childhood poverty rates are correlated with the overall poverty rates but always at a higher level.

Table 94.
Poverty and Income Estimates for 1995

	Poverty, All Ages	Percent of Population, All Ages	Poverty, Under Age 18	Percent of Population Under 18	Median Household Income
Benton, WA	11,840	8.7	5,019	12.0	45,696
Franklin, WA	8,514	18.6	4,033	24.4	32,261
Klickitat, WA	2,984	16.0	1,219	22.1	31,004
Skamania, WA	1,002	10.7	368	13.4	35,444
Gilliam, OR	147	7.4	48	9.2	33,403
Hood River, OR	2,955	15.2	1,034	19.1	31,349
Morrow, OR	773	8.3	282	9.9	30,677
Sherman, OR	215	11.6	69	13.7	29,434
Umatilla, OR	10,813	17.0	3,936	21.5	29,365
Wasco, OR	3,086	13.3	1,115	18.0	31,937

Source: U.S. Bureau of the Census, Small Area Income and Poverty Estimates Program.

Table 95 shows that the largest minority group in the area is Hispanics, with all but two of the Oregon counties having a higher percentage than the state as a whole. Hispanics make up over 82 percent of the population in Hood River County, Oregon. The next largest group is Native Americans, where the small percentages are generally above the percentages for the state as a whole. The percentage of African Americans is well below the low percentage for the state as whole, and two of the counties showed essentially zero African American population. The percentage of Asians is not shown, but it is low also. The female percentage of the labor force is lower than the state average in each of the Oregon counties.

Table 95. Percent of Civilian Labor Force by Race and Gender 1997					
	Total Minority	African American, not Hispanic	Native American, not Hispanic	Hispanic All Races	Female
State of Oregon	11.1%	1.5%	1.2%	5.5%	44.8%
Gilliam, OR	5.4%	0.3%	0.3%	4.4%	43.9%
Hood River, OR	26.3%	0.4%	1.5%	22.6%	40.1%
Morrow, OR	16.5%	0.0%	1.1%	15.1%	40.3%
Sherman, OR	4.9%	0.0%	0.8%	4.1%	39.6%
Umatilla, OR	16.3%	0.1%	2.8%	12.3%	43.8%
Wasco, OR	11.4%	0.4%	3.1%	6.8%	43.6%
Source: Oregon Employment Department.					

10.4.6 Social Effects of Drawdown

A variety of social impacts may arise as a result of changes in the use of the Columbia River. These impacts are often discussed in terms of their overall impact on employment and other economic indicators; but it is important to remember that the aggregate totals conceal many important details. First, aggregate totals are often long-run effects, but there are likely to be important distinctions between the short term and the long-term and the transition periods. Second, aggregate effects often mask interpersonal or geographic differences in impact. Thus, a net increase in jobs may not mean much to someone without the appropriate skills for the jobs created, while a net decrease in jobs may mask a substantial increase in employment opportunities for some. While it is often much more difficult to determine the detail of economic and social impacts, some discussion of likely trends may help to focus on the distribution of the impacts.

Related impacts occur through the process of capitalization of various economic values into land prices. Through the process of capitalization, the person owning the land at the time of an economic change actually bears much of the burden or receives much of the benefit of the changes even though the impact is spread over many years. Capitalization occurs with both positive and negative impacts. Thus, increased recreational opportunities may increase the value of land near the recreation site by some multiple of the expected annual value of increased recreation opportunities. While capitalization is seldom as efficient or complete as this discussion implies, it is important to take it into account when trying to determine the distribution of benefits and costs.

10.4.6.1 Assumptions and Uncertainties

The base case is assumed to be the retention of all dams on the Snake River and the continuation of current operations at McNary and John Day Dams. This case should be analyzed in some detail to provide a good comparison with the alternatives to be considered. Several factors are worth highlighting.

First, the reliance on agriculture in the region makes the economy subject to fairly substantial risks and volatility under the best of circumstances. The Oregon Employment Department reported that grain sales in the state were estimated to have fallen from $268 million in 1997 to $184 million in 1998. "The North Central District (Gilliam, Hood River, Morrow, Sherman, Umatilla, Wasco, and Wheeler Counties), which accounts for roughly 75 percent of

the state's grain production, also accounted for the brunt of the sales losses." (State of Oregon Employment Department, Mid-Columbia Labor Trends, July 1999.) Clearly, the region is subject to high variance in prices and earnings for agriculture.

Second, a variety of mitigation measures are likely to be imposed to improve conditions for salmon, and some of these measures could affect farm practices and costs. Since some of the mitigation measures may not be necessary if other actions are taken, the cost and impact of such measures should be analyzed as part of the base case for comparison purposes.

Third, electric power costs may be affected by various changes in the electric power industry. Currently, the cost of generating hydropower is below its market value. This allows for the sale of some power at preferential prices. Recipients of this power would be made worse off by an increase in their costs, but the level and distribution of these benefits are subject to uncertainty in the face of changes in the electric power market. Retention of such preferentially priced power may not be the most appropriate base case.

10.4.6.2 Social Effects by Area of Impact

The aggregate region wide effects of drawdown are likely to be quite small, but several issues may be worth considering. First, drawdown may affect the ability to maintain the shipping channel downriver. While the John Day Project is not used largely for storage, the possibility that the combined effect of the changes under consideration would influence the ability to maintain the navigation channel up to the Port of Portland has been mentioned. This would have a direct negative effect on the Port of Portland and its shippers, though it might have a positive effect on other ports and shipment modes. Even if the shipping channel is not affected, changes in the ability to ship products by barge may affect the relative attractiveness of various ports for products, primarily agricultural, destined for foreign markets. In particular, elimination of barge traffic to the Tri-Cities would have important implications for agricultural transportation in both eastern Oregon and eastern Washington. A switch to railroad shipping could make other ports, such as Tacoma and Seattle, more attractive as a final destination. Refined analysis of the likely transportation impacts would be necessary to determine the employment and economic effects of such changes.

Second, reduced electric generation is likely to result in higher regional energy prices and construction of other sources of energy supply. This would probably be a much smaller impact than it might have been in the past due to the improved technology for gas turbine generation and the projections of stable natural gas prices. Before the improvements in turbine technology, the replacement energy would most likely have come from large thermal plants, which are more costly to construct and operate and have a larger environmental impact. The likely location of these plants is an important consideration. Both the construction and operation generate economic activity, but the newer plants can be built at a much smaller scale than the old ones. Consequently, they are likely to be distributed over a wide geographic area. The higher energy prices are likely to be a relatively minor effect, but they may act disproportionately on industries, particularly aluminum production, that are energy-intensive and on homeowners who rely on electric heat. Certain utilities are likely to be affected more than others are, and customers of those utilities that are heavy users of electricity may experience significant impacts. Further, the future cost becomes more uncertain due to the potential variability in gas price. Power produced with gas appears to

have a much higher potential for both net cost increase and for cost variation than does hydropower.

Recreation changes will have direct employment impacts in the area affected, but many of the people who will either benefit from new recreation opportunities or suffer from the loss of old ones are located in other parts of the state and even the country. Many people argue that the recreation opportunities available in the Northwest are an important amenity, but it would be difficult to quantify the value of such changes or their distribution among the population.

Social impacts are subject to great uncertainty, especially when the issue of financing is not resolved. From the regional perspective, income is income, whether it comes from the sale of agricultural commodities or from federal payments for construction activity. Hence, the regional social impact analysis does not focus on the net benefits or costs of activities. Rather, it focuses on whether the local communities are made better or worse off. However, some activities may be financed from a variety of sources, including local ones. Then the source of the funds becomes an important issue. From the local perspective, federal funds generate only benefits, while local funds generate benefits and costs. This is true whether the local funds are raised through local governments (e.g., taxes paid for an improved municipal water system), or through private sources (e.g., higher irrigation costs). A variety of such issues are unresolved and will have a substantial effect on the ultimate impacts. Further, where there are likely to be negative local impacts, the potential levels of federal intervention become relevant. From an economic perspective, such issues often have little impact on the net economic outcome; from a social perspective; however, they may be decisive in determining the degree of impact. Where differences in the source of funding are clearly defined, they will be noted, but there are many areas where future decisions may substantially alter the impacts.

Water Supplies

Lowering the John Day Reservoir to either spillway crest or natural river levels will increase the costs of drawing water for irrigation, municipal water uses, and some industrial water uses. In general, it is expected that the cost of responding to such changes in operation will involve a capital cost to relocate the water intake and a higher operating cost associated with pumping water. For the natural river, two options are presented for analysis. The first is to simply allow each user to move the intake source and absorb the higher pumping costs. The initial cost of this option is expected to be around $239 million to move the pump intakes. The second is to construct canals on both sides of the river to provide water for irrigation purposes. This option is estimated to cost $375 million.

The initial cost of the canals is higher than the initial cost of relocating the water intake, but the operating costs for the latter would be higher. In addition, relocating intakes could cause the loss of a growing season. This would result in loss of net revenue for farmers with annual crops, but it could result in the loss of major investments in the case of perennial crops. In the latter case, it typically would take a number of years to reestablish the crops. The analysis for municipal and industrial use does not consider transition costs, although there may be some in this case as well.

Changes in the cost and availability of water would be expected to affect both the value of farmland and the viability of farming. A farmer may simply absorb an increase in the cost of

irrigation or may choose to make changes in crops or farming practices. If crops are changed or if farming proves to be less viable, there would be corresponding effects on employment in farming. In particular, much of the approximately 180,000 acres being irrigated is planted in high-value crops such as apples. The additional cost of annual irrigation does not seem large enough to result in abandonment of such enterprises; however, loss of orchards could have this impact. In particular, it could effectively bankrupt some farmers. Additional analysis is needed to determine whether there are alternative methods to preserve perennial crops during a transition period, as well as the cost of such alternatives. Alternative sources of water for high-value crops, such as drilling wells, also should be analyzed.

The type of response to the changes in the operation of the John Day Dam are likely to have an important effect on the farmers in the region. Most current irrigation is privately provided, taking advantage of the John Day Reservoir. Unless costs are distributed over a wider base (i.e., Federal or state taxpayers), the full cost of relocating pump intakes, increased annual operating costs, and lost crops, would be borne by farmers. In this case, many farmers could go out of business due to the costs imposed. This situation might occur even if the farm remained viable since some farmers might be forced into bankruptcy. This issue would be particularly important for small farms with limited financial options. Because a farmer goes out of business does not necessarily mean that production would cease. Another farmer might buy the land with the production potential at a rate below the cost of existing improvements. At the lower cost, the new farmer might be able to invest in a variety of water delivery systems.

Power

Changes in operation of any of the dams in question will result in reduced production of electricity. It is estimated that breaching the Snake River dams would result in the loss of 1,200 aMW of power. John Day Dam has a peaking capacity of 2,484 MW and annually generates an average of 1,146 aMW. Under the spillway crest drawdown alternatives, John Day would lose 551 aMW of generation; under the natural river level alternatives, all generating capacity would be lost. At either spillway crest or natural river level, the project would lose its flexibility to respond to shifts in demand and provide reserve capacity.

The power analysis identified likely replacement generation resources and estimated the additional costs associated with replacing lost hydropower with more costly types of generation. The study also identified the type of improvements that would be needed in the Pacific Northwest transmission system to assure a safe and reliable power system under the John Day drawdown alternatives. With the higher cost of alternative sources, power prices would be expected to rise, although the distribution of these costs will depend to some extent on how existing power sales are treated. The marginal cost of production for hydropower is below the market value, and some is sold at preferential rates.

The impact of the higher cost for replacement power will depend on a variety of factors, but average impacts have been estimated. The estimated impact on average energy prices is expected to be small. Preliminary analysis indicates that replacement power plants are likely to be built within the region to take advantage of the power distribution network. However, gas turbine plants have a smaller optimal size compared with many existing thermal-power generating facilities and tend to have less environmental impact. This may lead to a more

decentralized distribution of the construction, with some or all of the plants being constructed closer to markets.

Increased power costs are not likely to have a major impact on individuals in the region, but they may affect some of the larger power users, particularly the aluminum industry, food processors, and irrigation with high lifts. While most analyses discount the potential for increased power costs to affect industry operations, the jobs in these industries tend to be relatively high paying. Consequently, any loss in such jobs would have an impact on the wage distribution overall level of employment. Since these areas are not typically good locations for most types of industrial activity, other employment opportunities would not be likely to offset the jobs lost. Therefore, if such job losses did occur, they would likely result in either movement of workers out of the area or reemployment at lower wages. Further, substantial employment losses in primary industries would create ripple effects in the regional economy.

In general, the jobs in the power industry itself are likely to be unchanged on net. The loss of jobs in hydropower would be offset by the expected gain from alternative power generation. Thus, if the alternative power sources are built in this region, there would be a transitional effect as the hydropower jobs are eliminated and other plants are opened; the net change does not appear large and the wage structures are likely to be similar. However, if the new facilities are not built and operated within the region, there would be a net loss of jobs in the power industry, a relatively high-paying sector.

Anadromous Fish

All options are expected to increase natural fish runs to varying extents. This increase would apply to all species above the dam, although the full impact might take as long as 50 years for some species. This may result in increased harvests, generating both income and employment in commercial fishing and processing throughout the Pacific Northwest. The net impact is uncertain, due both to scientific information and policy information. A variety of policies, such as hatchery operations, would affect the net impact to fish runs. Other mitigation measures may affect survival rates, but it is not known whether or not changes in dam operation would make these other measures unnecessary.

Recreation

Many of the recreation opportunities in the area are associated with slack-water access. Drawdown to spillway crest is likely to result in a reduction of recreation opportunities by limiting the area of slack water for boating and fishing (assuming mitigation of recreation facilities). The reduction in area will also limit the habitat and productive capacity of the reservoir for resident fish, resulting in losses of recreational fishing activity. A temporary impact associated with drawdown to spillway crest will be a reduction in aesthetics as the shorelines recover over time. With drawdown to natural river level, aesthetics are expected to be affected in the short term but to improve over the long term. Recreation activity will shift from slack-water-oriented boating and fishing activities, such as skiing, windsurfing, and boat fishing, to a different range of activities applicable to natural river conditions. Fishing for anadromous fish will improve in the area, while fishing for resident fish will decline. High-valued recreation activities like whitewater rafting are not likely to occur at John Day Project with natural river drawdown due to river flow conditions. Because of the high level of current slack-water recreation at the John Day Reservoir, a slight decline in

recreation benefits with natural river drawdown and a more pronounced loss of benefits with the drawdown to spillway crest alternative are expected. However, more of the visitors attracted are expected to be from outside the local area. This would have the effect of increasing the impacts to the local economy through gains in household income and jobs even though the total number of visitors will be less.

Employment losses due to loss in recreation opportunities are expected in the short term. These losses may be offset in the long term as alternative recreation activities are developed and if increases in fish populations provide additional opportunities. Small businesses that rely on users of the recreation facilities may also face reduced patronage. Some may go out of business if the recreation users are their prime source of customers. While these losses may be offset by employment gains in the long term, there is likely to be a difficult transition period for existing businesses. In general, the job losses are likely to be in the service sector, and the anticipated growth in service sector employment should mitigate any adverse effects on employment. The most likely negative impacts would be to specific businesses.

Navigation

Breaching of the dams on the lower Snake River would cause some shifting of transportation modes for agricultural commodities, but it is not expected to have a large impact on net transportation rates. However, combining this change with the John Day Dam drawdown is likely to result in substantial changes in transportation choices. A major issue is the economic feasibility of using railroads for this traffic at current rates. Agricultural shipping tends to be somewhat seasonal, and dedication of rail cars for grain shipment is not a high priority for Class I railroads. Due to the truck vs. barge competition, a substantial amount of rail line has been abandoned in this area, and the State of Washington has responded by subsidizing the purchase of rail cars to help maintain rail car grain shipments from eastern Washington. This action implies that increased reliance on rail may also lead to higher prices. On the other hand, higher volumes of grain shipment by rail may reduce the net cost. This issue requires further analysis.

Construction

Activities associated with the drawdown would generate a substantial amount of construction employment. In addition, many of the actions likely to be taken in response to dam drawdown would also result in construction activity. For example, replacement power plants might have to be constructed or roads and railroads improved. It is generally expected that there would be a substantial increase in construction activity in the short term, and that this increase would provide a significant economic boost to the region during the construction period. The end of the construction period, however, would result in negative local effects as employment and other activities are withdrawn.

10.3.6.3 Urban and Community Impacts

Income Distribution

The net impact of drawdown is likely to have some effects on income distribution. In the short term, the increase in construction jobs and the likely decrease in recreation and possibly agricultural jobs will favor skilled workers over unskilled workers. This outcome may have an adverse effect on the distribution of income if few of the workers who lose jobs are able to find employment in construction. Alternatively, if the displaced workers can get

employment in construction, the income distribution is likely to improve due to the higher average wages in construction.

Owners of farmland are likely to be negatively impacted due to the higher cost of farming, and even more so if the changes force them to alter their farming practices drastically. For example, if the cost of irrigation makes fruit trees untenable, the farmer loses the investment in creating the orchard in the first place. Business owners may be benefited or negatively impacted depending on their activities and source of customers. Some businesses relying on recreation activities are likely to be made worse off, while those that work in the construction area are likely to be better off, at least in the short term.

When viewed from a regional perspective, the short term impact is likely to be positive due primarily to the increase in construction activity. Whether such jobs are filled by local residents or by "commuters," the effect is likely to be an increase in average income. The increased purchases of construction materials and other construction-related expenses would have a favorable impact on many local businesses. Offsetting this to some extent would be a loss for farm-related businesses. While farm activity may not be negatively affected in the long term, there are a variety of reasons why farmers would be more cautious about their activities in the short term. Small businesses that focus on recreation would also experience a negative impact.

In the long term, the loss of construction activity could create a substantial negative impact if it were to occur over a short period of time. However, if the activity tapers off over a long period, the loss would not be as noticeable. Nevertheless, the long term effect would likely be a net job loss relative to what otherwise would have been the case. Timing is an important element when evaluating these changes. A concentration of job losses in the short term would have a much more negative impact than similar losses spread over a long period of time, especially when the time trend is for employment gains. Over time, the region would likely have a lower level of employment after the changes in dam operation than would have occurred without such changes, but this may not result in an actual reduction in employment if the changes take place over a long enough time period. An important issue is how much of the projected employment growth would be associated with expansion of agriculture and whether such expansions would be forestalled.

In looking at the net effect over time, much of the projected employment growth is in the service area; however, service employment still depends on a healthy economy. Reductions in projected employment levels for other sectors would have a compound effect on the service sector. In particular, this relationship could result in a typical boom-bust economic impact if the construction activity starts and ends abruptly.

Employment Distribution

In the short term, the employment changes are likely to favor skilled over unskilled workers. This may be a particular loss for agricultural workers. The share of minorities in the affected communities is greatest for Hispanics and above average for Native Americans. Hispanics are most likely to be negatively affected by the loss of agricultural jobs and their relatively low representation in the skilled trade categories. In 1990, 20 percent of employed Hispanics in Oregon were in farming, forestry, and fishing occupations. This represents a much higher concentration in these occupations than for other ethnic groups. Associated with this concentration is a per capita income that was only a little over half of that for all Oregonians.

(Oregon Employment Department, Hispanics In Oregon's Work Force, 1998). While these relative positions have changed since then, it seems safe to assume that losses in agricultural jobs would disproportionately affect Hispanic workers. Further, high dropout rates and low skills relative to the rest of the labor force make it less likely that Hispanics would be eligible for the jobs created in construction and other areas.

Native Americans may benefit in the long term as fish runs return, but there do not appear to be any obvious short term effects on employment or income opportunities for this group. The long-run benefits of the improved fish runs would be cultural, subsistence, and commercial for this group. Salmon fishing has an important cultural benefit for many tribes. In addition, it provides direct food benefits and part of the catch may be sold commercially, providing income.

Women may also be at a relative employment disadvantage due to their historically low participation in construction activities.

Population Distribution and Composition

The changes associated with drawdown are likely to affect location patterns by making dispersed employment opportunities associated with agriculture and recreation less available and concentrating more of the employment activity in specific areas. In particular, considerable construction activity would occur around any dams that are to be breached, and drawdown of the John Day Dam would affect the communities in that area. The loss in dispersed areas would depend on the overall effect on agriculture. Higher transportation, power, and irrigation costs would likely reduce employment related to agriculture over dispersed areas. To the extent that farming activity is not disrupted, the changes will be associated with a population gain for growing areas but not necessarily at the expense of other areas in the region. Rather, the gain is likely to be associated with net migration into the region in response to employment opportunities.

Changes in economic factors will create incentives for migration in response to employment and business opportunities. Sudden changes tend to affect demographic composition. For example, younger workers are likely to be more mobile than older workers are. This affects the demographic composition of growing and declining areas. Loss of economic opportunity tends to result in young people moving out of an area, and this could be a particular issue for farm families. Conversely, growing areas with good employment opportunities are particularly attractive to such workers. The likely effect would be neutral for small rural farming communities and positive for areas of concentrated economic activity. However, if there is a substantial loss in farm income and employment, then the demographic effects would also be negative. Younger, more mobile workers would tend to leave first, with a resultant concentration of older, less mobile population seen in other declining areas.

Fiscal Condition of State and Local Governments

State governments are not likely to see noticeable effects in terms of their income and expenditures. The impact on state economic activity is likely to be quite small relative to the overall state economies.

The effect of changes in local activity on local government revenues and expenditures is likely to differ between Oregon and Washington. Historically, local governments relied on property taxes for most of their locally generated revenue, and changes in property taxes

were an important fiscal issue. This has been changed in Oregon for two reasons. First, local schools, the largest user of property tax revenue for most local governments, no longer rely on property taxes. While local school districts do collect property taxes, the state determines the level of school expenditure and adjusts state contributions to offset changes in property tax revenue. Thus, an important source of local funding is drastically curtailed by the financing mechanism in Oregon. Second, the Oregon property tax system is based on an assessed value that is considerably below market value for most property in the state. Although assessed value cannot increase beyond market value; it can grow by 3 percent per year as long as it is below market value. Hence, even for general government in Oregon, a decrease in property values may not result in any loss of tax revenue as long as the market value does not decline below the assessed value. On the other hand, since the drawdown would not occur until 2013, market values may be above assessed values or other changes in the financing system may have occurred by that date.

In Washington, changes in assessed value would have a more direct effect on local government finance, but these impacts would not be large unless there were substantial changes in economic activity. Most of the projected impacts appear to be either neutral or positive in the short term for most local governments. The exception would be in primarily rural areas where the decline in value for agricultural land might have a noticeable impact.

Local impacts can be expected to vary. Some communities, especially those near construction sites, should see increases in activity. This would be expected to generate corresponding increases in revenue, although it could also create increased demand for services. If population growth is rapid, then costly infrastructure improvements and personnel expansions may be necessary. However, if the increases in activity are moderate, then the local government impact is likely to be a net improvement in fiscal condition.

Communities that are more oriented to agriculture and recreation are likely to have negative impacts. In addition to overall decreases in economic activity, disruptions tend to drive down real estate prices. Because local governments rely on property taxes, the reductions in real estate values could have a negative impact. This issue is problematic for Oregon because assessed value is well below market value for most properties. Consequently, market value would have to fall significantly to affect local tax collections. The tax revenue and property values should be more closely correlated in Washington. In both states, there are likely to be changes in business taxes, but such taxes go primarily to the state governments, where they would have a small impact.

Quality of Community Life

Drastic changes in economic conditions typically have negative effects on the quality of community life in the short term. If the change is negative, then the disruptions caused by reduced business and farm income and loss of employment create the negative impacts. However, even if the impact is an increase in employment and business activity, there is often a negative effect on the quality of community life due to overcrowding of infrastructure and the demand for more services than the local governments are prepared to provide. In the long term, these effects tend to be alleviated by adaptation to the new level of economic activity. While most communities prefer adapting to growth rather than decline, there is no definitive evidence that growth is necessary to generate a high quality of community life in the long term. Nevertheless, the transition to lower levels of economic activity can create

negative effects for long periods of time, and some communities may find that they are no longer economically viable.

The potential exists that the combined effects of increased transportation costs, irrigation costs, and power costs could have a widespread effect on agriculture in the region. The transition would be difficult, and many farmers could be pushed into insolvency. This would be particular troublesome if the changes occurred at a time, like the present, of low agricultural commodity prices.

Although the potential for major impacts on various social measures exists, it is problematic whether any large-scale effects would occur. Even within the affected region, the expected employment changes represent a relatively small percentage of total employment. These changes are likely to take place over a period of time in which the region is in a growth trend. Therefore, the negative effects could be offset by natural growth. Further, the expectation of substantial increases in construction activity further offsets the impact in the short term.

While potential negative effects have been identified for various groups, the most likely outcome is that negative effects would be geographically concentrated. These effects would be oriented toward areas with major changes in activity, such as transportation, and could possibly show up through widespread losses in farming.

Again, a geographic analysis might be of greatest benefit in refining the issue, since there are likely to be some lands that are only marginally productive under current cost structures. These are the lands likely to be taken out of production if irrigation and transportation costs rise. They may be geographically concentrated, in which case there would be secondary effects on supporting businesses and communities. However, there appears to be little analysis of the distribution of farms by cost vs. revenue. In general, not all farms, or any other business, would be affected in exactly the same way. Without further information on the distribution, however, it is difficult to predict the impact of the expected changes.

Section 11. Public Involvement/Agency Coordination

When this study was formulated, there were multiple public involvement goals: to get factual input from the public (general public, media, interest groups, tribes, congressionals) regarding the impacts of drawing down the John Day reservoir to spillway crest and natural river level; to give the public, through the media and directly, factual information to alleviate their concerns to the greatest extent possible; to help the public understand the Study and the implications of drawdown to them; and to present factual information in a timely, proactive manner to news media to encourage factual coverage of the Study.

The plan included involvement opportunities for a variety of target audiences: the general public; the tribes; special interest groups and organizations; state and federal agency representatives at local levels; county, city and port officials and citizen groups; the System Configuration Team; congressional staffers; the media; and the Corps family.

The methods used to reach those audiences, and to give them the opportunity to be involved and voice their feelings and concerns, were varied.

Public Involvement, initial: A first round of seven *public meetings* was held in 1999 in the following locations: during February, in Juneau, Alaska; Helena, Montana; Lewiston, Idaho; Portland and Umatilla, Oregon; Pasco; and in April, in Goldendale, Washington. Each of those meetings began with an *open house* with topic tables staffed by the John Day study team members handling that topic, for example, irrigation, flood control, etc. *Comments* made during the public meetings, and responses to those comments, were recorded. Public meeting transcripts and written comments were included in the Public Involvement/Agency Coordination Appendix, of the Draft Report, and are included in the final report, which will be forwarded to Congress. Congressional staff members attended several of those meetings.

Information papers, 17 prepared by the Corps, three by National Marine Fisheries Service, and a graphic depicting the various drawdown alternatives, were provided at all public meetings, and also to meet individual public requests. Each meeting included a "big picture" presentation by a NMFS representative to lay out the reasons behind the many regional fisheries actions, and the John Day Drawdown Study.

Prior to each meeting, *editorial boards* were offered to local newspapers. Five editorial boards were held with: the Oregonian, Portland, Oregon; the Hermiston Herald, near Umatilla, Oregon; the Tri-City Herald, Pasco, Washington; the Goldendale Sentinel, Goldendale, Washington; and the Lewiston Tribune, Lewiston, Idaho. The Juneau Empire turned down the offer of an Editorial Board, but attended the public meeting. The Helena Independent Record was not interested and did not attend the meeting.

News releases were used to announce the Study, and provide information about the public meetings. Media interviews were given on request, with some of those interviews sparked by personal contacts.

Separate discussions, as appropriate, were held with Council members of the Yakama, Warm Springs, Nez Perce and Umatilla tribes, as well as the Columbia River Intertribal Fish Commission. Meetings were held with representatives of the Umatilla Electrical Coop, Pacific NW Project (irrigators/ farmers), IRZ consulting, and port officials as requested.

Congressional staff members attended various workshops, as did representatives of various levels of local, state and federal governments. The project manager attended meetings of regional decision-makers, such as the System Configuration Team, to report on the Study.

Also, a *Planning Aid Team* was formed to analyze and comment on the fisheries aspects of the Study. People attending the public meetings were given the opportunity to volunteer for the PAT. Tribes also were invited to participate, but did not do so. The PAT met during summer 1999 and received and reviewed biological reports.

The U.S. Fish and Wildlife Service was consulted throughout the study and prepared a Planning Aid Letter that analyzes and details the anticipated affects to fish and wildlife resources.

A Study *web site* was established to provide easy access to information for members of the public who like the convenience of electronic information.

During the first series of public meetings sign-in sheets provided attendees the opportunity to request copies of the draft report in one of two forms: on CD or hard copy. Following that series of public meetings, it was decided that an Executive Summary of the draft report would be valuable, and could fulfill the needs of many members of the public for information. To ensure the public received what they really wanted, all on the mailing list received Executive Summaries, and then could make a choice of additional material, as desired: the draft report minus appendices, the draft report with appendices, or the executive summary. The quantity of material in each was noted. The draft report and appendices are online at: http://www.nwp.usace.army.mil/pm/projects/jddds

A news release announcing the public comment period on the draft report also listed ways the report could be obtained and a second expanded series of public meetings.

The second round of public meetings was held in February and March 2000.

Public meetings on the John Day Drawdown Phase I Study only were held in Umatilla, Oregon, and Goldendale, Washington, on Feb. 16 and 24, respectively. At those meetings, displays and information were available, and an overview presentation was given, followed by a comment and question/answer session. In addition, John Day team members participated in 15 additional public meetings in coordination with the Lower Snake River Study/ EIS and the Federal Caucus "All – H" Process (renamed: Salmon Recovery Strategy), plus related studies. Meetings were held: Feb. 3, Portland, Oregon; Feb. 8, Spokane, Washington; Feb 10, Lewiston, Idaho; Feb. 15, Astoria, Oregon; Feb. 17, Pasco, Washington; Feb. 23, Boise, Idaho; Feb. 29, Seattle, Washington; March 1, Kalispell, Montana; March 2, Missoula, Montana; March 6, Ketchikan, Alaska; March 7, Idaho Falls, Idaho; March 7, Sitka, Alaska; March 8, Twin Falls, Idaho; March 8, Juneau, Alaska; and March 9, St. Petersburg, Alaska.

The transcripts of each meeting transcript were searched for comments relating specifically to the John Day Drawdown Study. Those comments are included in the Final Report, Public Involvement/Agency Coordination Appendix.

Editorial boards on the subject of John Day Drawdown were held in Hermiston, Oregon, which serves the Umatilla, Oregon, area, and Goldendale, Washington. Editorial boards were held by Federal Caucus members in many of the other meeting cities.

Based on untimely coverage of the first series of John Day Drawdown public meetings by print media, individual contacts were made with reporters and display ads were purchased in the Hermiston, Oregon, and Goldendale, Washington, newspapers. Also, because those requests could not ensure timely coverage, display ads were purchased in both newspapers.

John Day Study team members staffed a booth in the open house portion of each meeting to discuss the Study with the public. The Alaska sessions were the exception to that policy, as no open house sessions were held there. During the second series of public meetings, signup sheets provided attendees the opportunity to request copies of the final report in one of two forms: on CD or hard copy.

Final Report: Comments on the draft report were received orally at public meetings, and in written form, both via the postal service and by electronic mail. All comments submitted were considered as the final report was prepared. In some cases, changes were made in the final report to reflect new or additional information provided by the public, interest groups and government agencies.

In general, comments were overwhelmingly in support of eliminating further study of John Day Drawdown. There were some requests, however, for further study. Oral comment transcripts, written comments and an overall comment summary are included as part of the Public Involvement/Agency Coordination Appendix in the final report.

Neither economic nor biological findings support further study of drawdown. The recommendation for no further study, which was made in the draft report, was not changed in the final report.

The final report and appendices can be found online at:
http://www.nwp.usace.army.mil/pm/projects/jddds

The public involvement process for the Phase I Study provided involvement opportunities for the general public, tribes, congressional offices, special interest groups/organizations, state and federal agencies, counties, cities, ports, the System Configuration Team, and the Northwest Power Planning Council.

SECTION 12. Recommendations

After assessing the potential biological benefits and economic costs, the recommendation is that no further study is required for Congress and the Region to decide on drawdown of the John Day Reservoir, or removal of the John Day Dam.

The Phase I Study indicated that drawdown of the John Day Reservoir contributes little to the probability of survival and recovery of listed Snake River stocks.

Effects on Upper Columbia stocks vary widely. Survival and numbers of endangered Upper Columbia spring chinook would likely increase. The population level of the healthy and commercially important Hanford Reach upriver bright fall chinook stock, however, would likely decrease.

Significant short-term loss of riparian, wetland, and shallow water habitats would result in direct and often immediate negative impacts to wildlife, particularly at the Umatilla National Wildlife refuge and other wildlife management areas.

The up-front costs to achieve drawdown range from $2.0 billion to $4.7 billion depending on the alternative. The total annual costs range from $403 million to $673 million, averaged over a period of 100 years.

The effects of all four alternatives on fish were evaluated in this study, and the maximum potential fisheries benefits were considered in formulating a recommendation. The maximum benefits to threatened and endangered Snake River and Upper Columbia chinook salmon species are derived from drawdown to natural river without flood control. Refined benefit estimates that would be developed during a Phase II Study are likely to be substantially less than those reported, further supporting the recommendation not to proceed with Phase II. While the magnitude of all major impacts has been identified in the Phase I Study, additional studies also could refine the economic impacts associated with drawdown. The cost, or economic impact, however, would likely increase from what is presented in this report, therefore further supporting the recommendation not to continue with John Day Drawdown studies.

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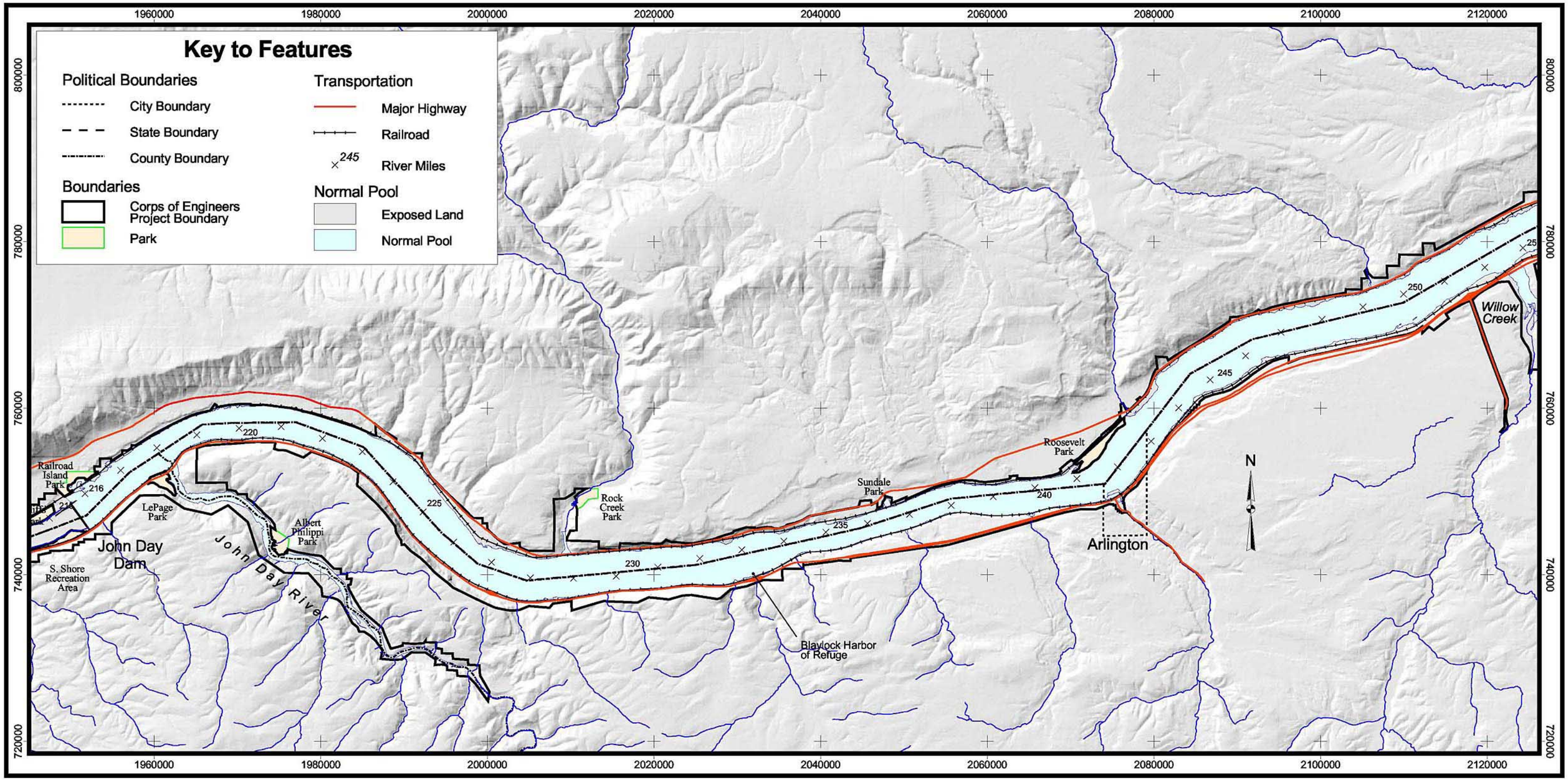


Projection: State Plane, Oregon North Zone, NAD 27
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

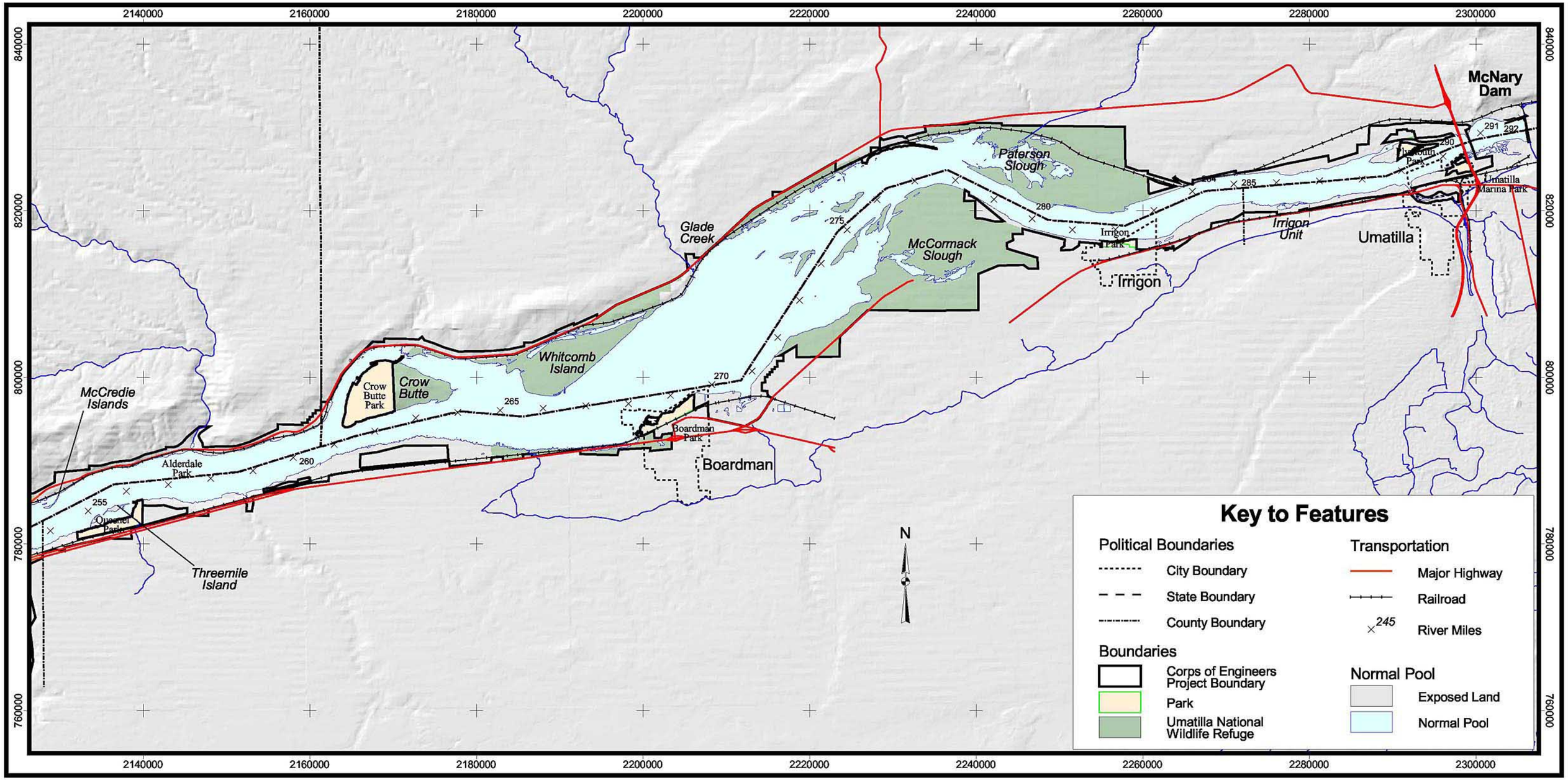
2 0 2 4 6 Miles

US Army Corps of Engineers
Portland District

JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

Study Area Overview Map

Plate 1



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Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

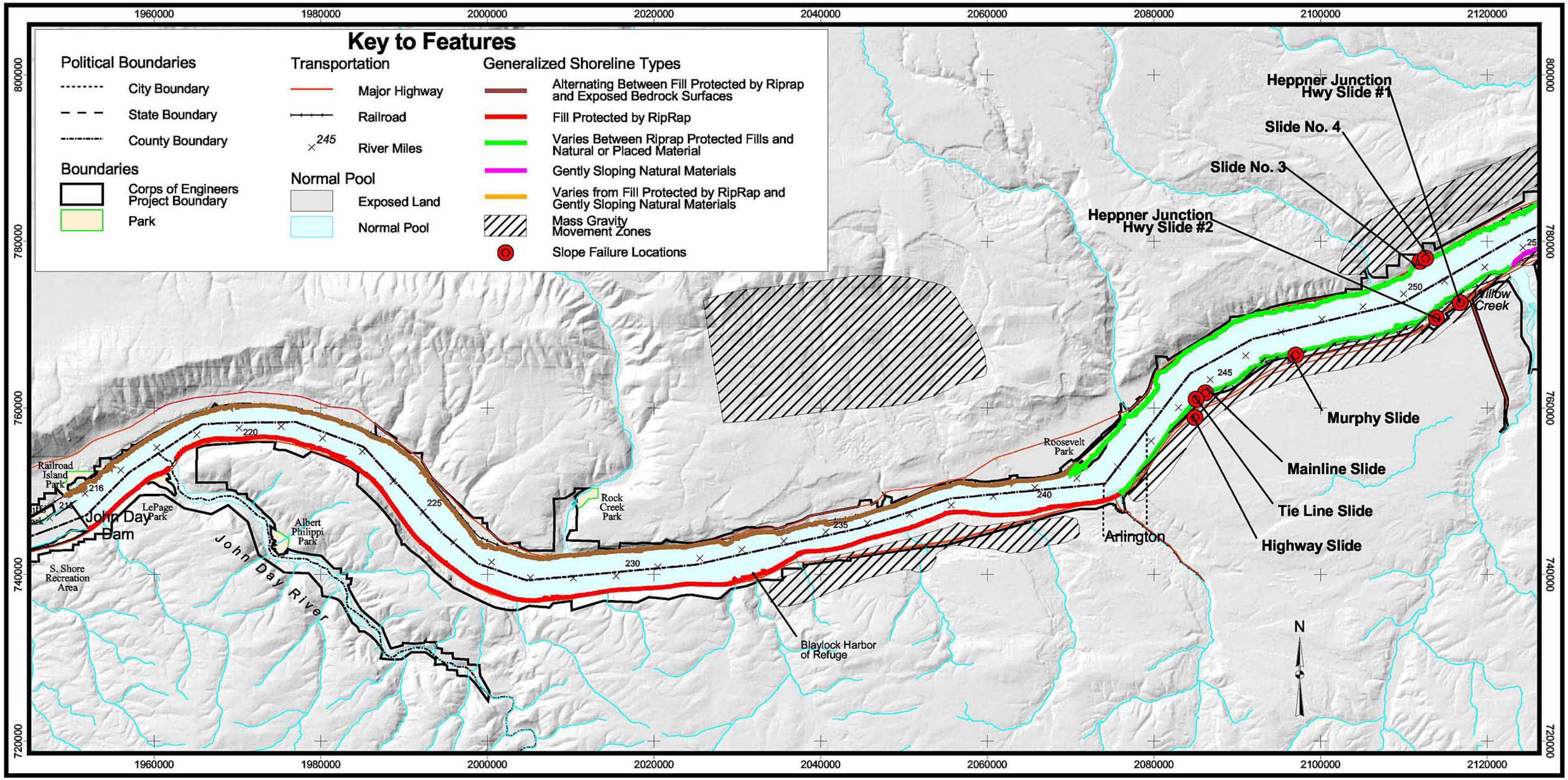
2 0 2 4 6 Miles

US Army Corps of Engineers
Portland District

JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

Study Area Overview Map

Plate 2



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Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

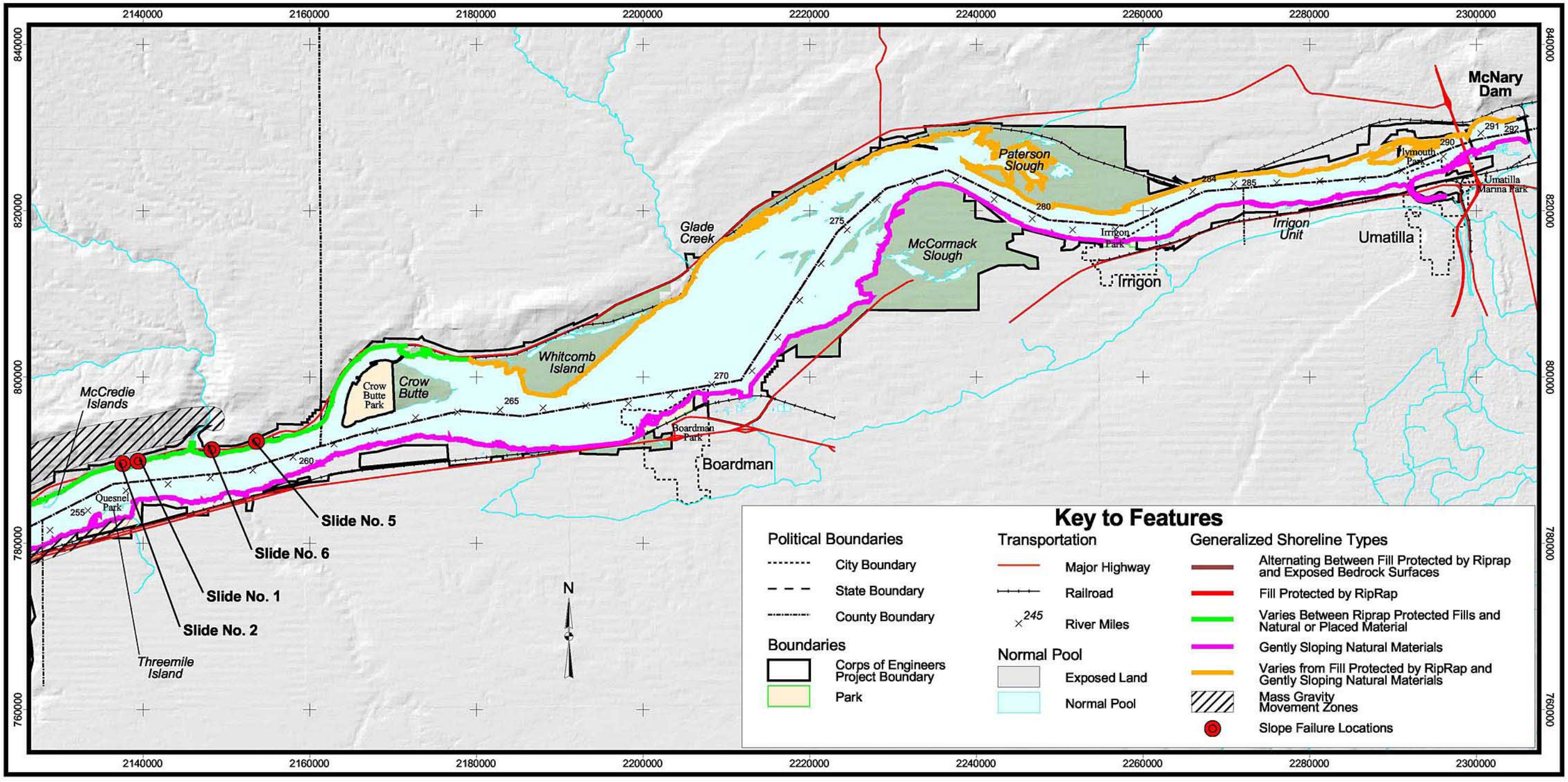
2 0 2 4 6 Miles

US Army Corps of Engineers
Portland District

JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

Generalized Shoreline Description and Location of Slope Failures

Plate 3



Projection: State Plane, Oregon North Zone, NAD 27
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

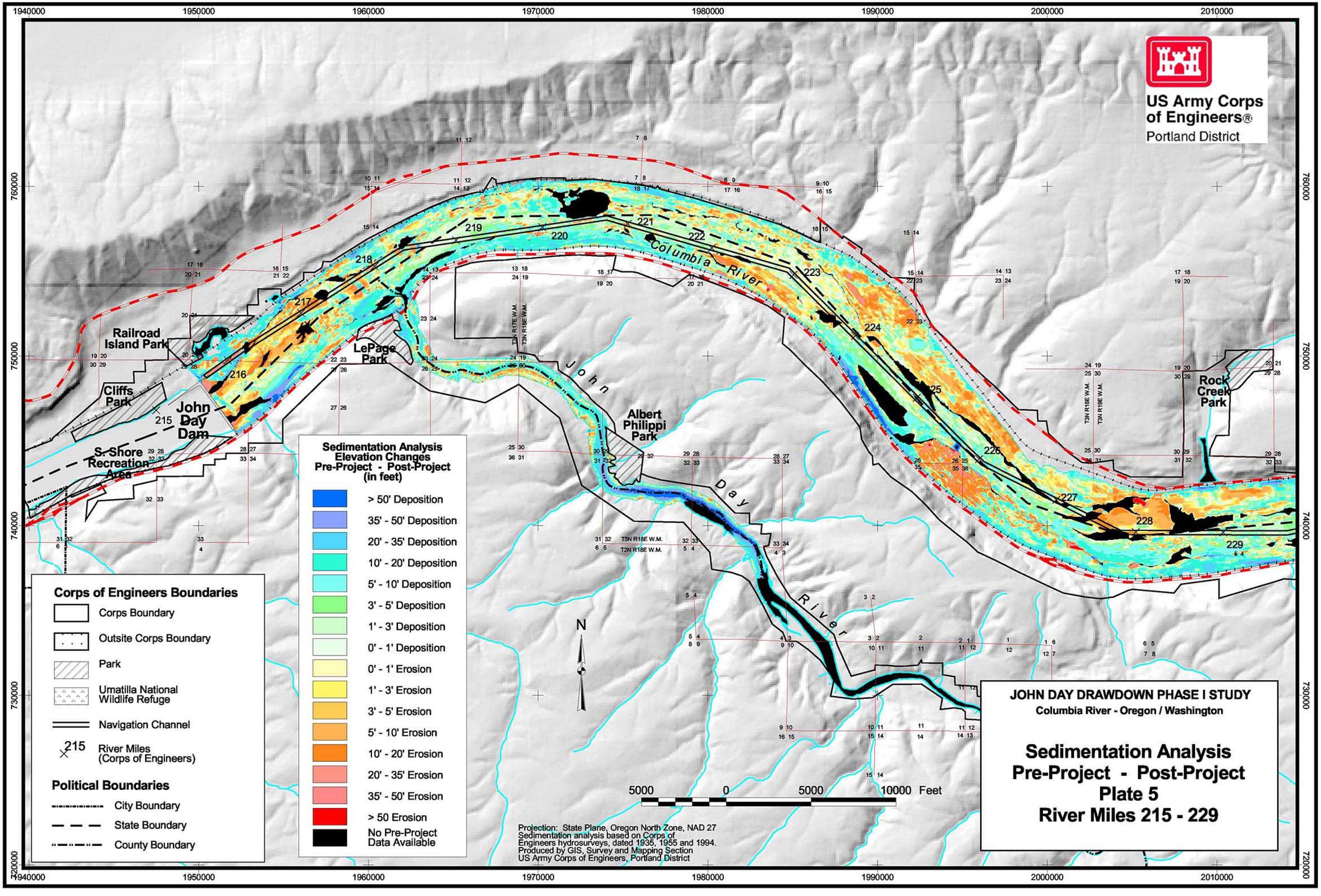
2 0 2 4 6 Miles

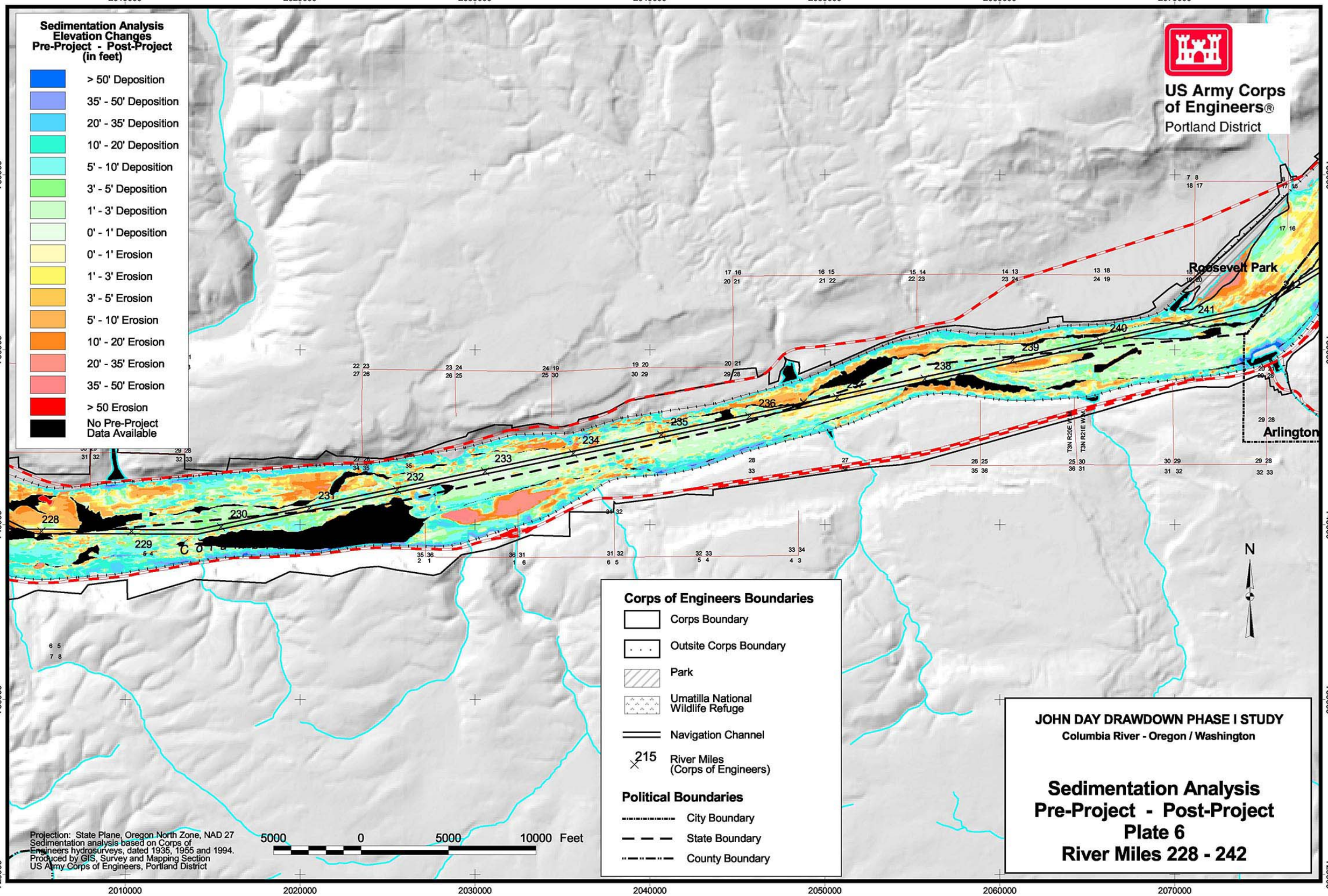
US Army Corps of Engineers
Portland District

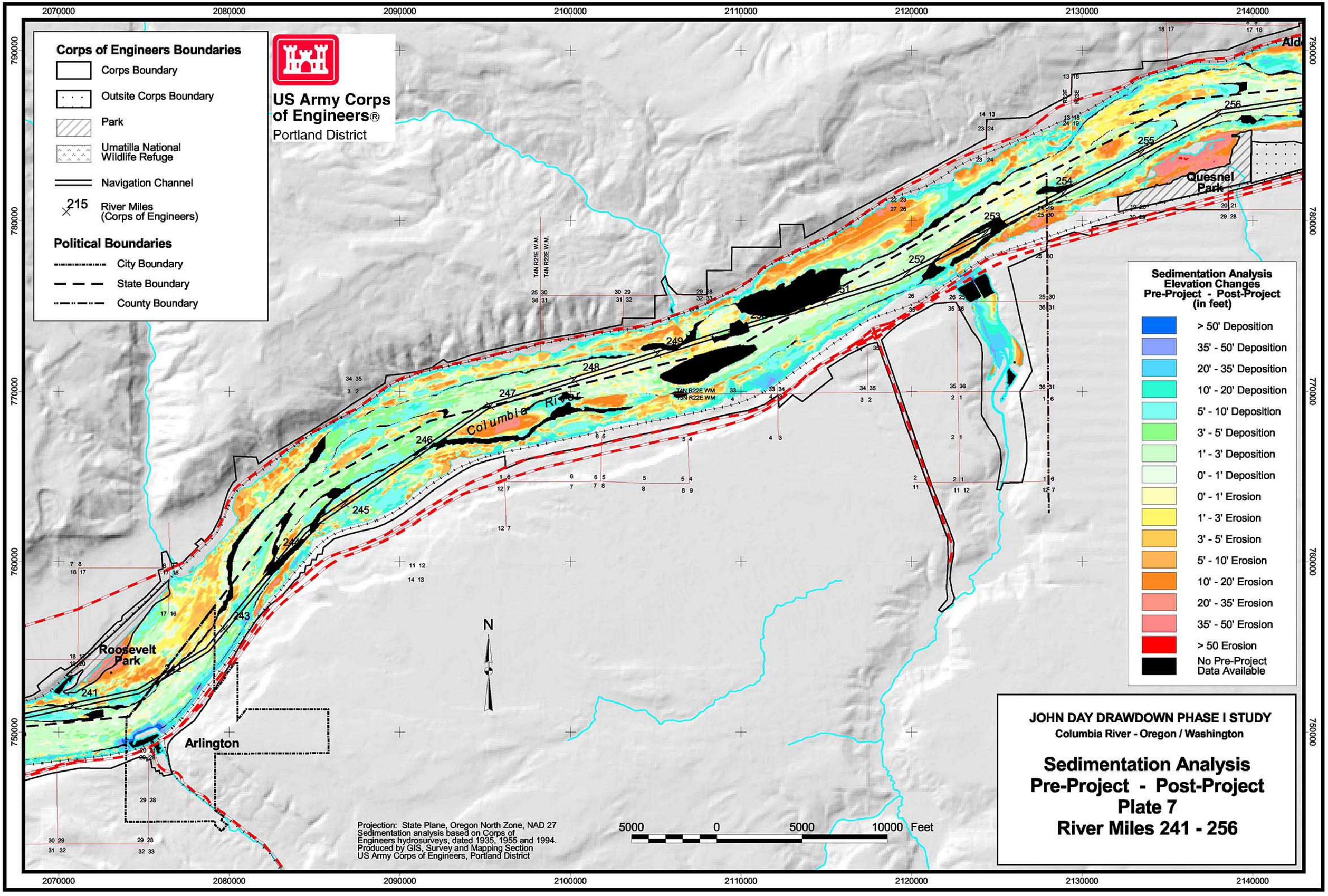
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

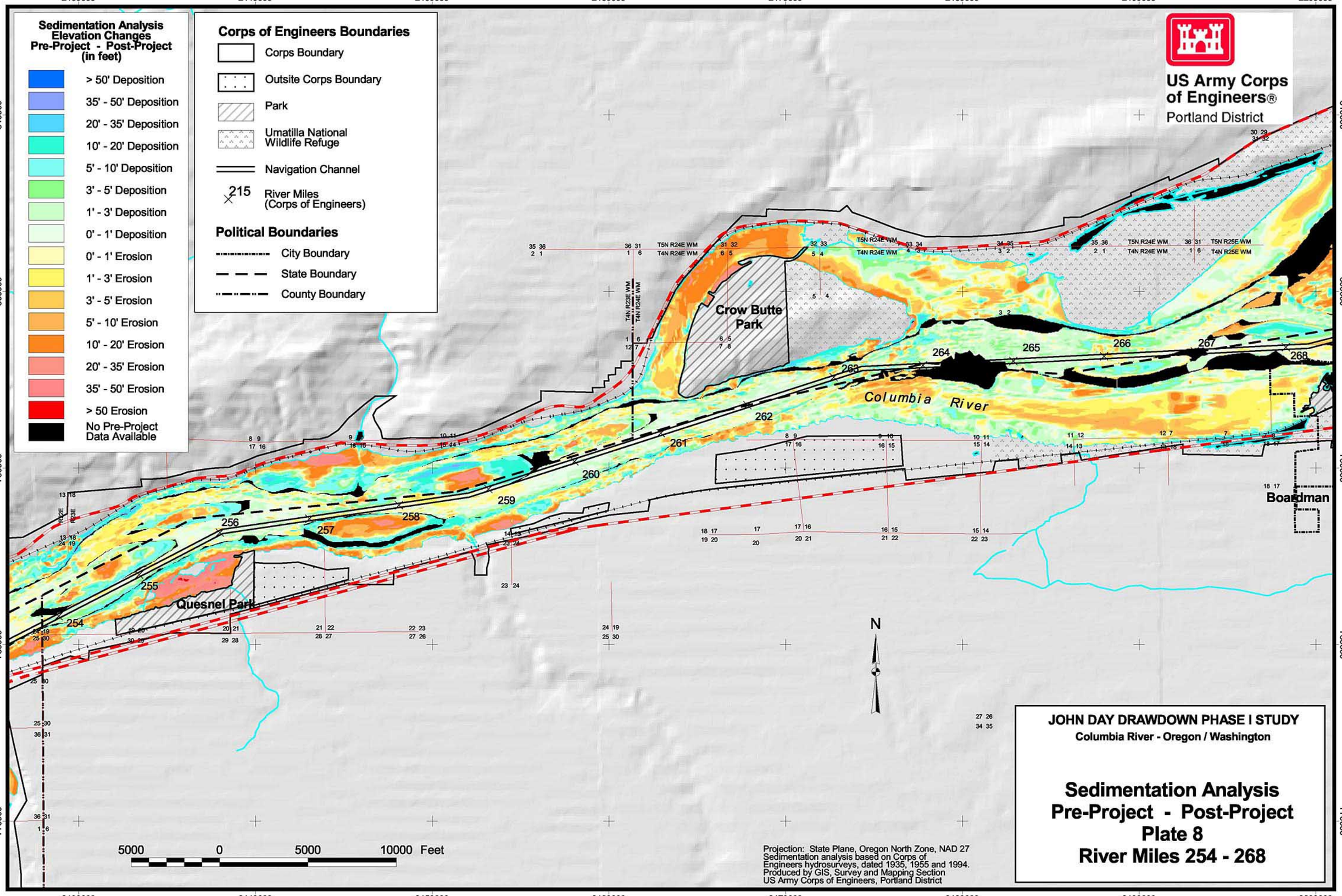
Generalized Shoreline Description and Location of Slope Failures

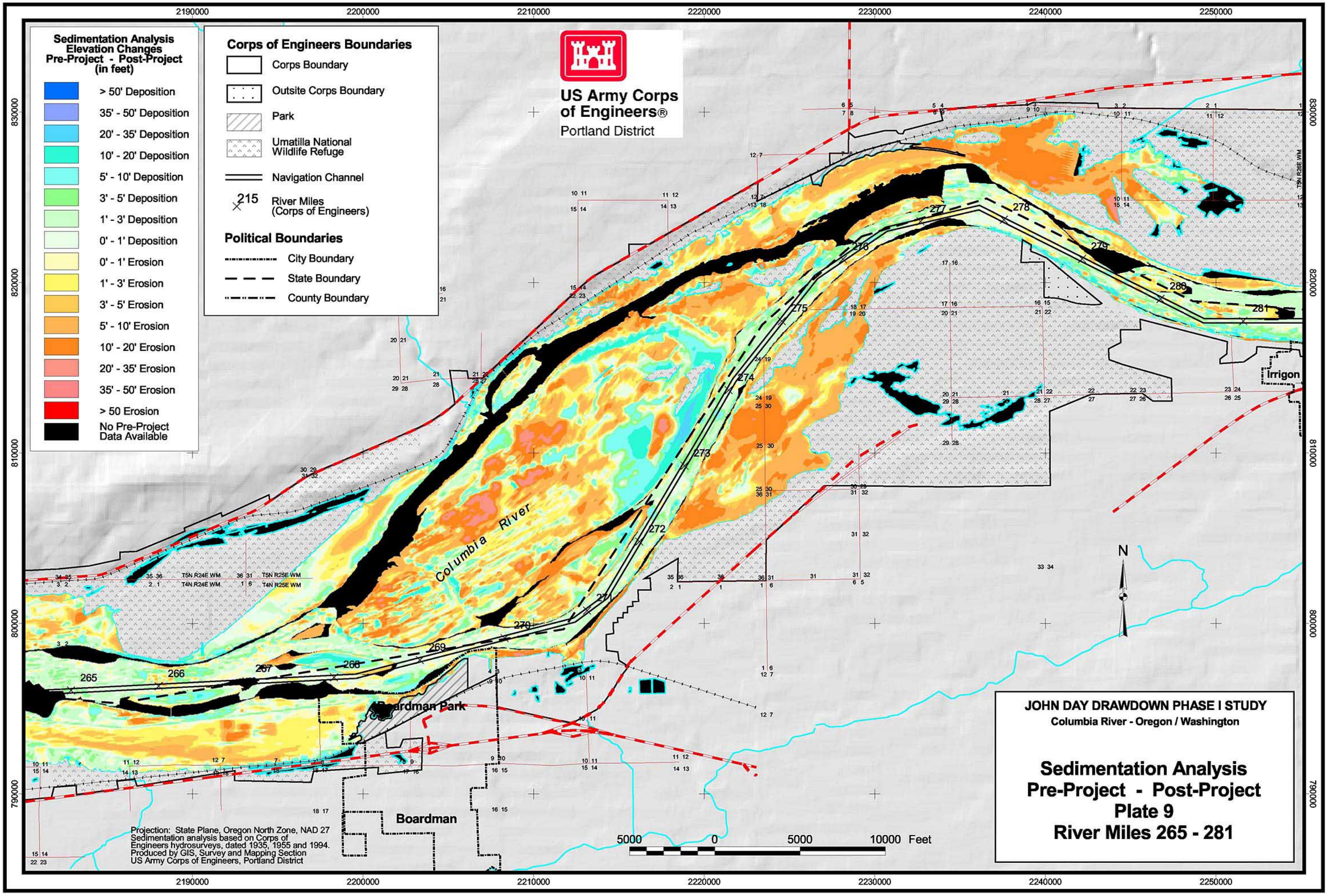
Plate 4

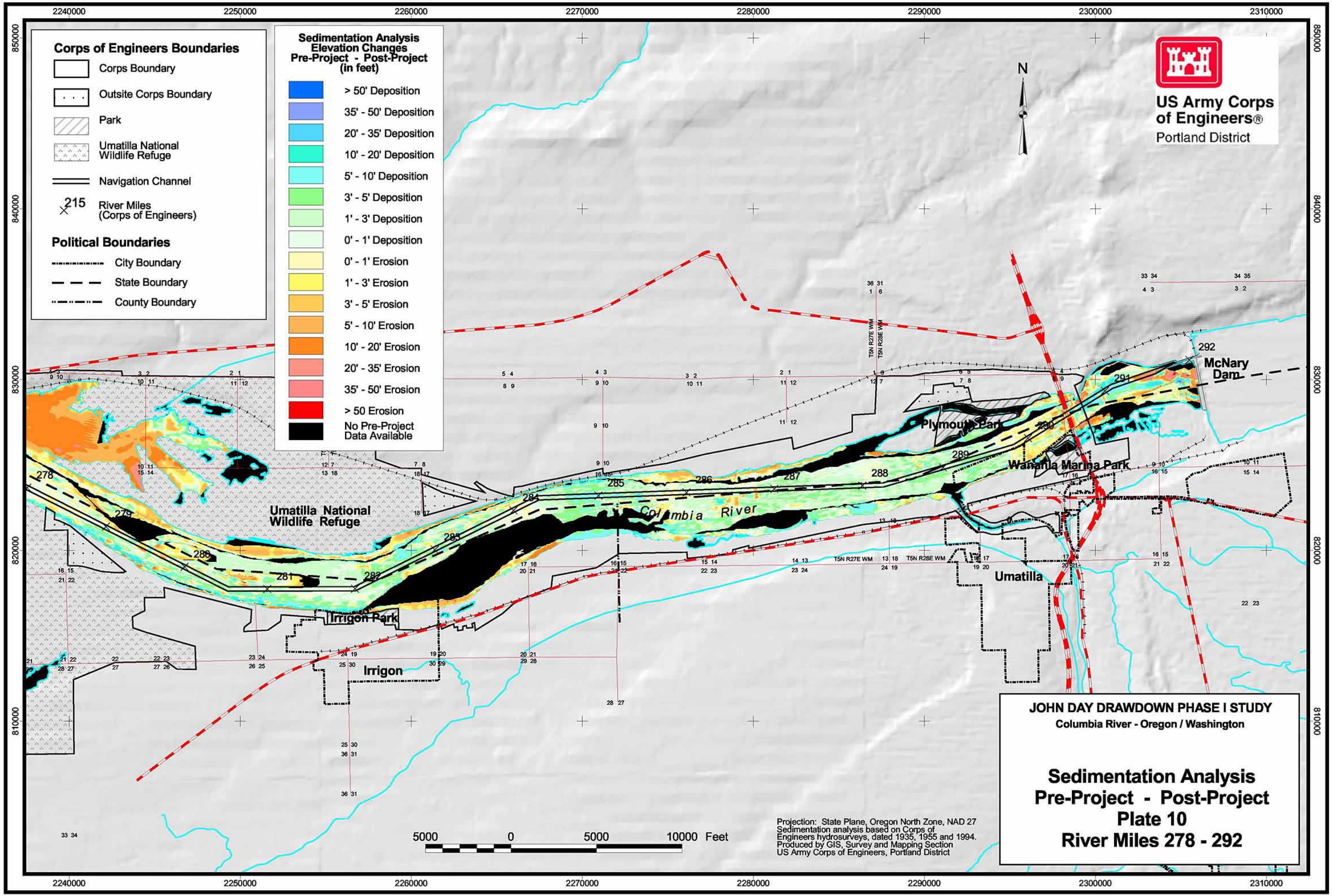

US Army Corps of Engineers®
Portland District
Columbia River
John Day River
Railroad Island Park
Cliffs Park
John Day Dam
S. Shore Recreation Area
LePage Park
Albert Philippi Park
Rock Creek Park
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
T3N R17E W.M.
T3N R18E W.M.
T2N R18E W.M.
Sedimentation Analysis
Elevation Changes
Pre-Project - Post-Project
(in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
N
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 5
River Miles 215 - 229


Sedimentation Analysis
Elevation Changes
Pre-Project - Post-Project
(in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
US Army Corps of Engineers®
Portland District
Roosevelt Park
Arlington
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
N
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 6
River Miles 228 - 242


Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers®
Portland District
Sedimentation Analysis Elevation Changes Pre-Project - Post-Project (in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
Columbia River
Roosevelt Park
Arlington
Quesnel Park
N
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 7
River Miles 241 - 256


Sedimentation Analysis
Elevation Changes
Pre-Project - Post-Project
(in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers®
Portland District
Crow Butte Park
Quesnel Park
Columbia River
Boardman
N
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 8
River Miles 254 - 268


Sedimentation Analysis
Elevation Changes
Pre-Project - Post-Project
(in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers®
Portland District
Columbia River
Boardman Park
Boardman
Irrigon
T5N R24E WM
T4N R24E WM
T5N R25E WM
T4N R25E WM
T5N R26E WM
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
N
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 9
River Miles 265 - 281
2190000
2200000
2210000
2220000
2230000
2240000
2250000
830000
820000
810000
800000
790000


Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
Sedimentation Analysis Elevation Changes Pre-Project - Post-Project (in feet)
> 50' Deposition
35' - 50' Deposition
20' - 35' Deposition
10' - 20' Deposition
5' - 10' Deposition
3' - 5' Deposition
1' - 3' Deposition
0' - 1' Deposition
0' - 1' Erosion
1' - 3' Erosion
3' - 5' Erosion
5' - 10' Erosion
10' - 20' Erosion
20' - 35' Erosion
35' - 50' Erosion
> 50 Erosion
No Pre-Project Data Available
N
US Army Corps of Engineers®
Portland District
McNary Dam
Plymouth Park
Wanapa Marina Park
Umatilla
Columbia River
Umatilla National Wildlife Refuge
Irrigon Park
Irrigon
T5N R27E WM
T5N R28E WM
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Sedimentation analysis based on Corps of Engineers hydrosurveys, dated 1935, 1955 and 1994.
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
Sedimentation Analysis
Pre-Project - Post-Project
Plate 10
River Miles 278 - 292

US Army Corps of Engineers®
Portland District

Goldendale Aluminum

Railroad Island Park

LePage Park

Cliffs Park

John Day Dam

S. Shore Recreation Area

WS (1)

WS (2)

Albert Philippi Park

Rock Creek Park

Columbia River

John Day River

T3N R17E W.M.
T3N R18E W.M.
T3N R19E W.M.
T2N R18E W.M.

N

5000 0 5000 10000 Feet

Key to Features

WS Water Supply

Pumpstations and Utilities

215 River Miles (Corps of Engineers)

Political Boundaries

City Boundary

State Boundary

County Boundary

Corps of Engineers Boundaries

Corps Boundary

Outsite Corps Boundary

Park

Umatilla National Wildlife Refuge

Navigation Channel

Pool Extents

Normal Pool

Spillway Crest at 75k cfs

Natural River at 75k cfs

Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP

River Miles 215 - 229

PLATE 11

US Army Corps of Engineers®
Portland District

N

Harris Farms Pump Station

Roosevelt Park

Rock Creek Park

Arlington

Columbia River

228 229 230 231 232 233 234 235 236 237 238 239 240 241

Key to Features

- WS — Water Supply
- Pumpstations and Utilities
- 215 — River Miles (Corps of Engineers)

Political Boundaries

- City Boundary
- State Boundary
- County Boundary

Corps of Engineers Boundaries

- Corps Boundary
- Outsite Corps Boundary
- Park
- Umatilla National Wildlife Refuge
- Navigation Channel

Pool Extents

- Normal Pool
- Spillway Crest at 75k cfs
- Natural River at 75k cfs

Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

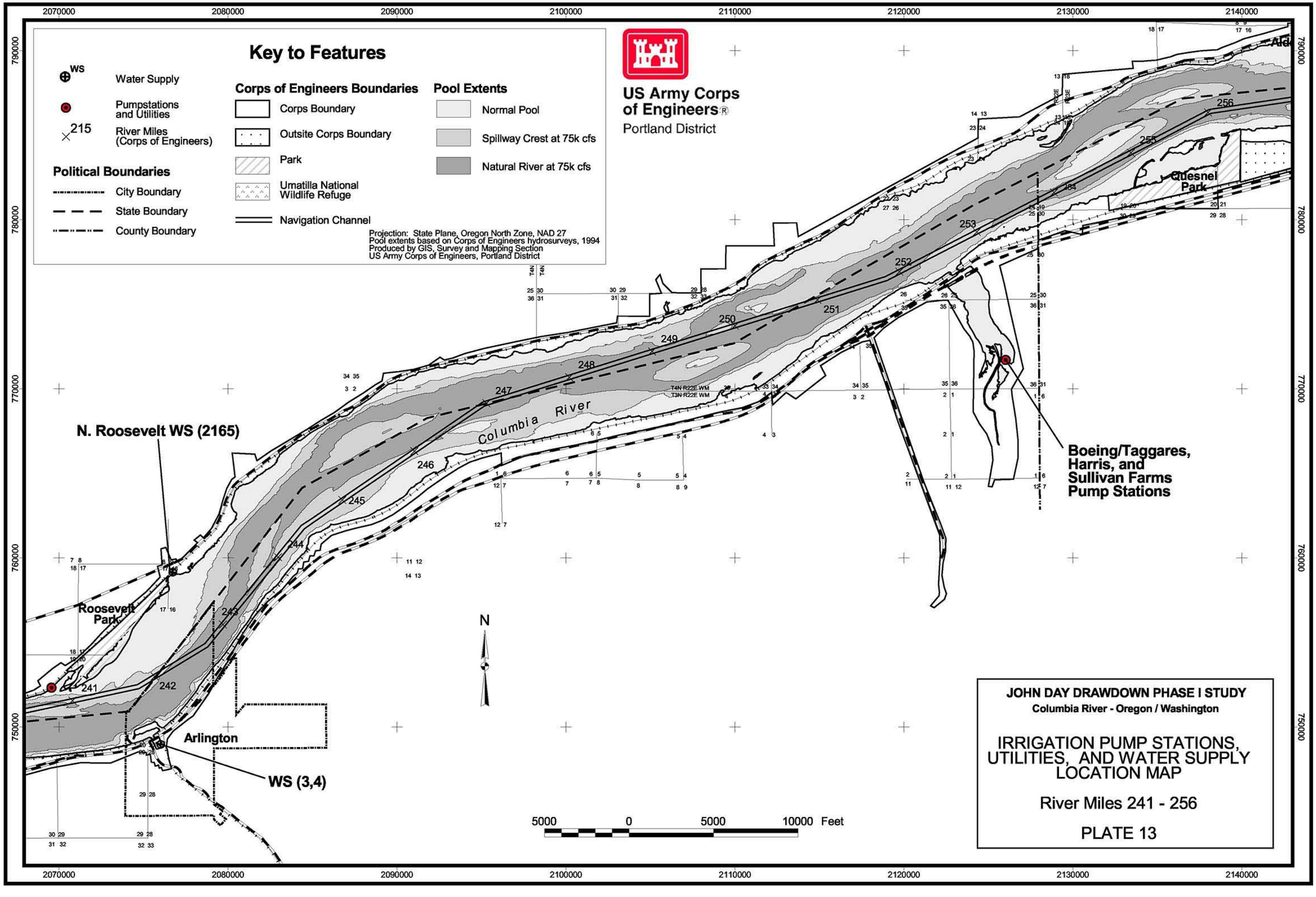
5000 0 5000 10000 Feet

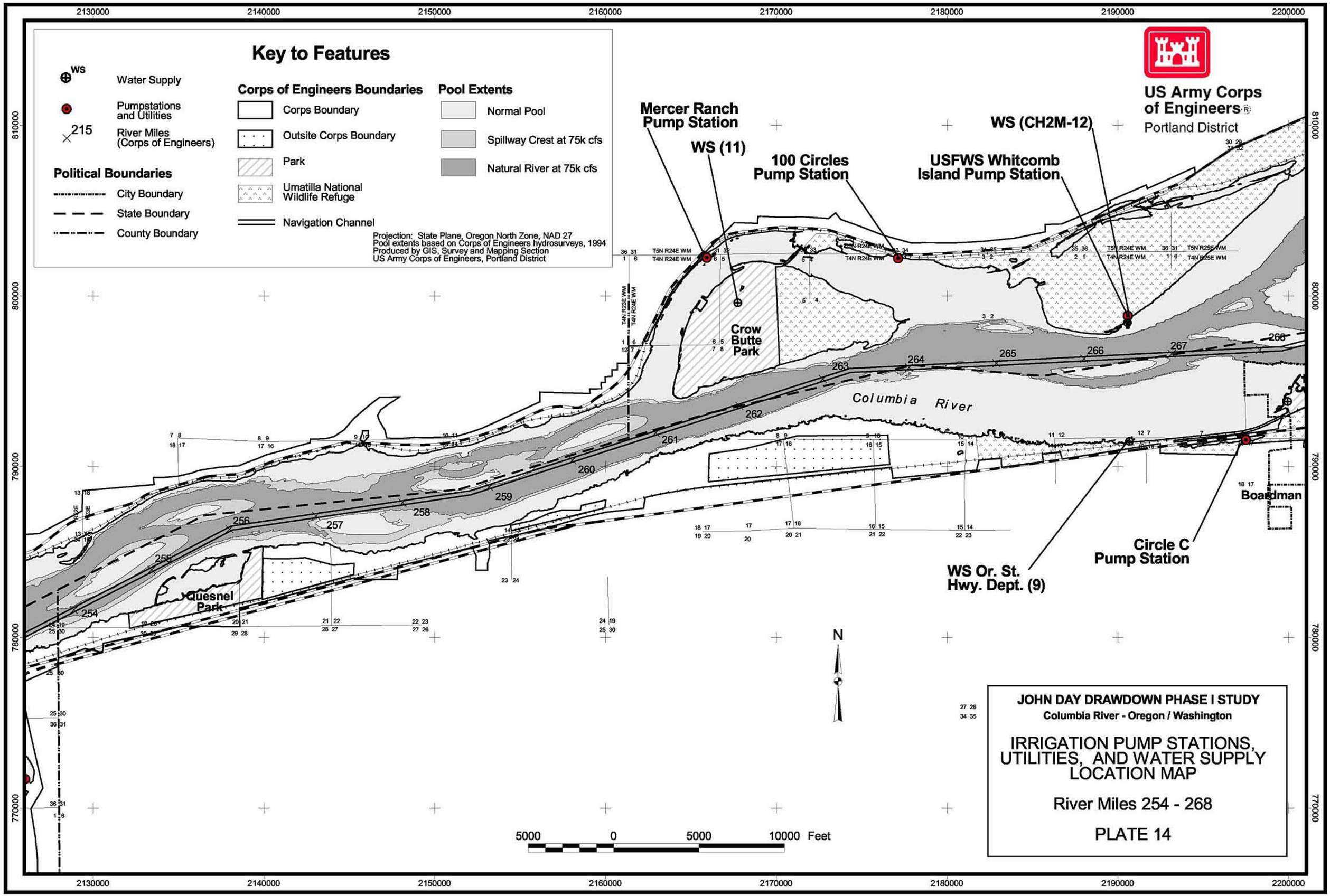
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

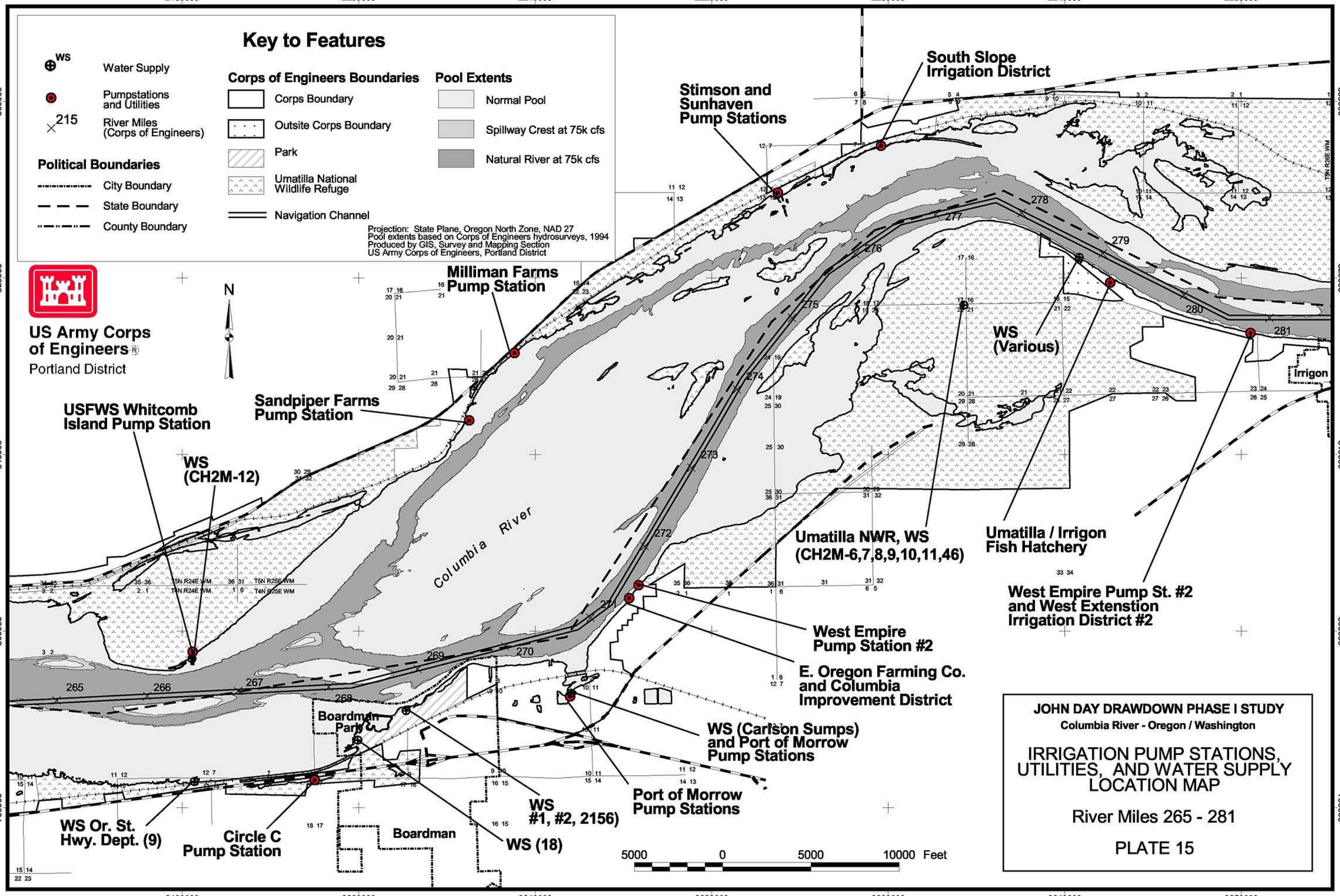
IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP

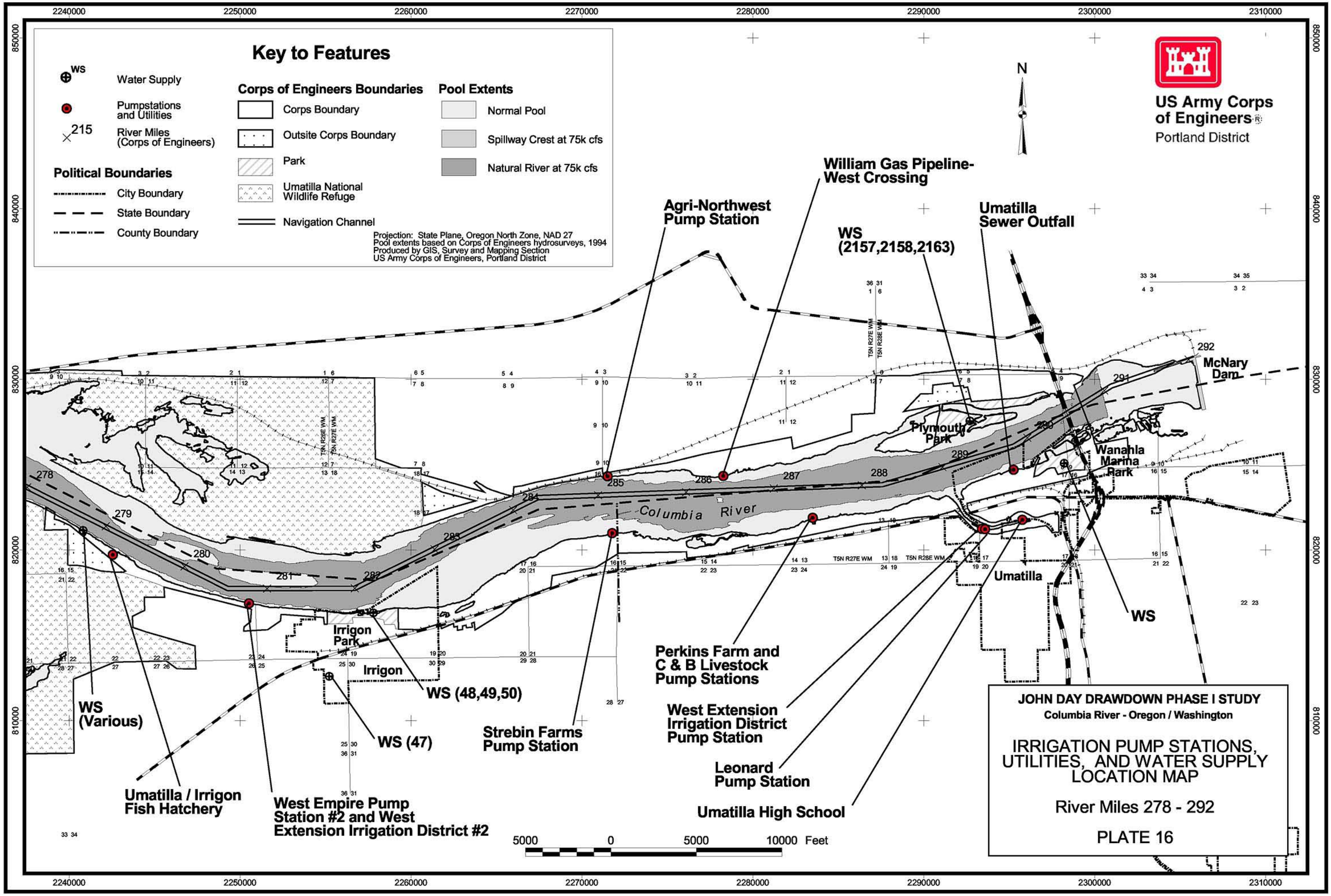
River Miles 228 - 242

PLATE 12


Key to Features
Water Supply
Pumpstations and Utilities
215 River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
US Army Corps of Engineers®
Portland District
Columbia River
N. Roosevelt WS (2165)
Roosevelt Park
Arlington
WS (3,4)
Quesnel Park
Boeing/Taggares, Harris, and Sullivan Farms Pump Stations
N
5000 0 5000 10000 Feet
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP
River Miles 241 - 256
PLATE 13


Key to Features
Water Supply
Pumpstations and Utilities
River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
US Army Corps of Engineers
Portland District
Mercer Ranch Pump Station
WS (11)
100 Circles Pump Station
USFWS Whitcomb Island Pump Station
WS (CH2M-12)
Crow Butte Park
Columbia River
Quesnel Park
WS Or. St. Hwy. Dept. (9)
Circle C Pump Station
Boardman
N
5000 0 5000 10000 Feet
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP
River Miles 254 - 268
PLATE 14


Key to Features
Water Supply
Pumpstations and Utilities
River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
US Army Corps of Engineers
Portland District
N
South Slope Irrigation District
Stimson and Sunhaven Pump Stations
Milliman Farms Pump Station
Sandpiper Farms Pump Station
USFWS Whitcomb Island Pump Station
WS (CH2M-12)
WS (Various)
Irrigon
Umatilla NWR, WS (CH2M-6,7,8,9,10,11,46)
Umatilla / Irrigon Fish Hatchery
West Empire Pump St. #2 and West Extenstion Irrigation District #2
West Empire Pump Station #2
E. Oregon Farming Co. and Columbia Improvement District
WS (Carlson Sumps) and Port of Morrow Pump Stations
Port of Morrow Pump Stations
WS #1, #2, 2156)
WS (18)
Boardman Park
Boardman
WS Or. St. Hwy. Dept. (9)
Circle C Pump Station
Columbia River
5000 0 5000 10000 Feet
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP
River Miles 265 - 281
PLATE 15


Key to Features
Water Supply
Pumpstations and Utilities
River Miles (Corps of Engineers)
Political Boundaries
City Boundary
State Boundary
County Boundary
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
N
US Army Corps of Engineers
Portland District
William Gas Pipeline-West Crossing
Agri-Northwest Pump Station
WS (2157,2158,2163)
Umatilla Sewer Outfall
McNary Dam
Plymouth Park
Wanahla Marina Park
Columbia River
Umatilla
WS
Irrigon Park
Irrigon
WS (48,49,50)
WS (Various)
WS (47)
Strebin Farms Pump Station
Perkins Farm and C & B Livestock Pump Stations
West Extension Irrigation District Pump Station
Leonard Pump Station
Umatilla High School
Umatilla / Irrigon Fish Hatchery
West Empire Pump Station #2 and West Extension Irrigation District #2
5000 0 5000 10000 Feet
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
IRRIGATION PUMP STATIONS, UTILITIES, AND WATER SUPPLY LOCATION MAP
River Miles 278 - 292
PLATE 16

US Army Corps of Engineers®
Portland District

Goldendale Aluminum

Railroad Island Park

Cliffs Park

S. Shore Recreation Area

John Day Dam

LePage Park

Albert Philippi Park

Rock Creek Park

Columbia River

John Day River

T3N R17E W.M.
T3N R18E W.M.
T3N R19E W.M.
T2N R18E W.M.

N

Key to Features

HTRW Listings
- CERCLIS
- EPCRA TRI
- NPDES
- OR ECSI
- UST
- WA CSCS

Corps of Engineers Boundaries
- Corps Boundary
- Outsite Corps Boundary
- Park
- Umatilla National Wildlife Refuge
- Navigation Channel
- 215 River Miles (Corps of Engineers)

Pool Extents
- Normal Pool
- Spillway Crest at 75k cfs
- Natural River at 75k cfs

Political Boundaries
- City Boundary
- State Boundary
- County Boundary

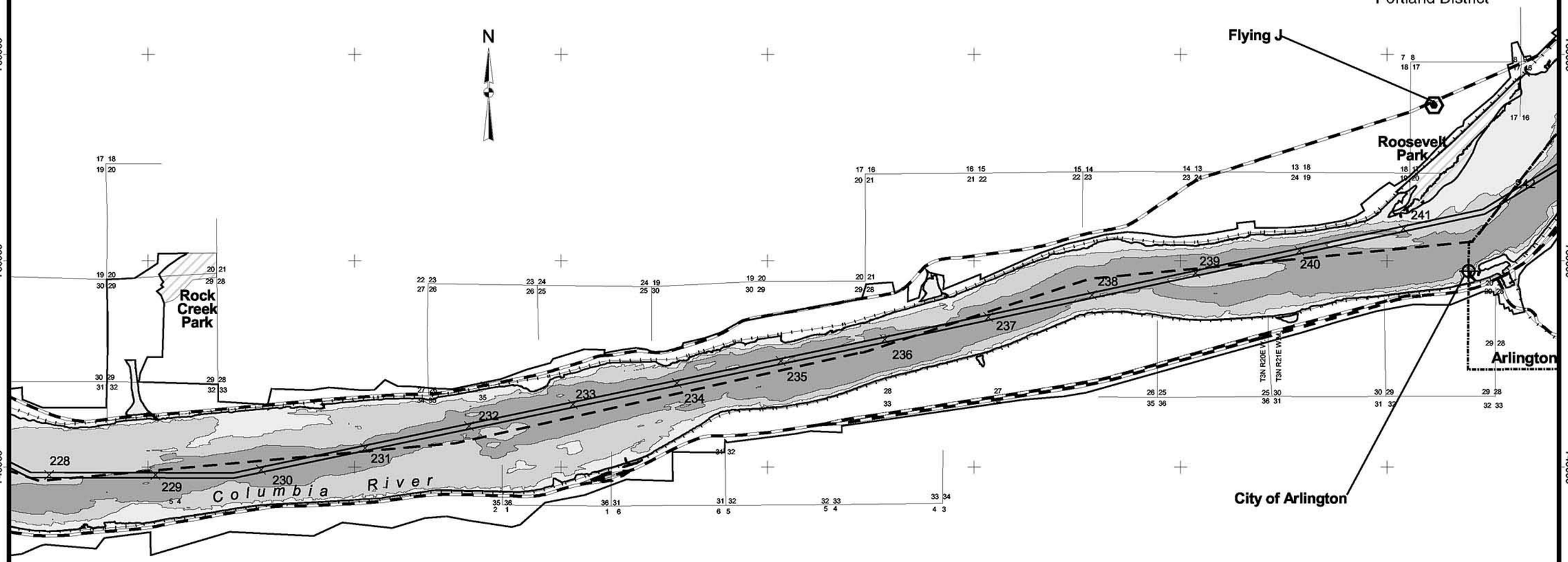
5000 0 5000 10000 Feet

Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

HTRW Sites
Plate 17
River Miles 215 - 229

US Army Corps of Engineers®
Portland District



Key to Features

HTRW Listings
- CERCLIS
- EPCRA TRI
- NPDES
- OR ECSI
- UST
- WA CSCS

Corps of Engineers Boundaries
- Corps Boundary
- Outsite Corps Boundary
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- 215 River Miles (Corps of Engineers)

Pool Extents
- Normal Pool
- Spillway Crest at 75k cfs
- Natural River at 75k cfs

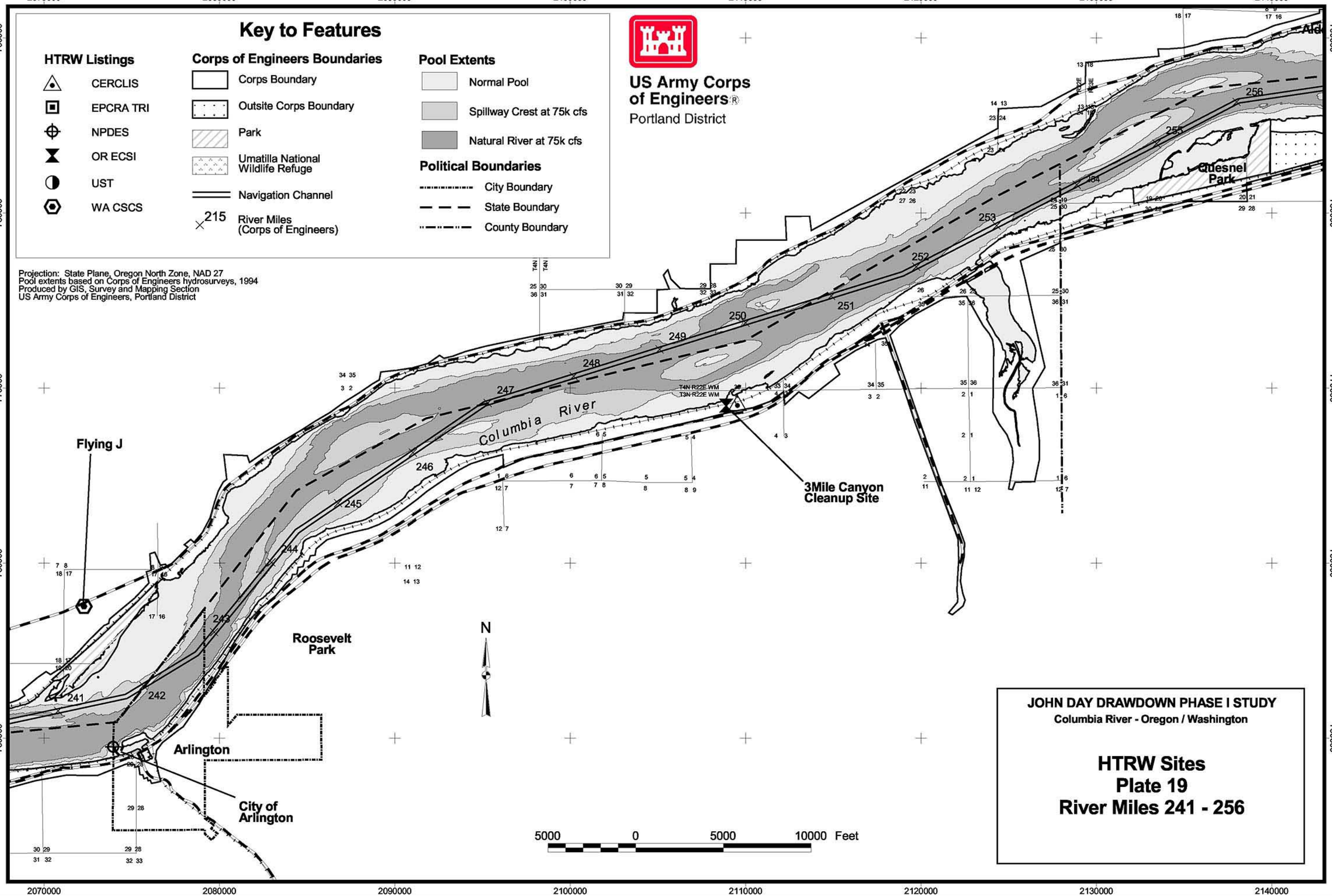
Political Boundaries
- City Boundary
- State Boundary
- County Boundary

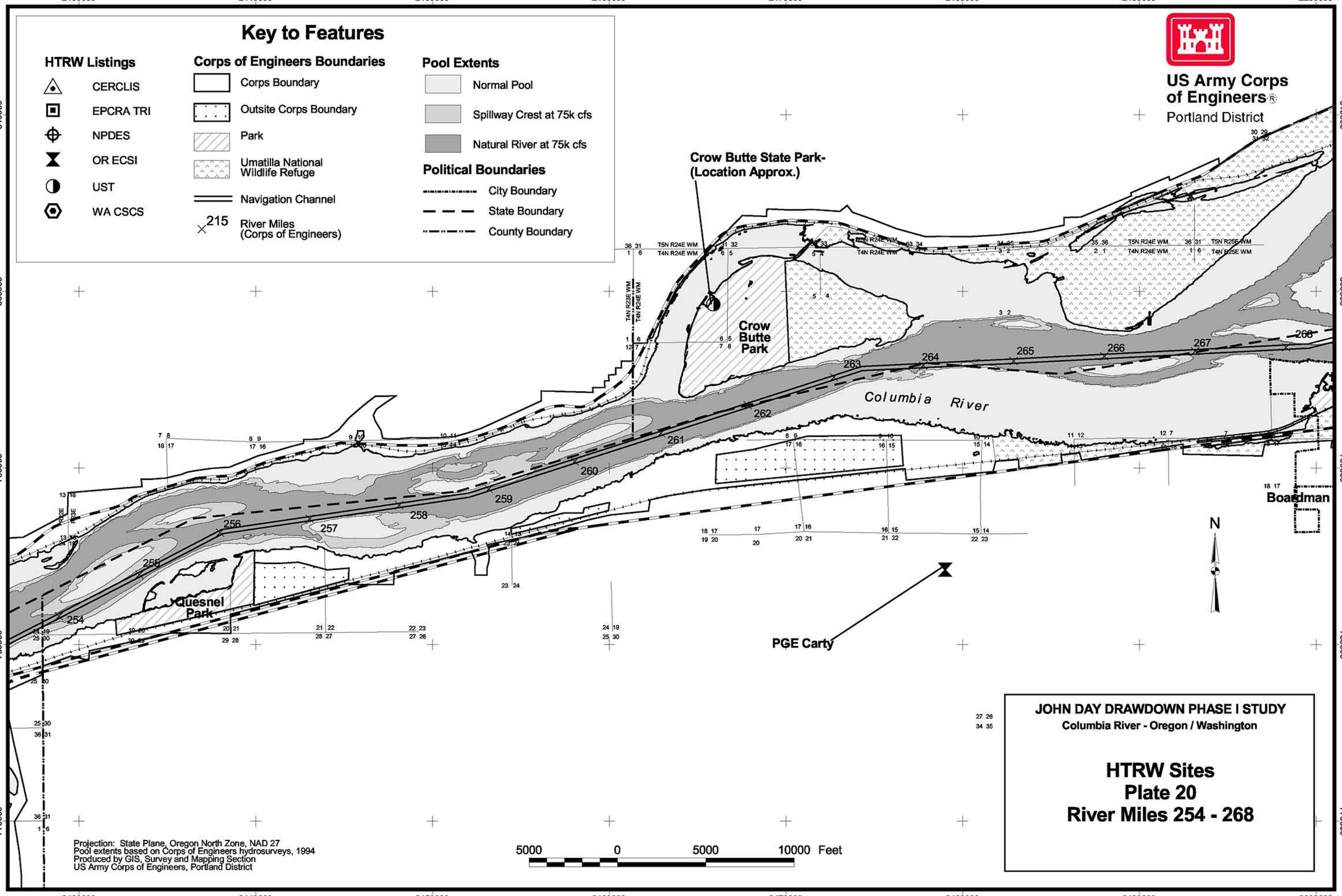
5000 0 5000 10000 Feet

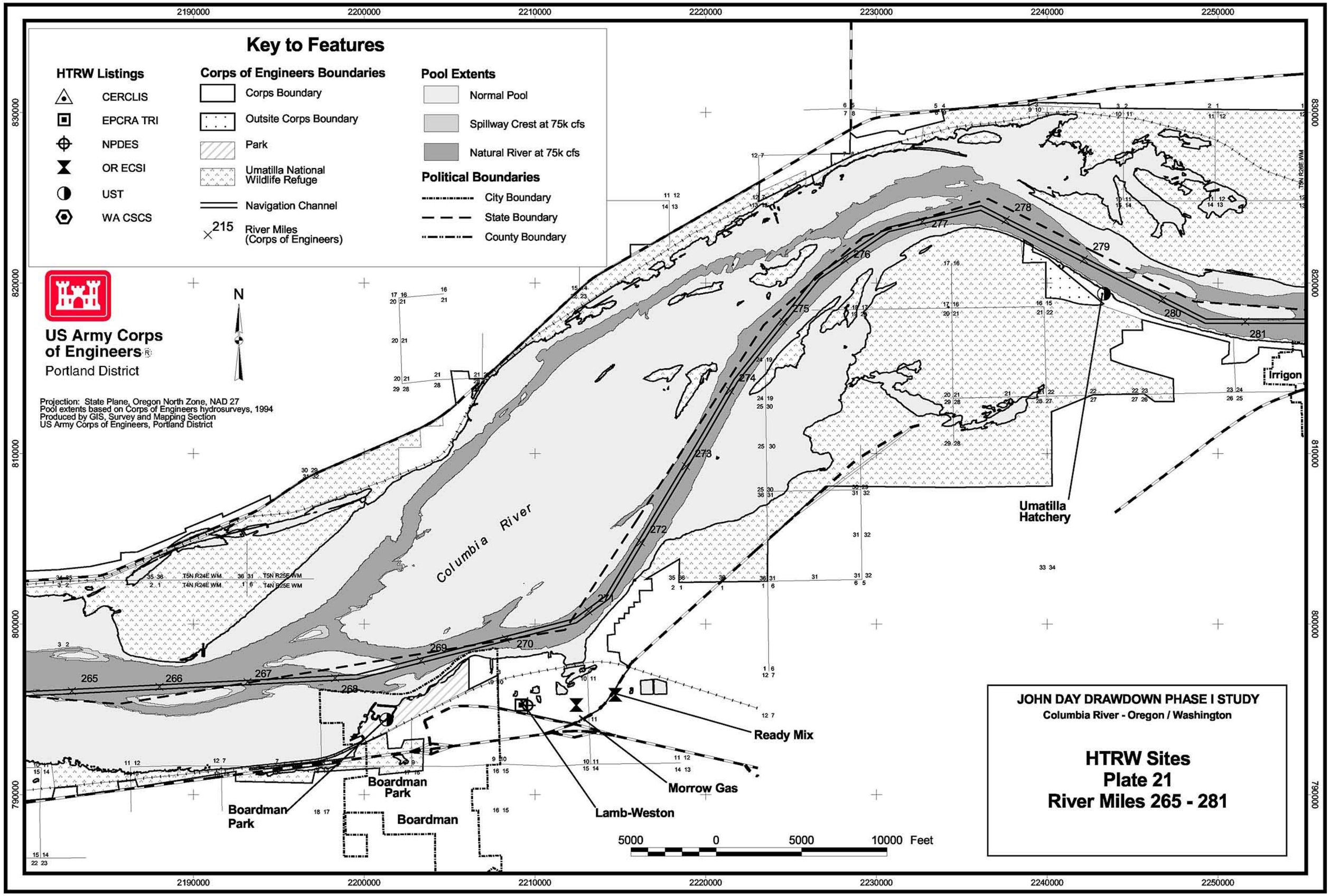
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District

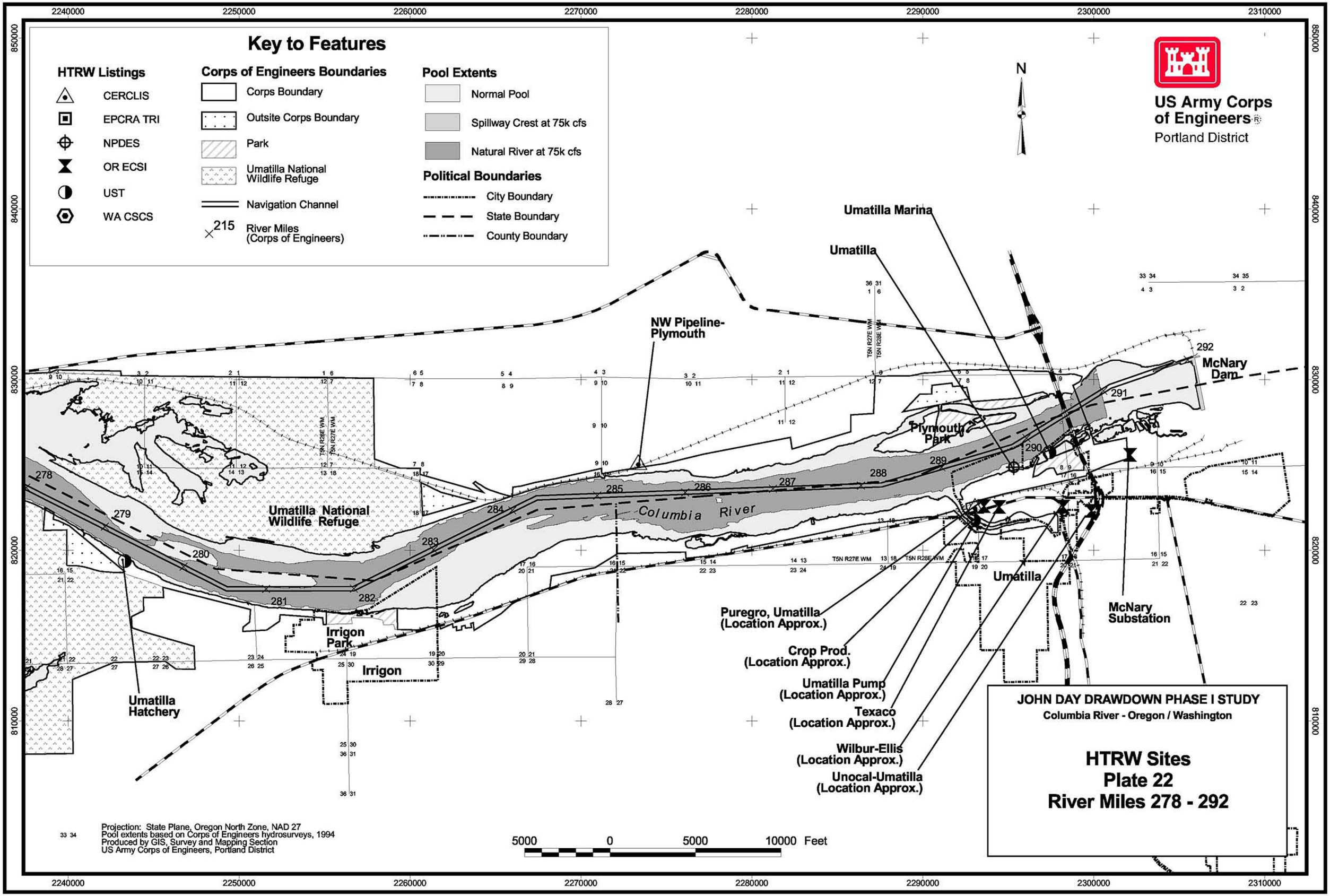
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

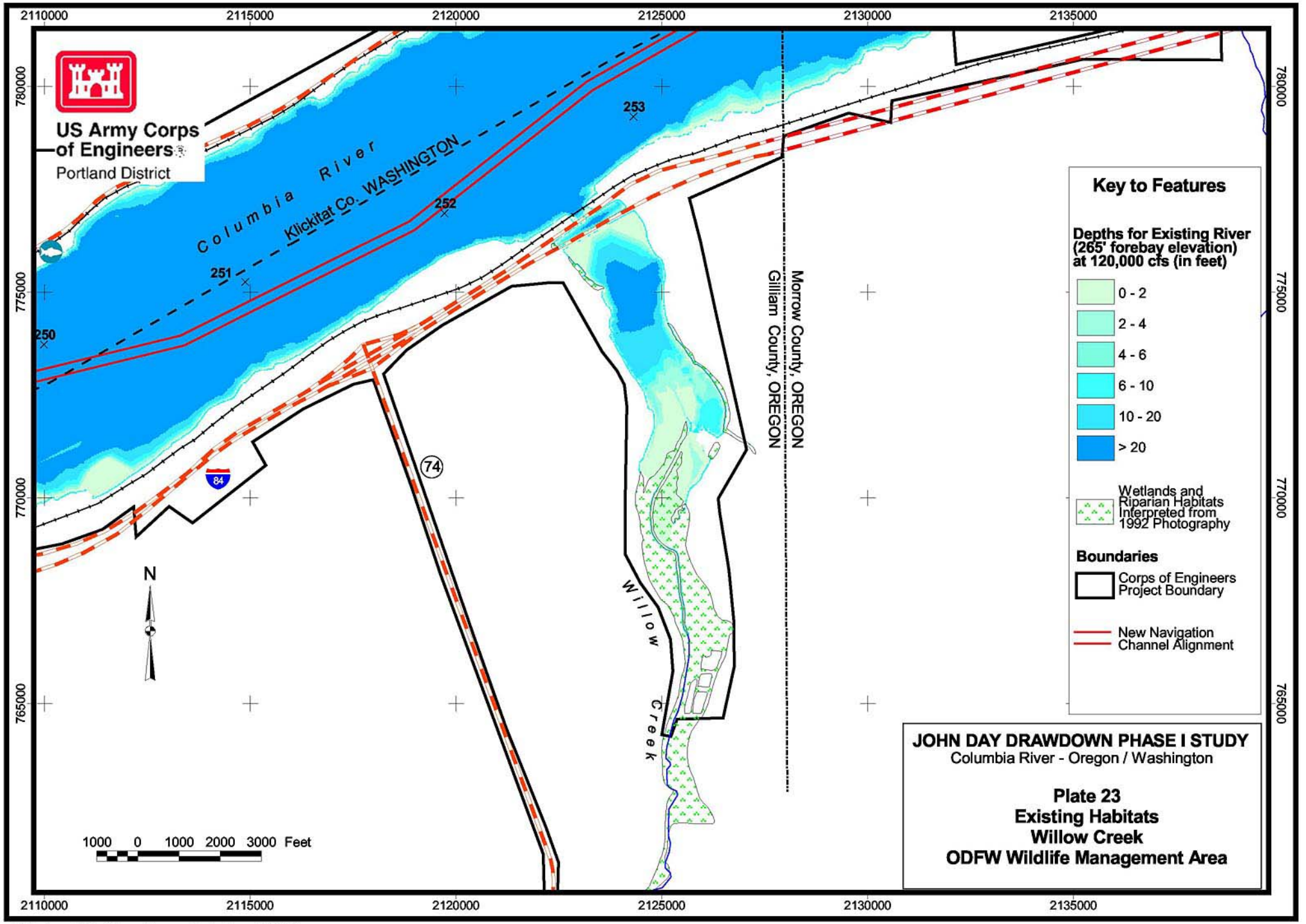
HTRW Sites
Plate 18
River Miles 228 - 242


Key to Features
HTRW Listings
CERCLIS
EPCRA TRI
NPDES
OR ECSI
UST
WA CSCS
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers®
Portland District
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
Columbia River
Flying J
3Mile Canyon Cleanup Site
Roosevelt Park
Arlington
City of Arlington
Quesnel Park
N
5000 0 5000 10000 Feet
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
HTRW Sites
Plate 19
River Miles 241 - 256


Key to Features
HTRW Listings
CERCLIS
EPCRA TRI
NPDES
OR ECSI
UST
WA CSCS
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers®
Portland District
Crow Butte State Park- (Location Approx.)
Crow Butte Park
Columbia River
Quesnel Park
PGE Carty
Boardman
N
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
HTRW Sites
Plate 20
River Miles 254 - 268


Key to Features
HTRW Listings
CERCLIS
EPCRA TRI
NPDES
OR ECSI
UST
WA CSCS
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Political Boundaries
City Boundary
State Boundary
County Boundary
US Army Corps of Engineers
Portland District
N
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
Columbia River
Irrigon
Umatilla Hatchery
Ready Mix
Morrow Gas
Lamb-Weston
Boardman Park
Boardman Park
Boardman
T5N R24E WM
T4N R24E WM
T5N R25E WM
T4N R25E WM
T5N R26E WM
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
5000 0 5000 10000 Feet
2190000
2200000
2210000
2220000
2230000
2240000
2250000
830000
820000
810000
800000
790000
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
HTRW Sites
Plate 21
River Miles 265 - 281


Key to Features
HTRW Listings
CERCLIS
EPCRA TRI
NPDES
OR ECSI
UST
WA CSCS
Corps of Engineers Boundaries
Corps Boundary
Outsite Corps Boundary
Park
Umatilla National Wildlife Refuge
Navigation Channel
215 River Miles (Corps of Engineers)
Pool Extents
Normal Pool
Spillway Crest at 75k cfs
Natural River at 75k cfs
Political Boundaries
City Boundary
State Boundary
County Boundary
N
US Army Corps of Engineers
Portland District
Umatilla Marina
Umatilla
NW Pipeline-Plymouth
McNary Dam
Plymouth Park
Umatilla National Wildlife Refuge
Columbia River
Umatilla
McNary Substation
Puregro, Umatilla (Location Approx.)
Crop Prod. (Location Approx.)
Umatilla Pump (Location Approx.)
Texaco (Location Approx.)
Wilbur-Ellis (Location Approx.)
Unocal-Umatilla (Location Approx.)
Irrigon Park
Irrigon
Umatilla Hatchery
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
T5N R27E WM
T5N R28E WM
5000 0 5000 10000 Feet
Projection: State Plane, Oregon North Zone, NAD 27
Pool extents based on Corps of Engineers hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District
JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington
HTRW Sites
Plate 22
River Miles 278 - 292



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Depths based on Corps of Engineers Hydrosurveys, 1994
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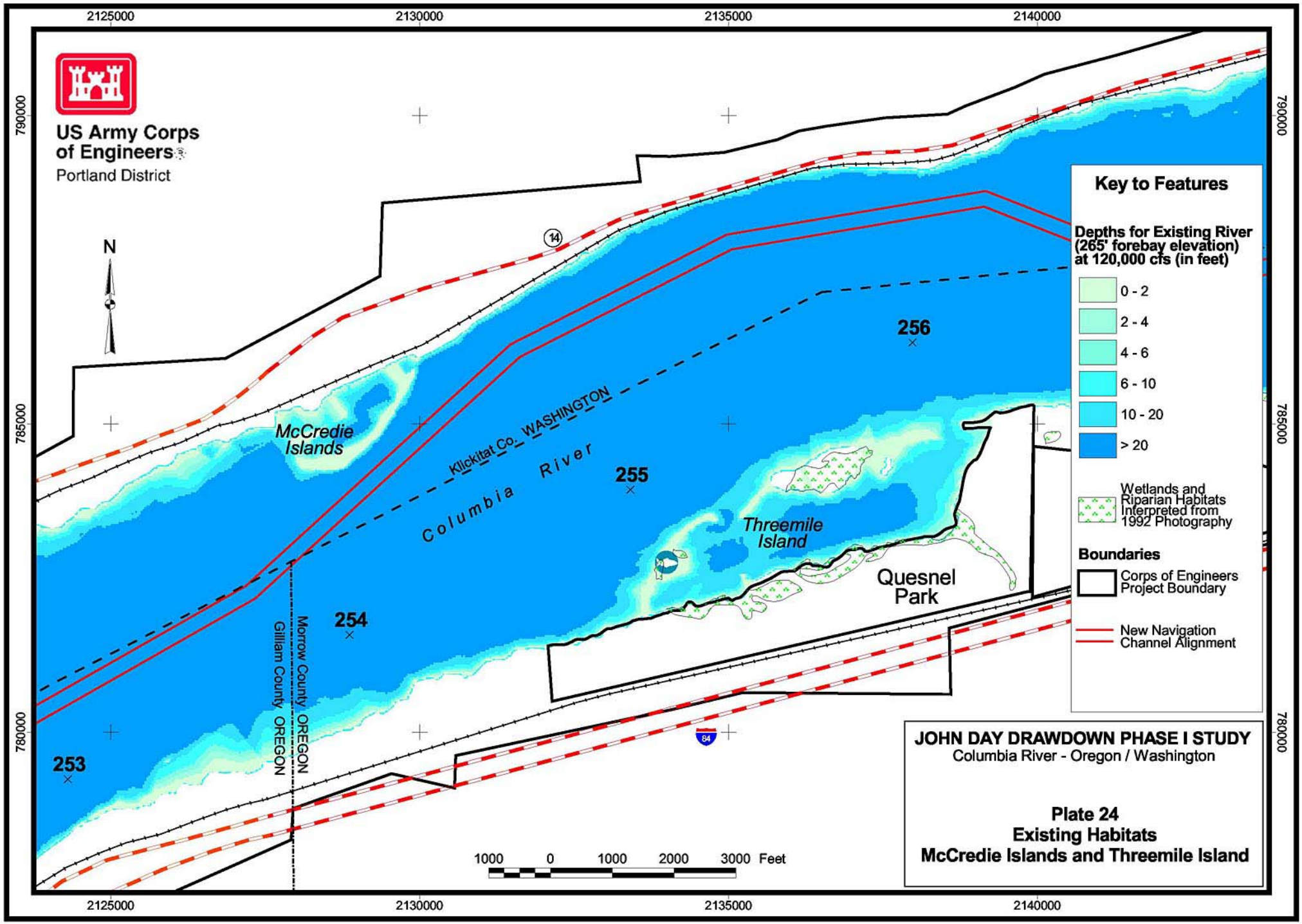
US Army Corps of Engineers, Portland District



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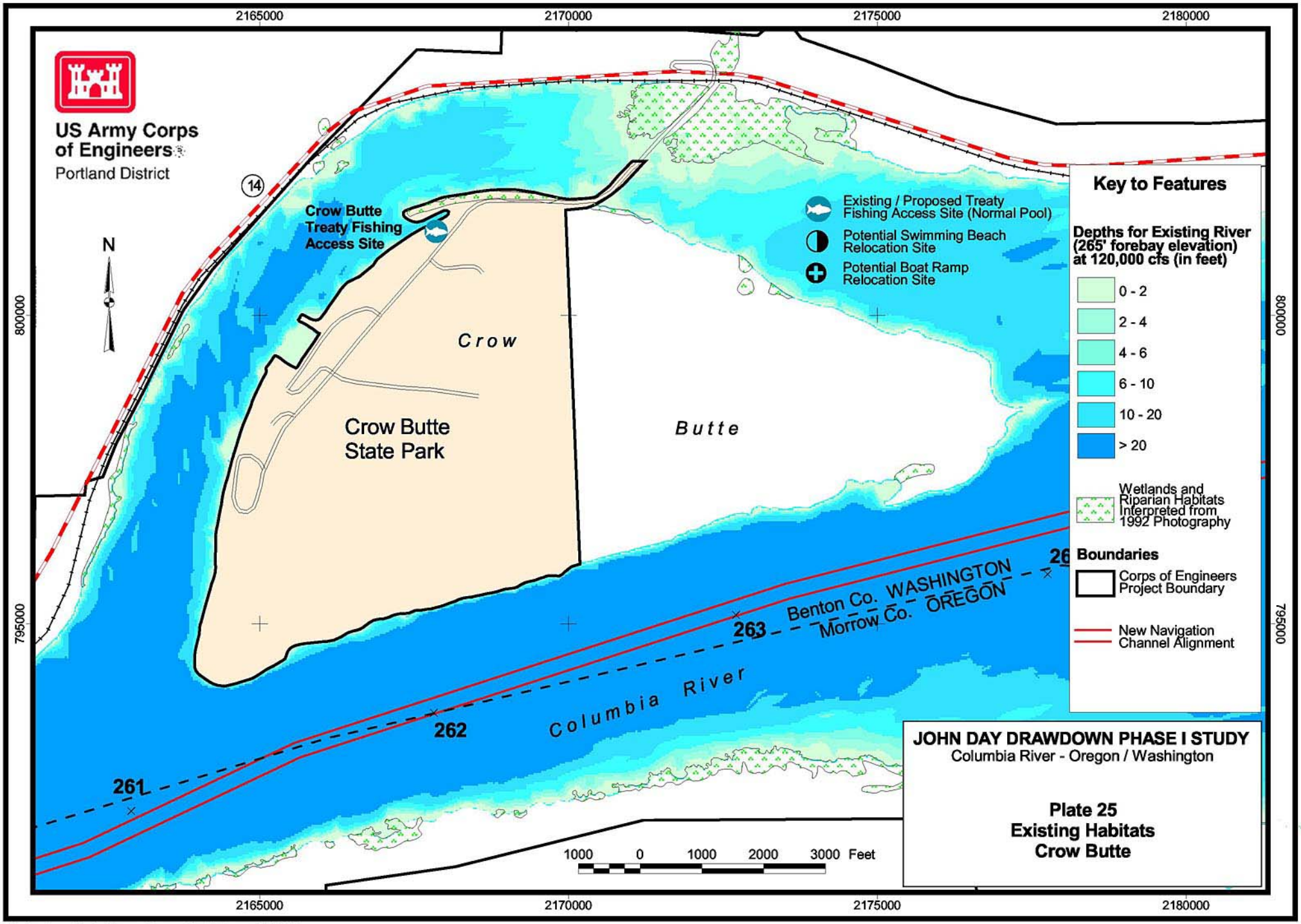
US Army Corps of Engineers, Portland District



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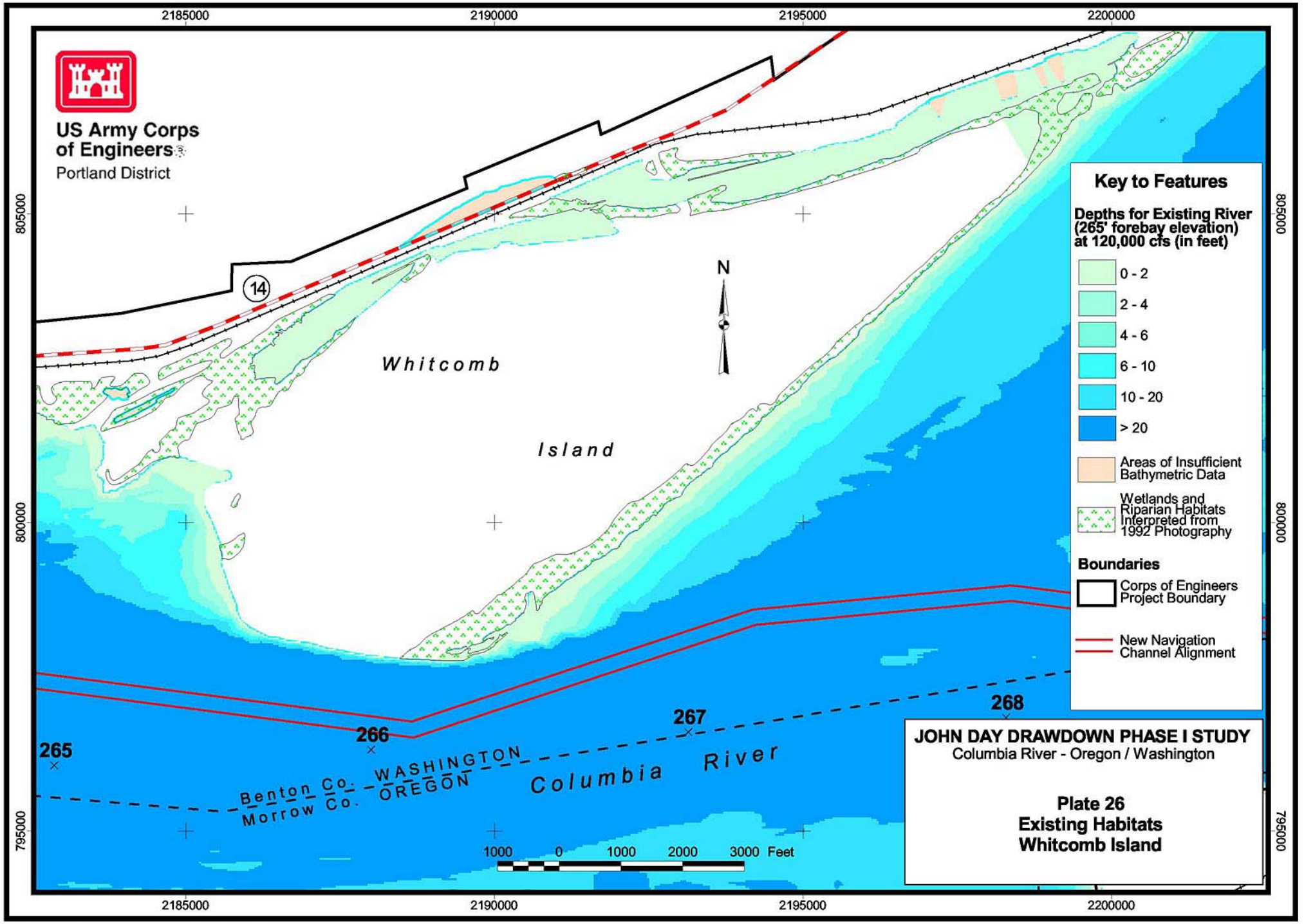
US Army Corps of Engineers, Portland District



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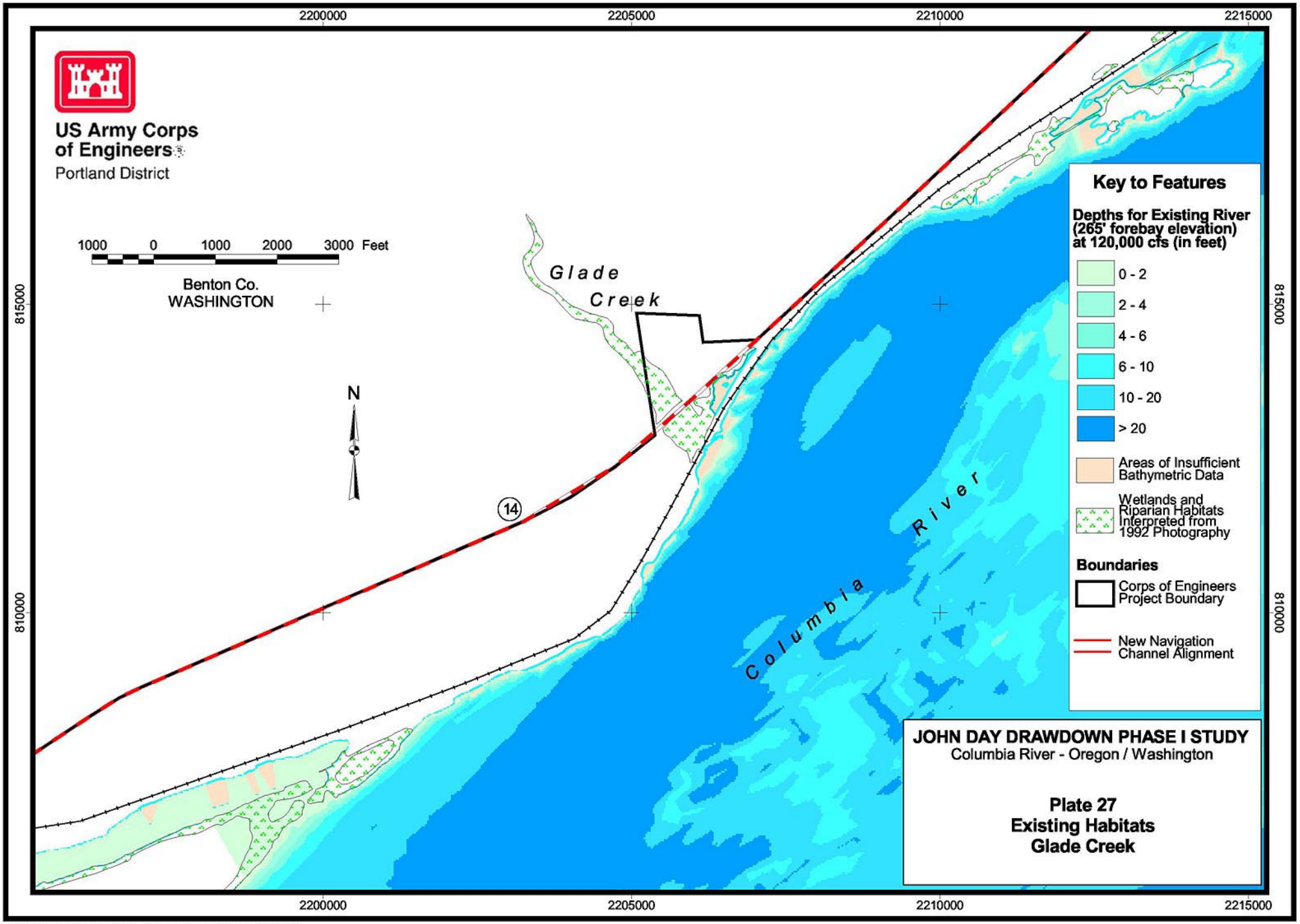
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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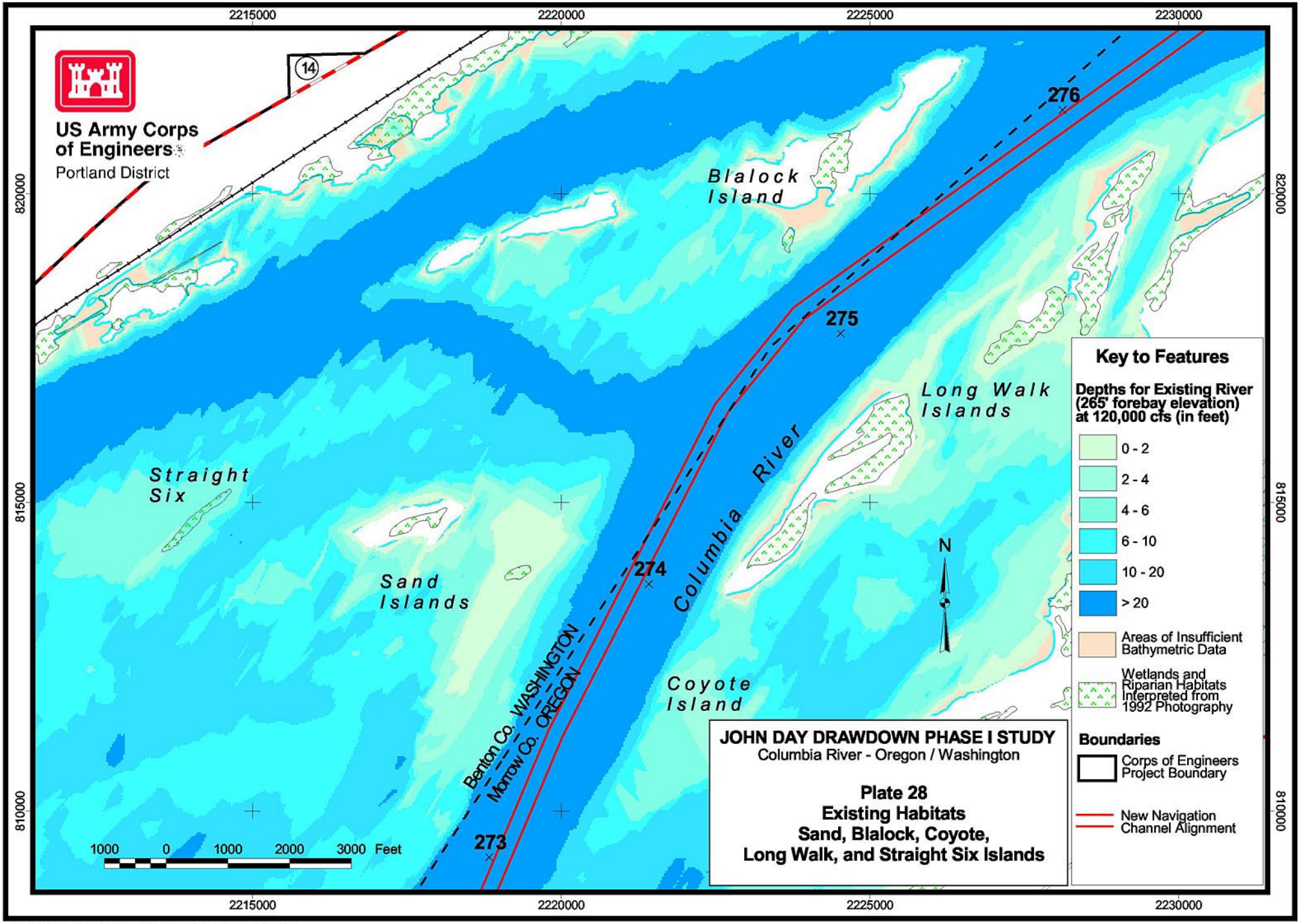
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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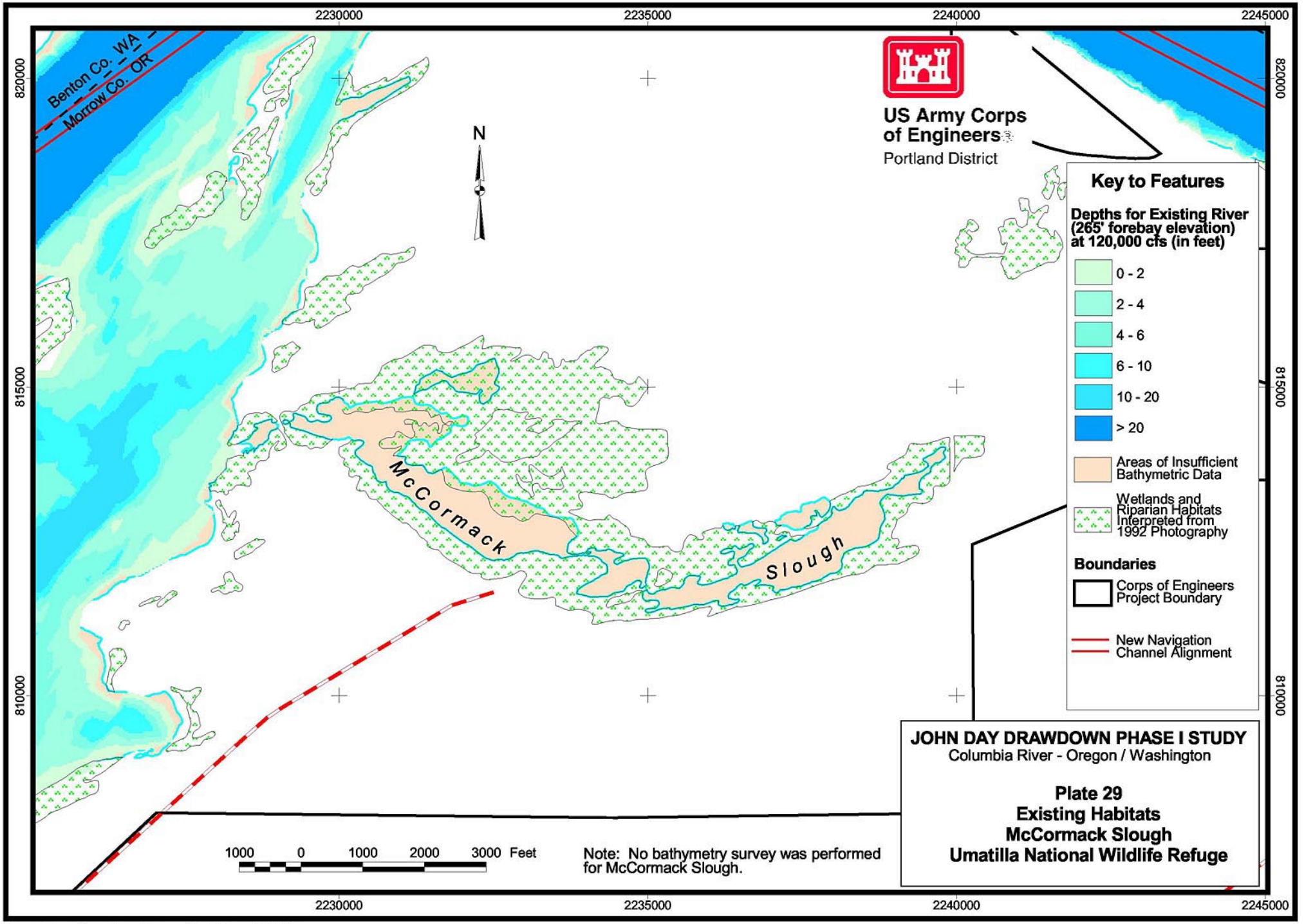
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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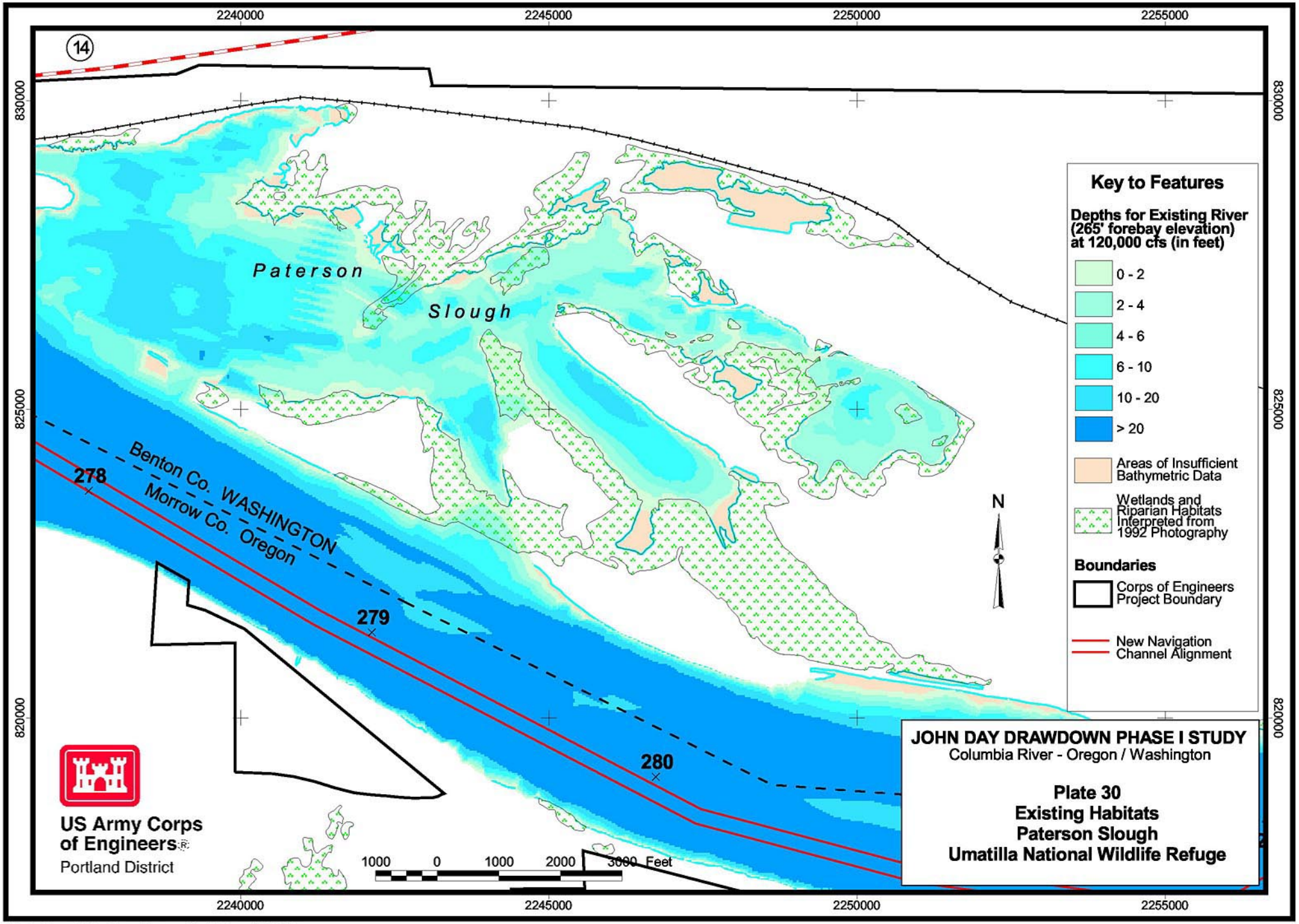
US Army Corps of Engineers, Portland District



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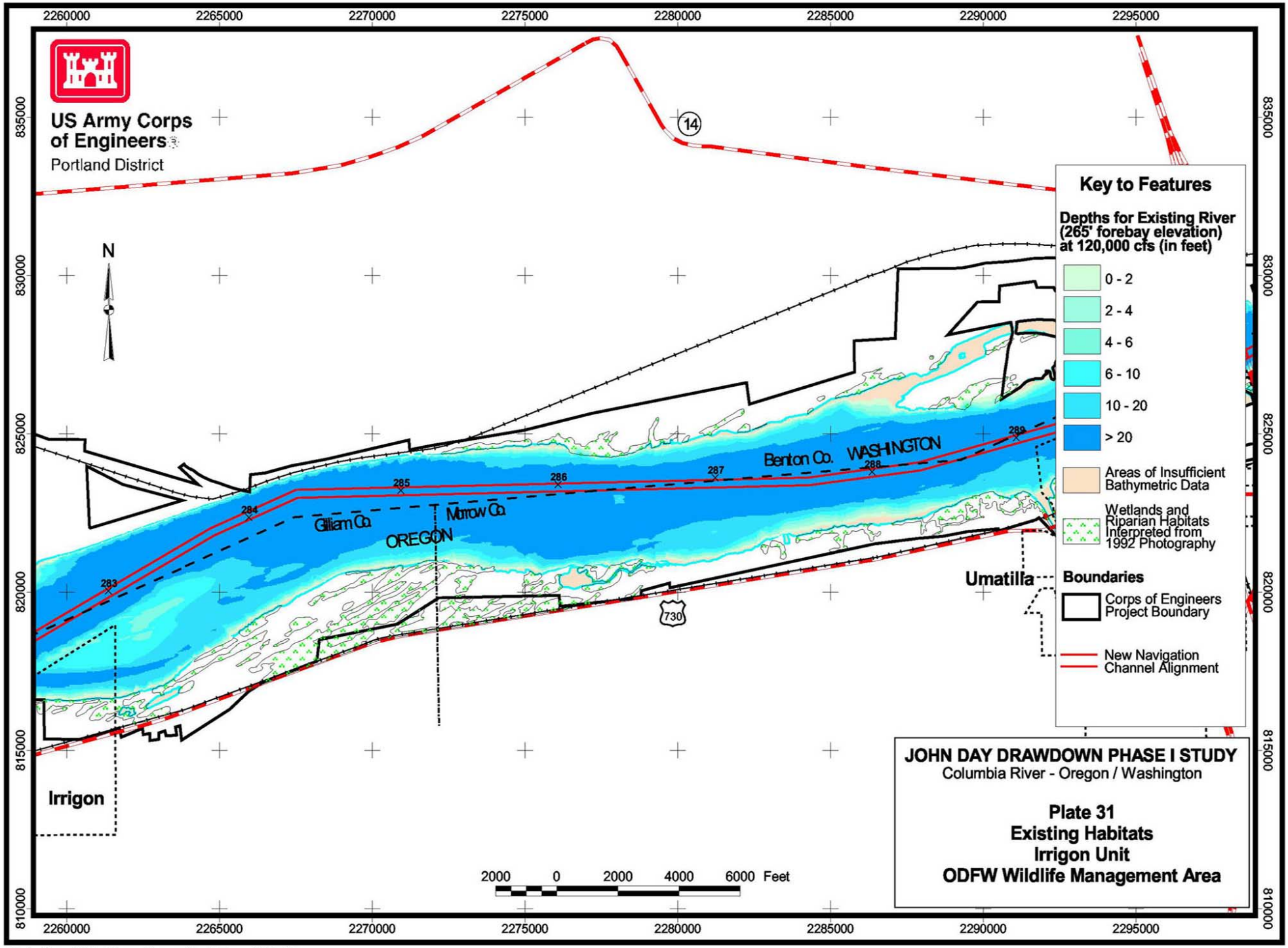
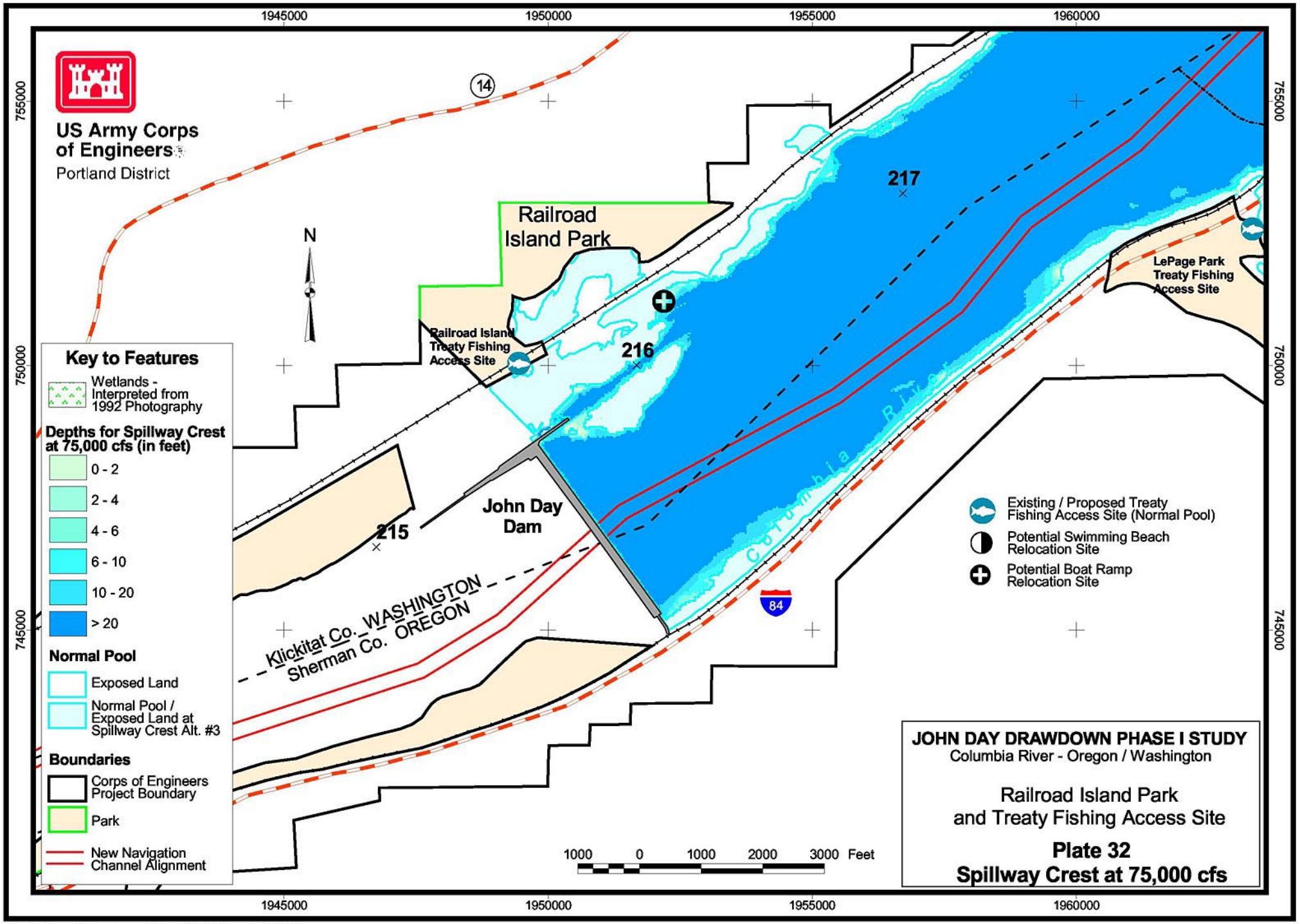
US Army Corps of Engineers, Portland District



JOHN DAY DRAWDOWN PHASE I STUDY
Columbia River - Oregon / Washington

Plate 31
Existing Habitats
Irrigon Unit
ODFW Wildlife Management Area

Projection: State Plane, Oregon North Zone, NAD 27
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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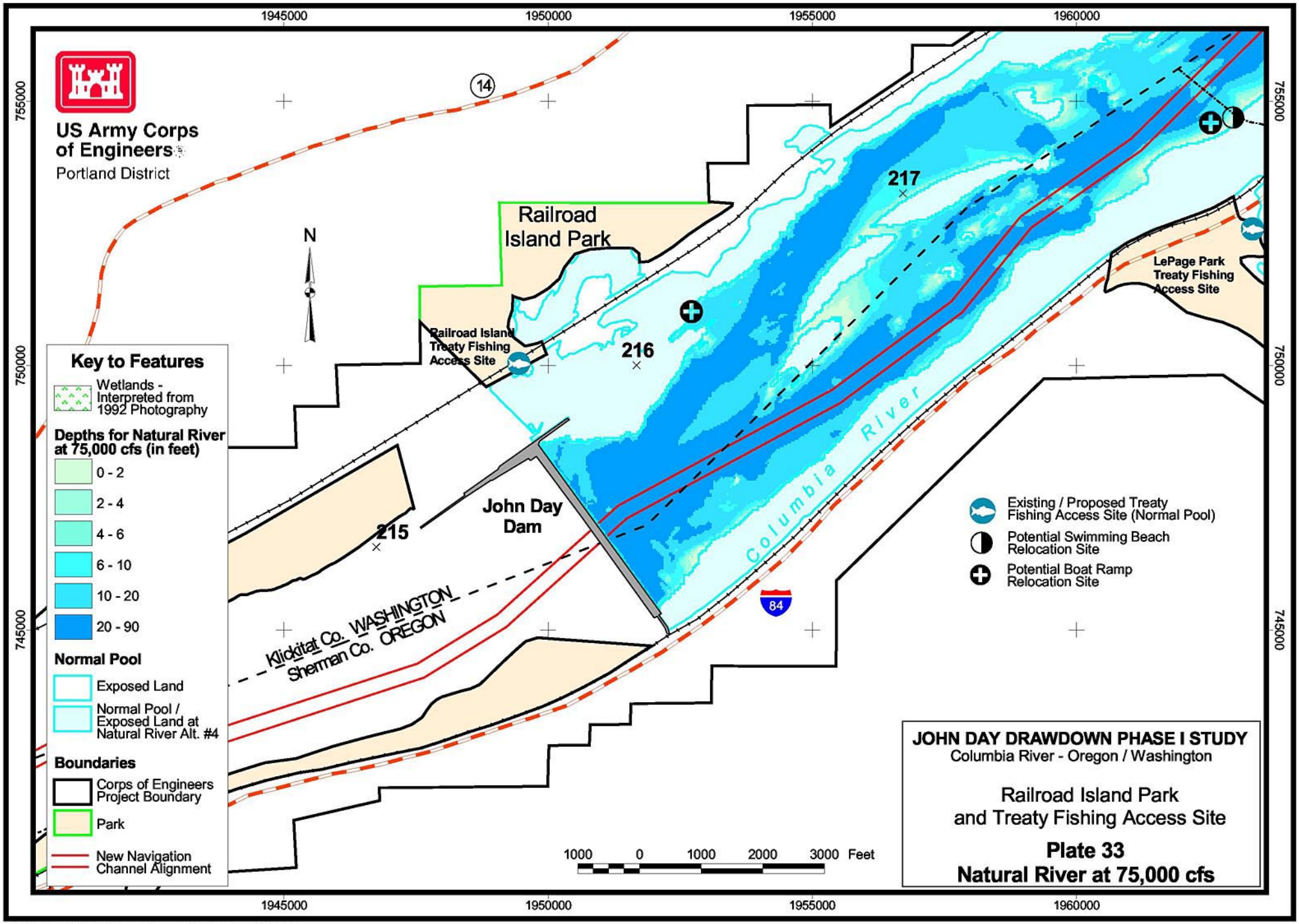
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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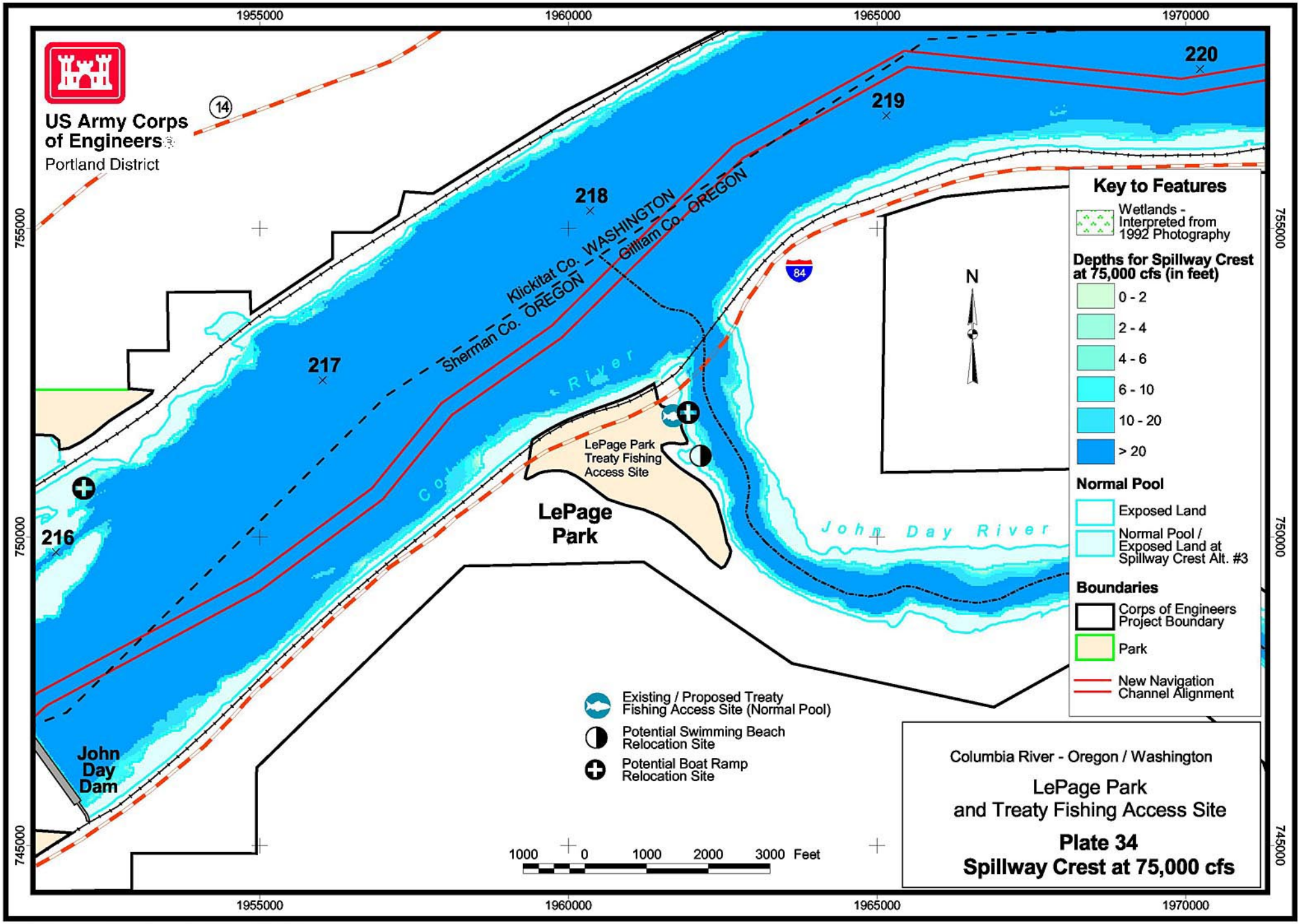
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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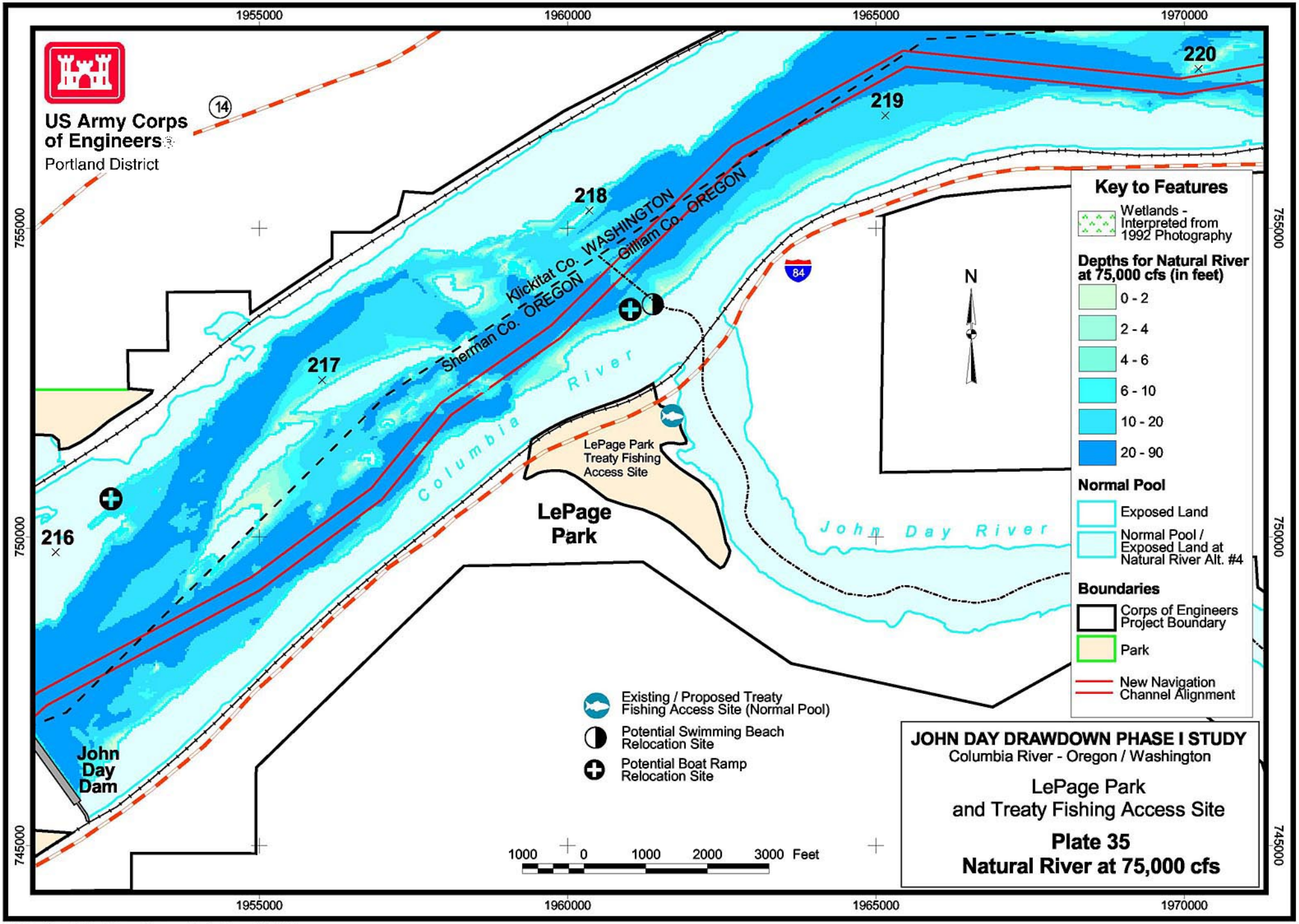
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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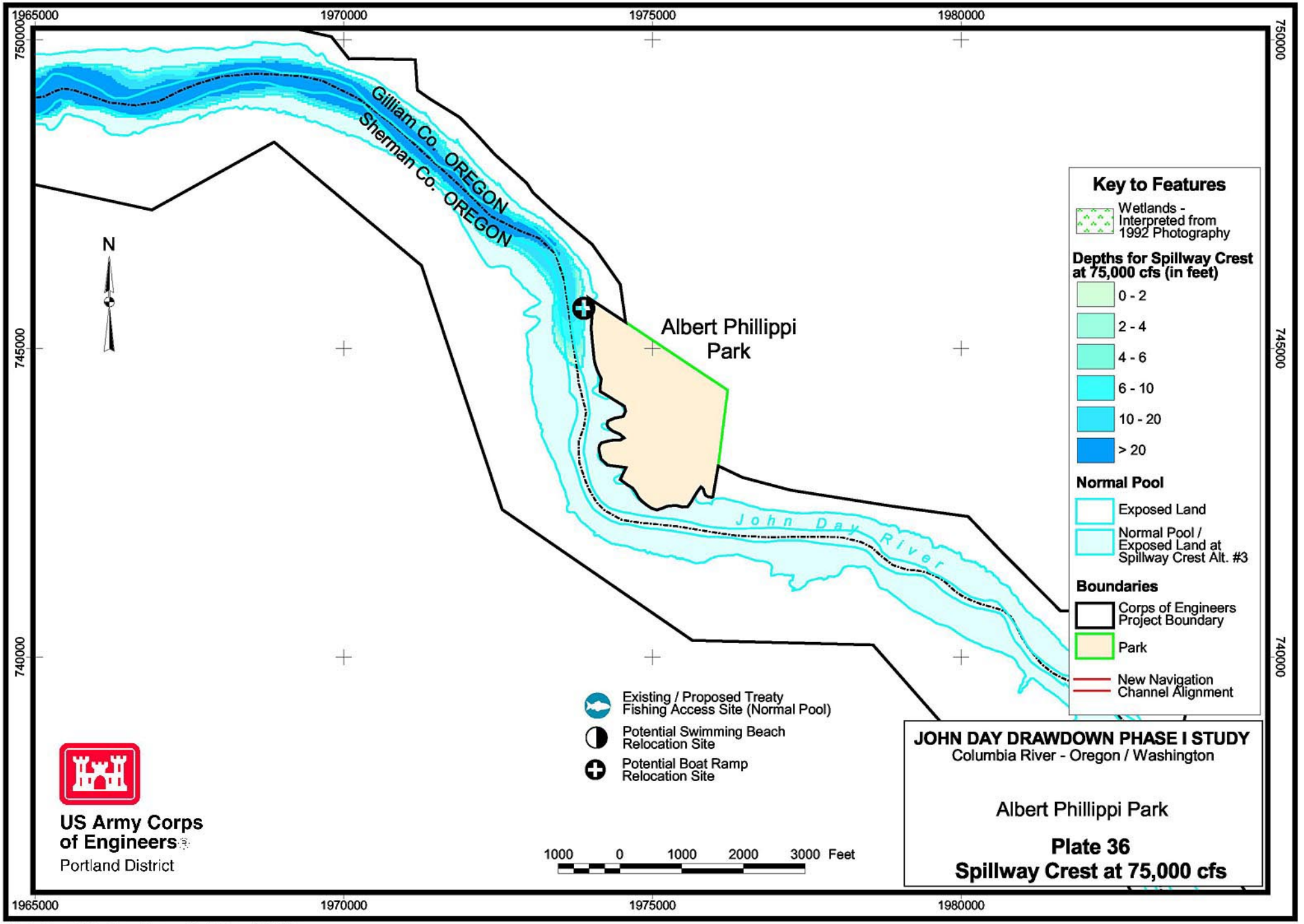
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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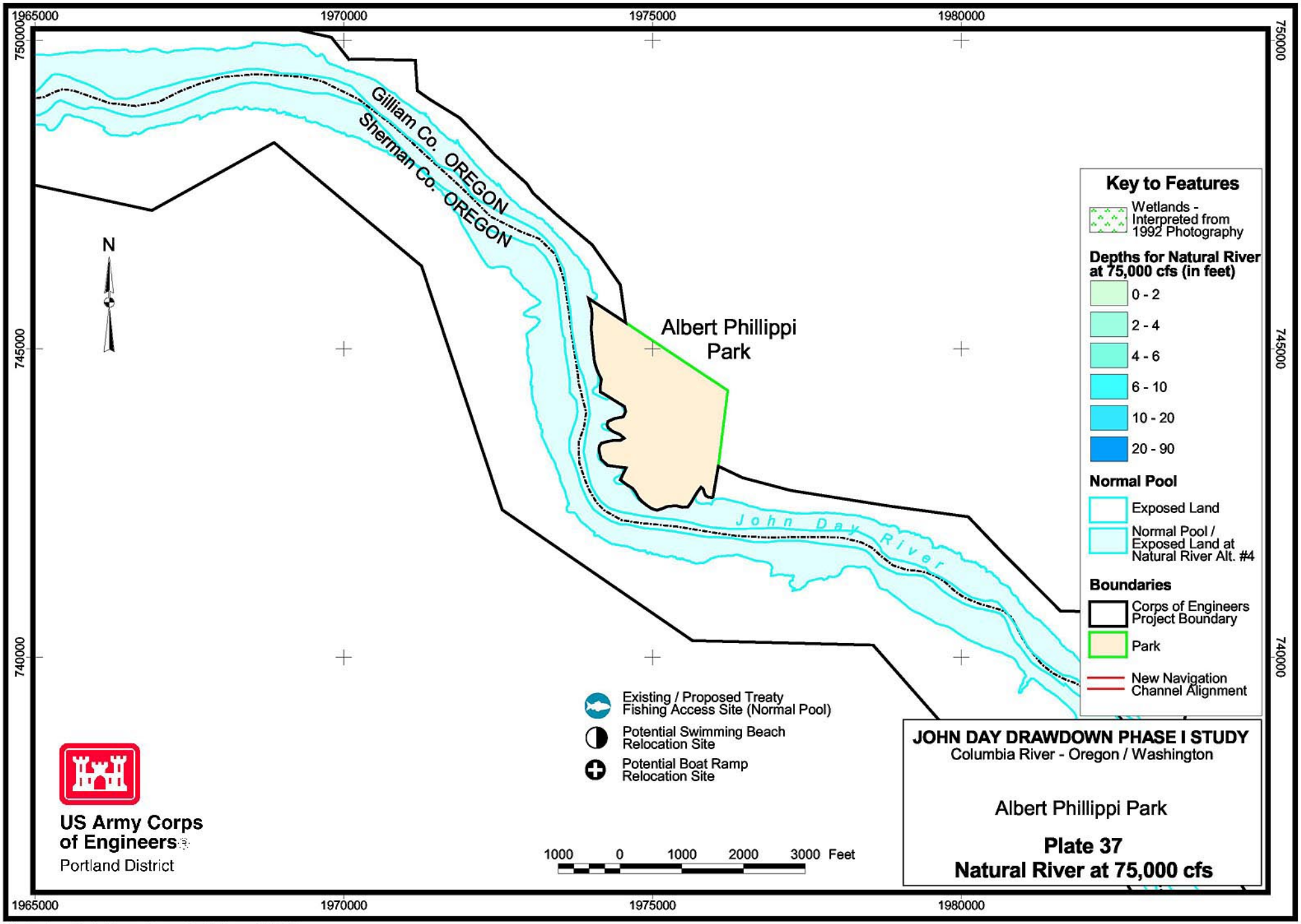
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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Depths based on Corps of Engineers Hydrosurveys, 1994
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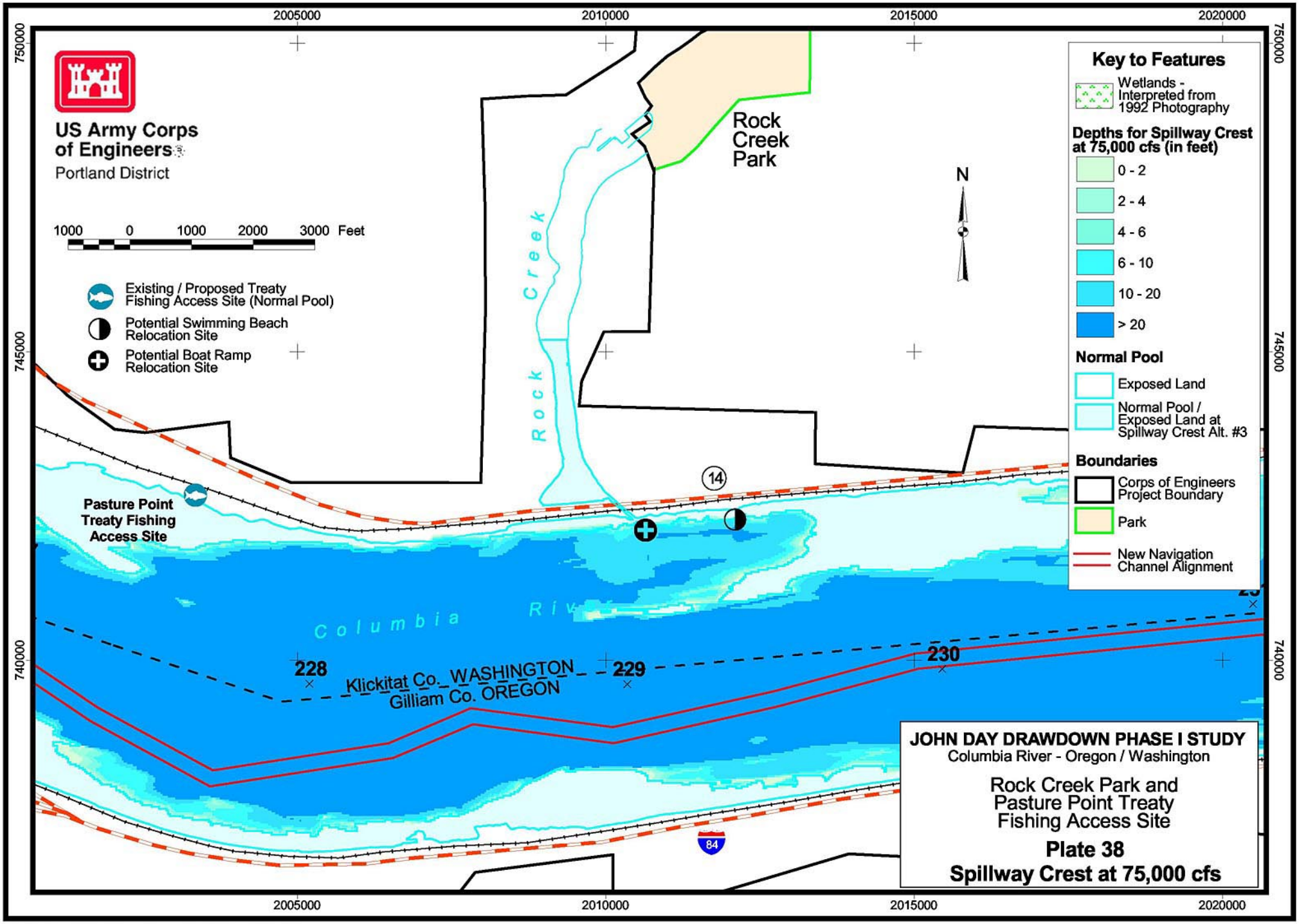
US Army Corps of Engineers, Portland District



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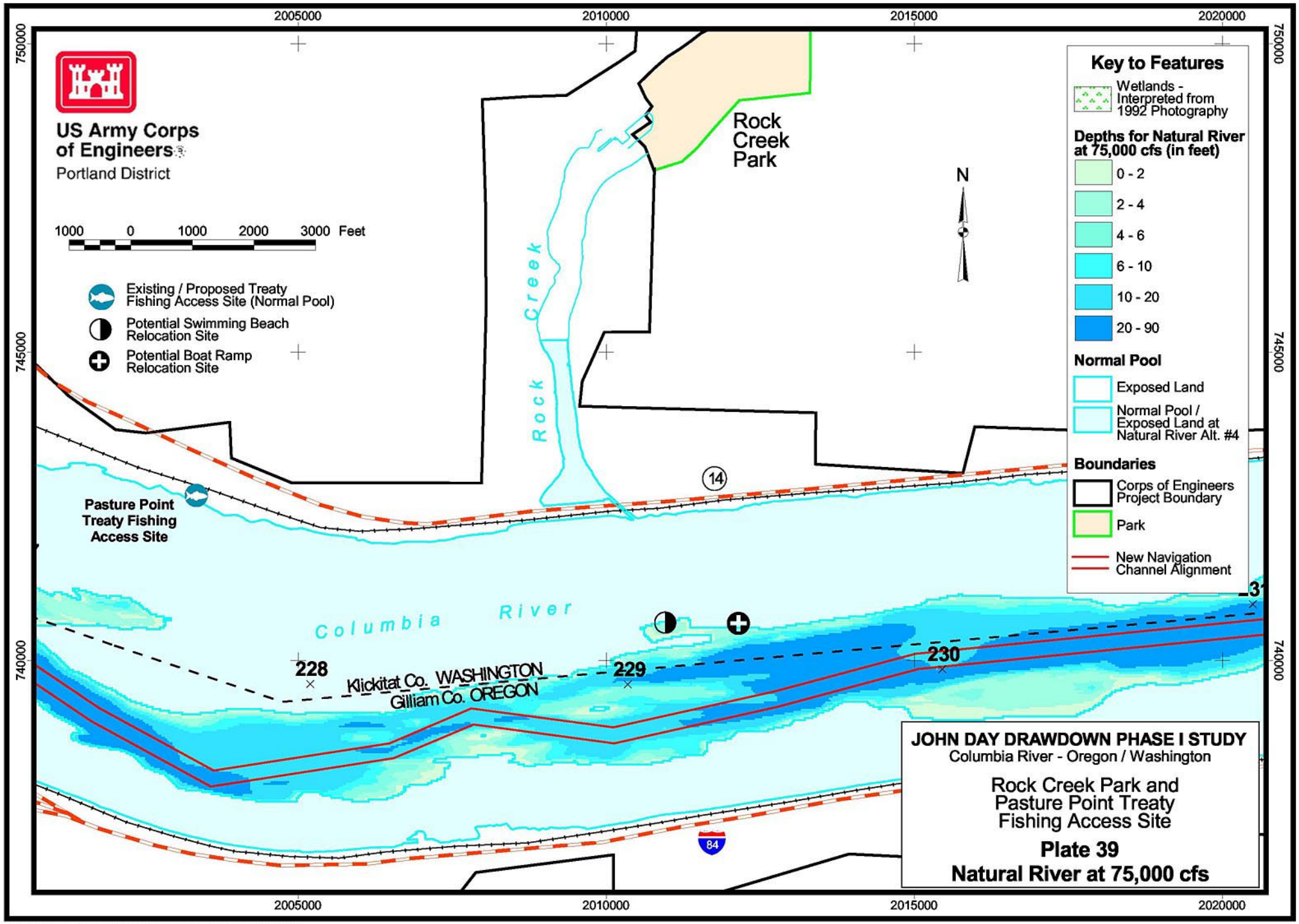
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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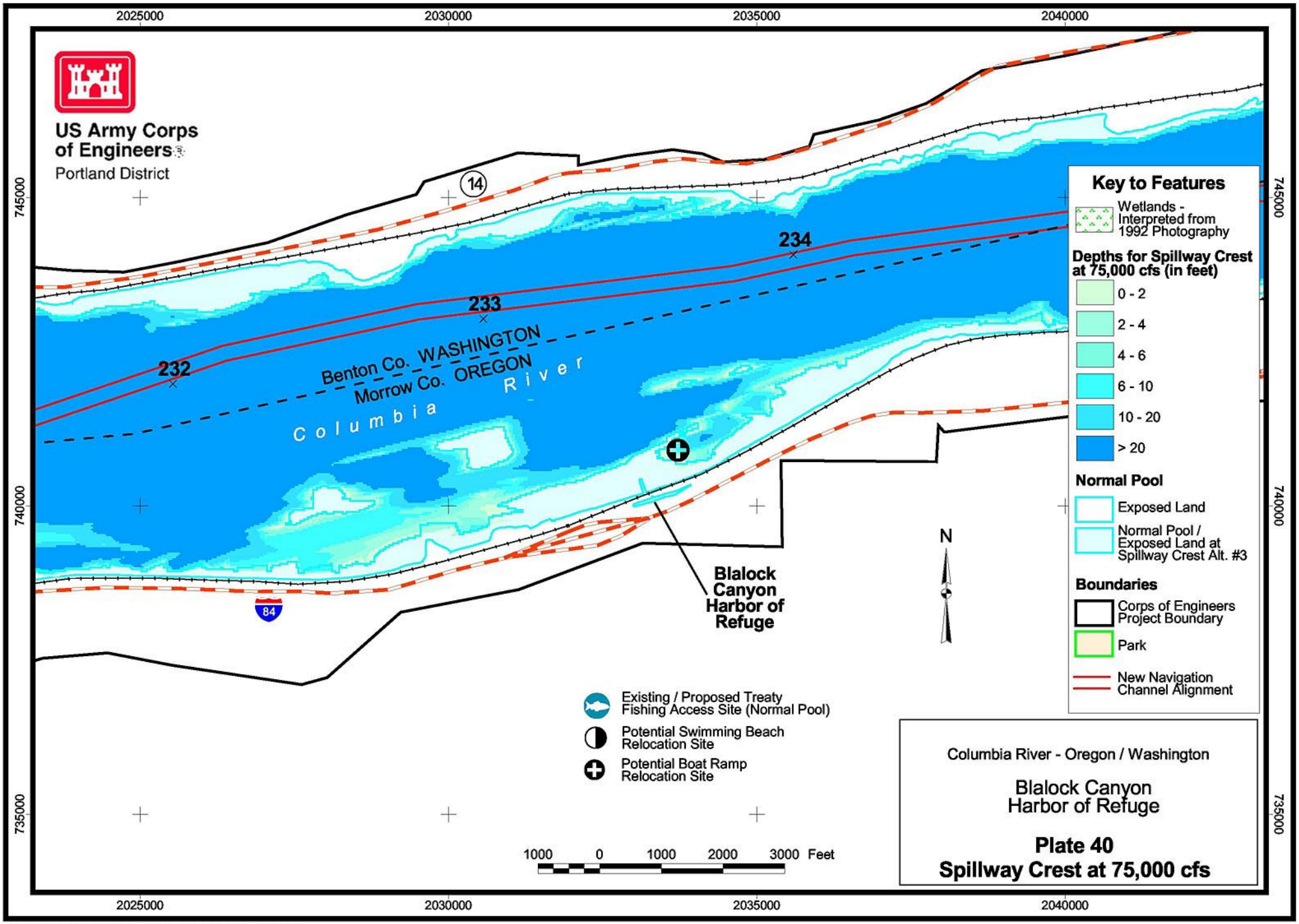
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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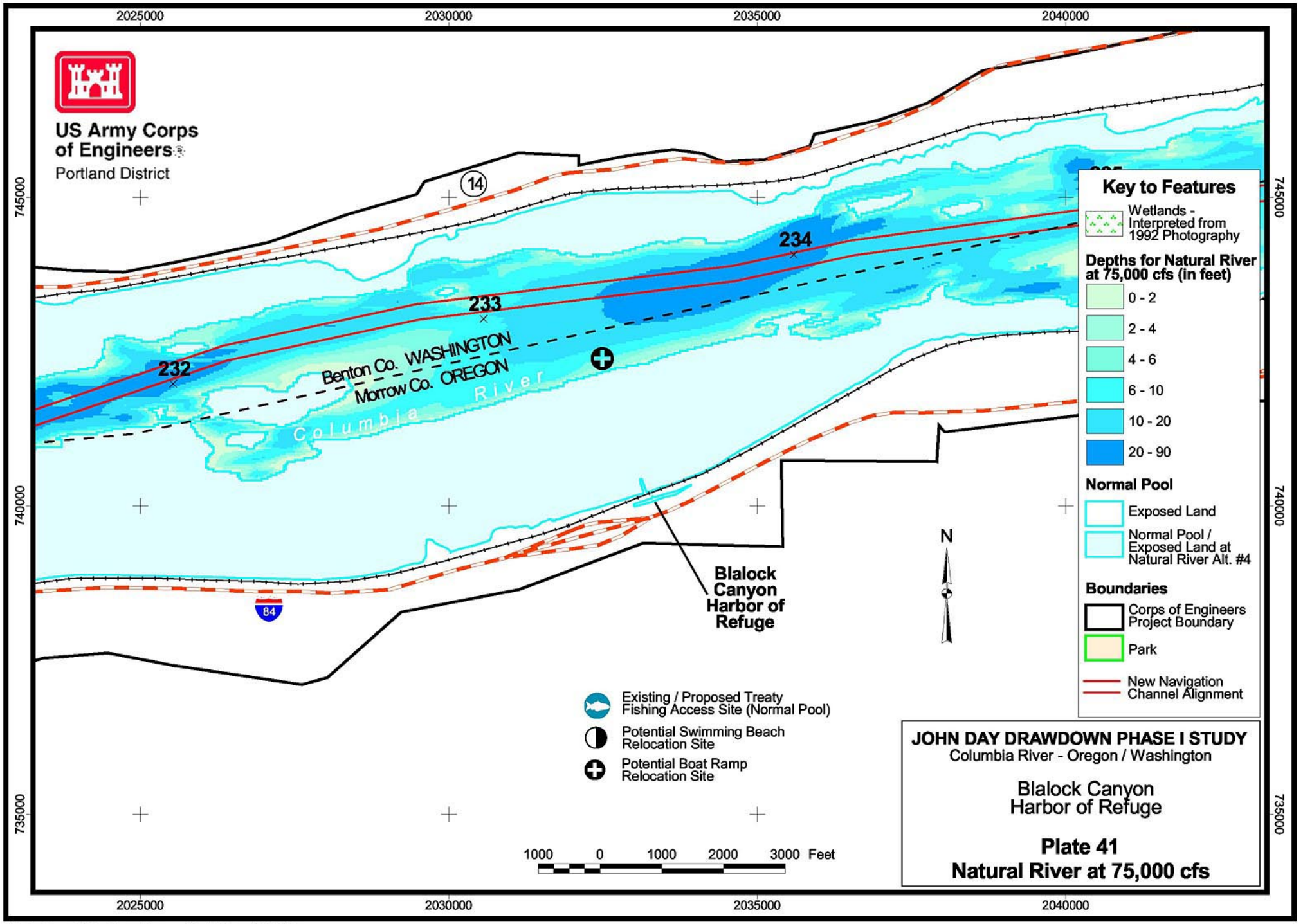
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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Depths based on Corps of Engineers Hydrosurveys, 1994
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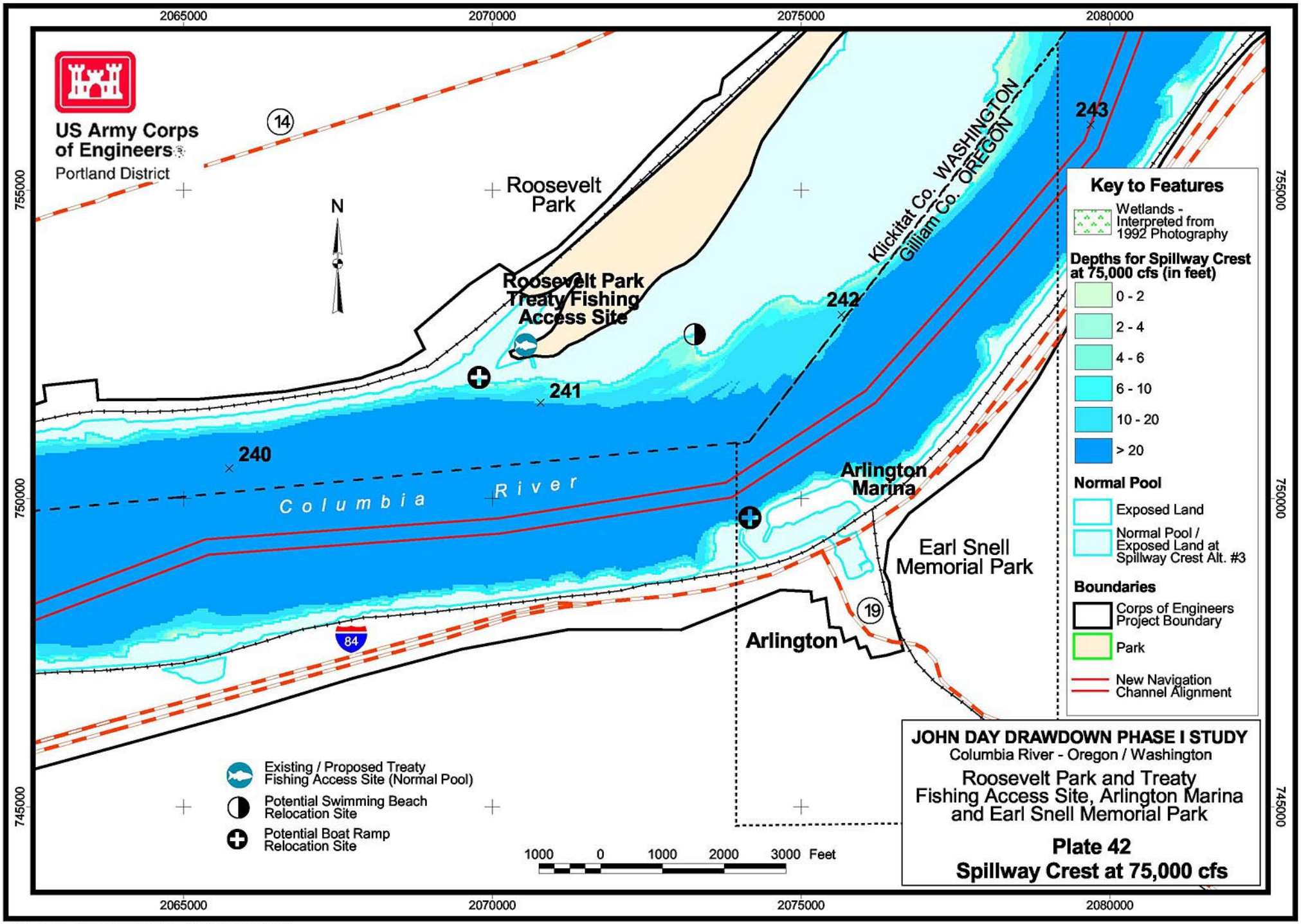
US Army Corps of Engineers, Portland District



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Depths based on Corps of Engineers Hydrosurveys, 1994
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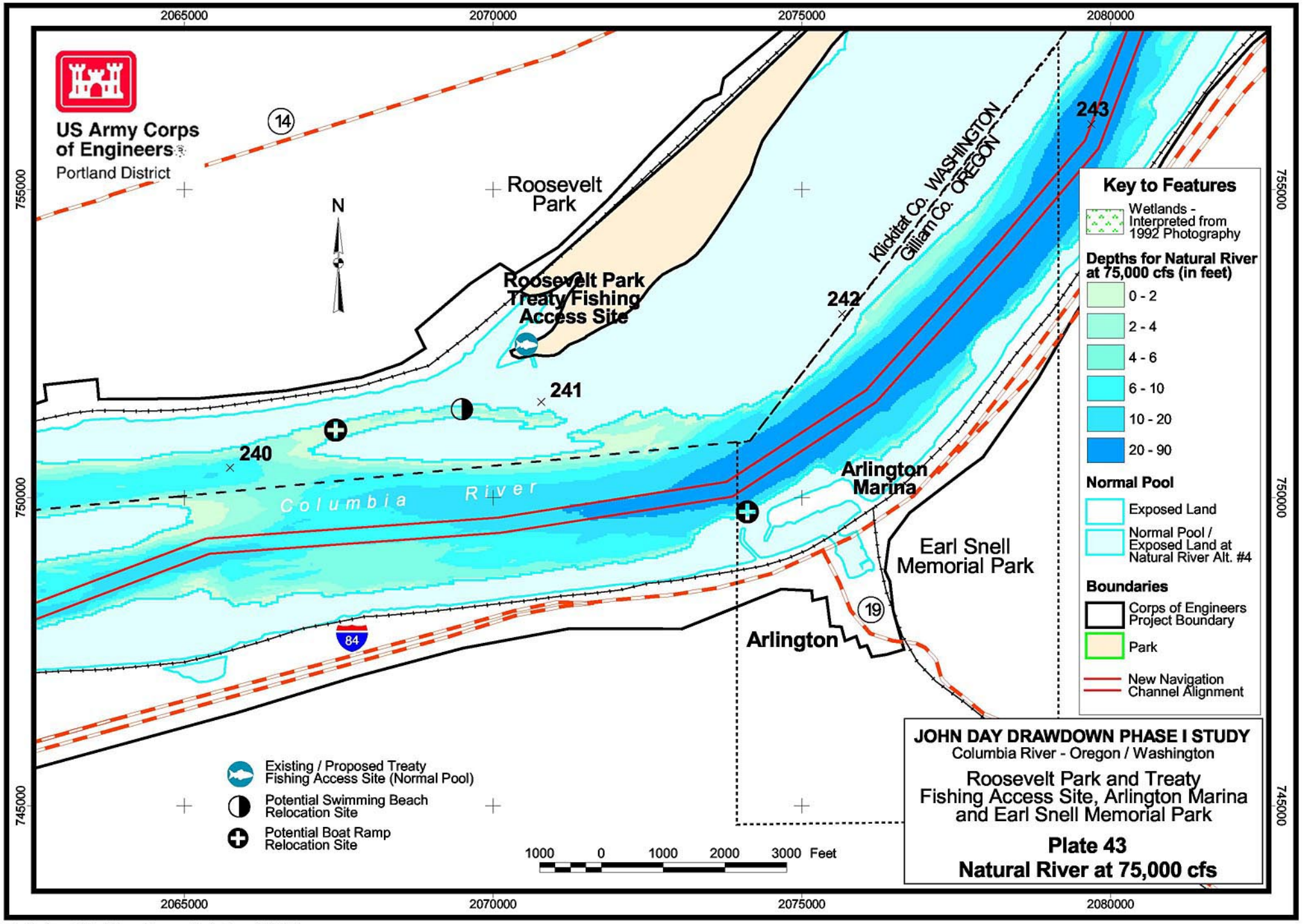
US Army Corps of Engineers, Portland District



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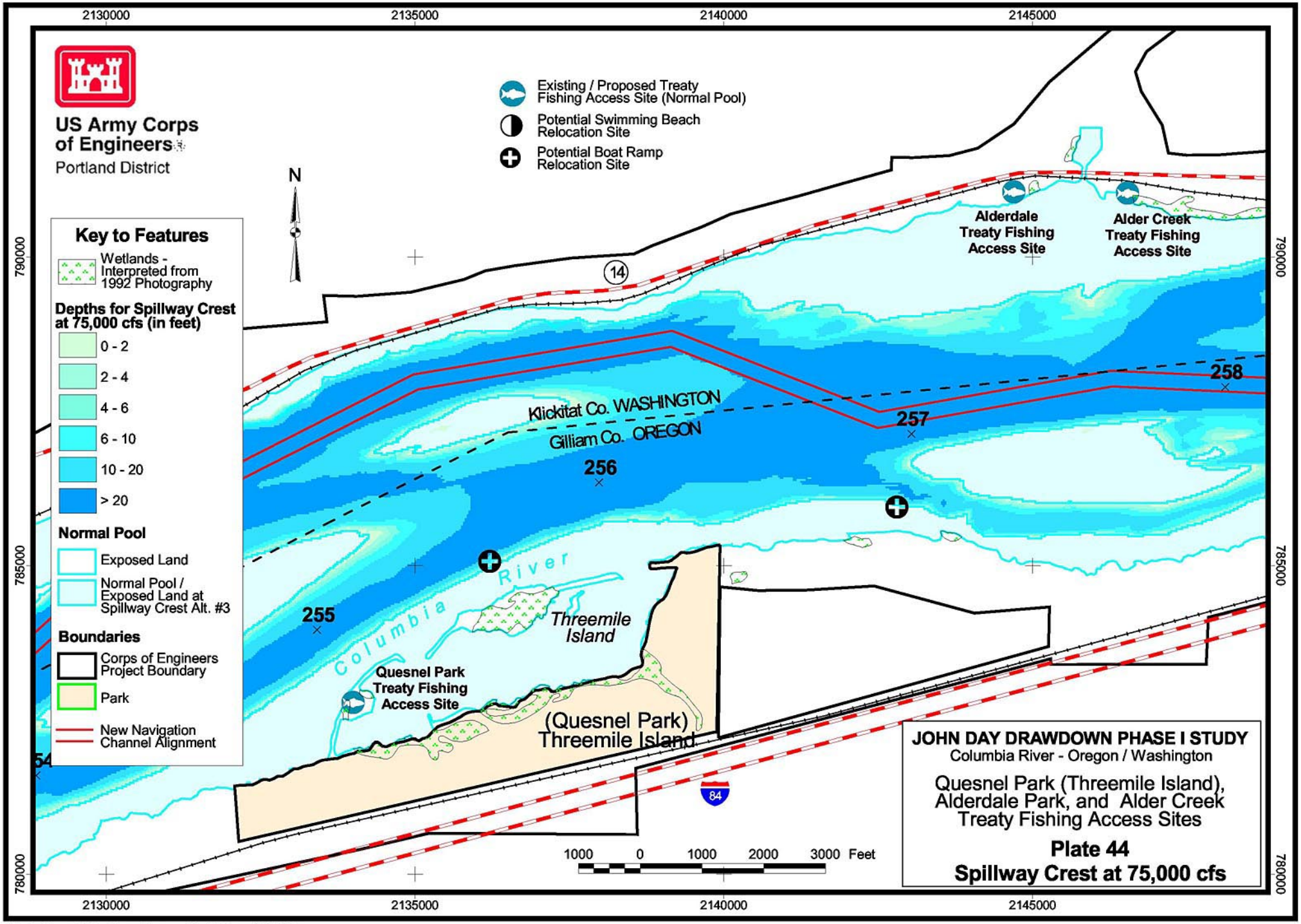
US Army Corps of Engineers, Portland District



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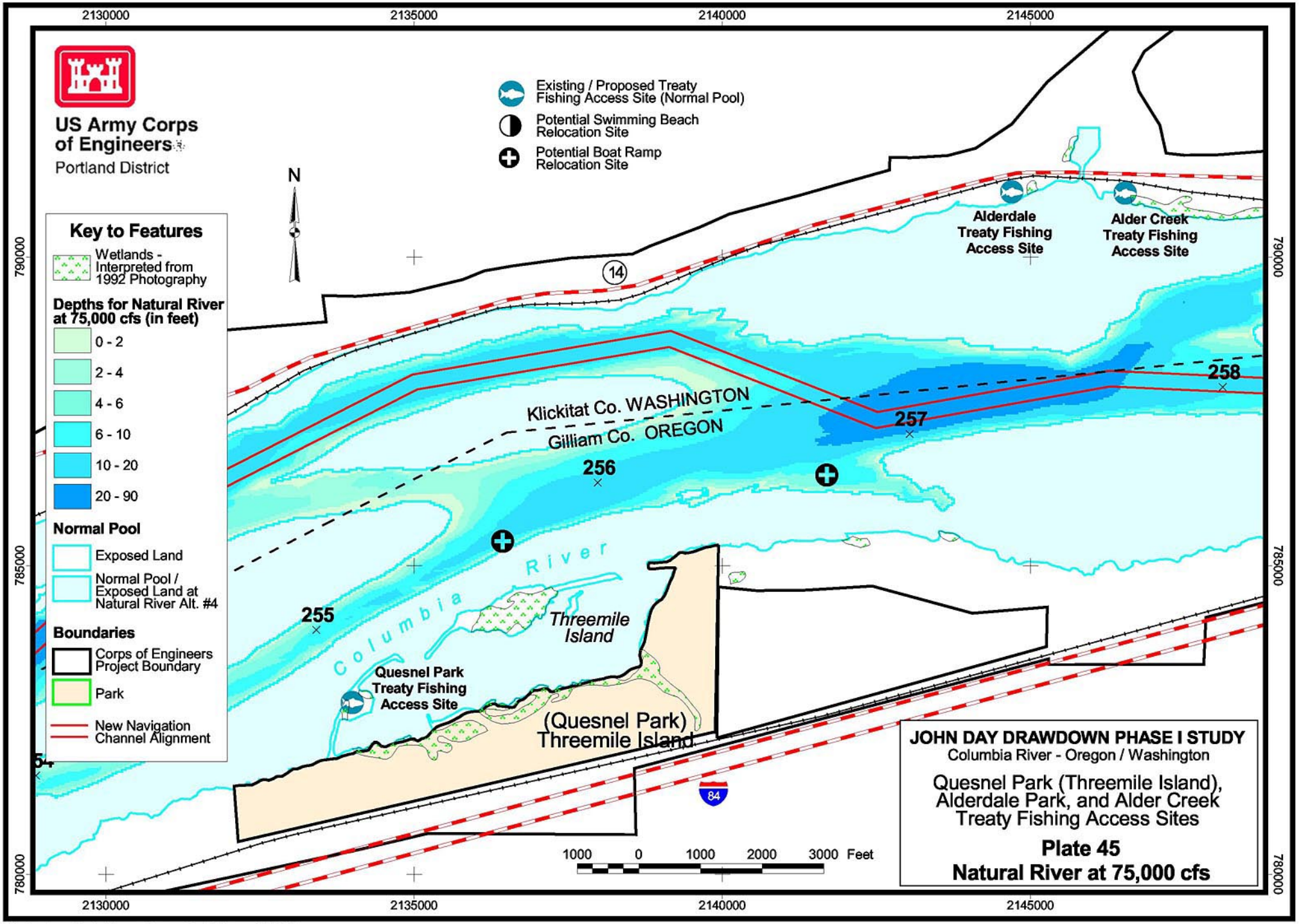
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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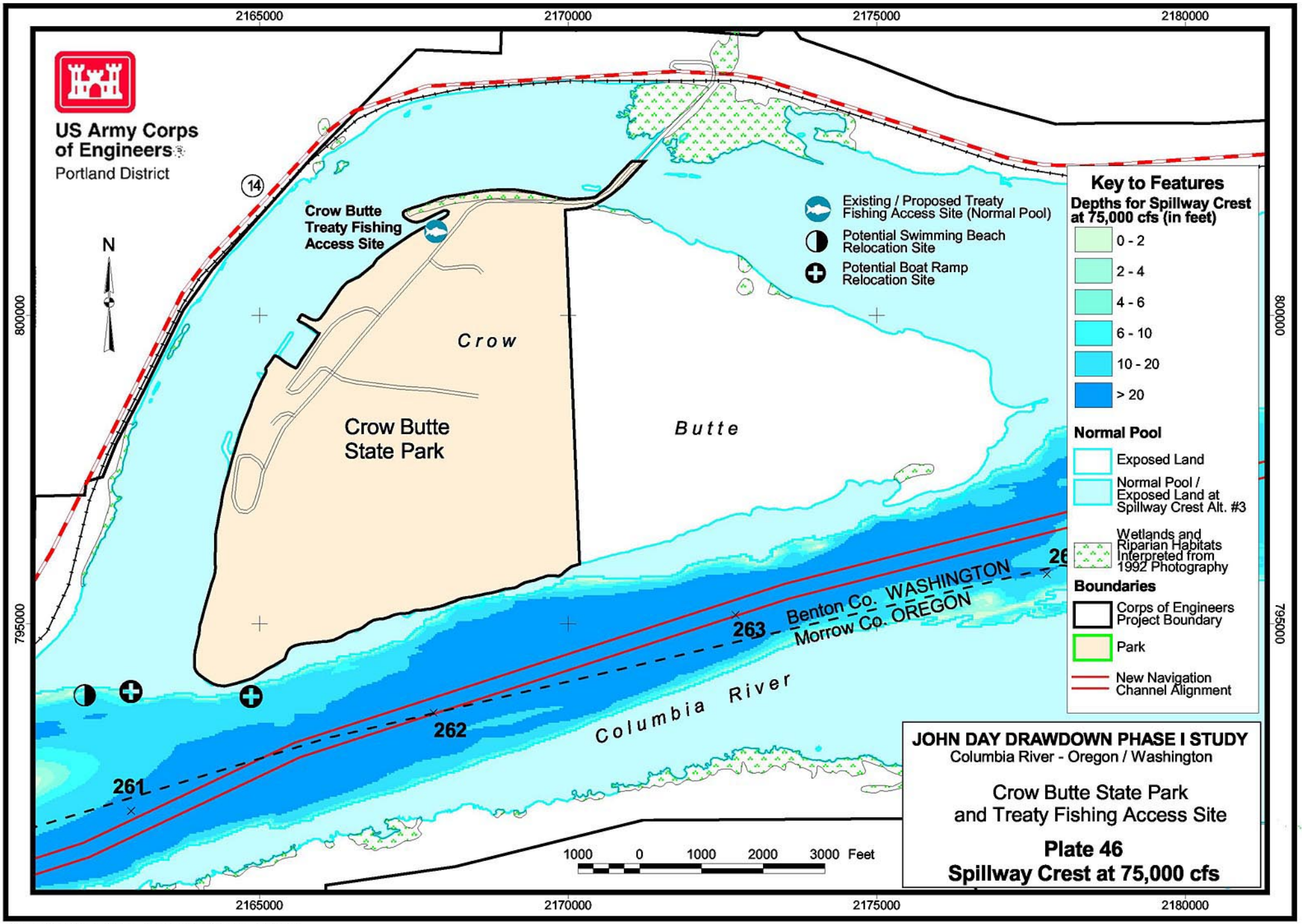
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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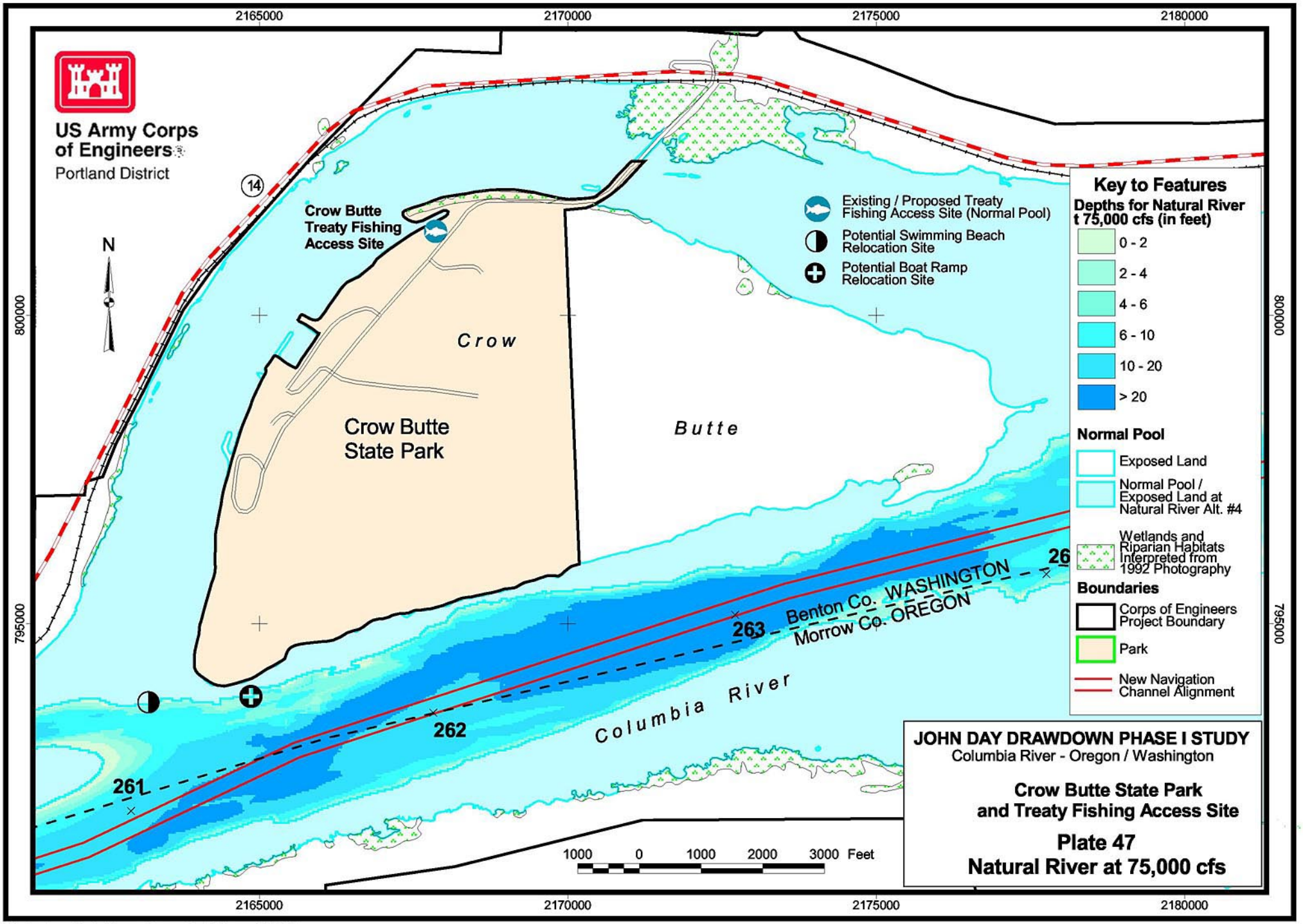
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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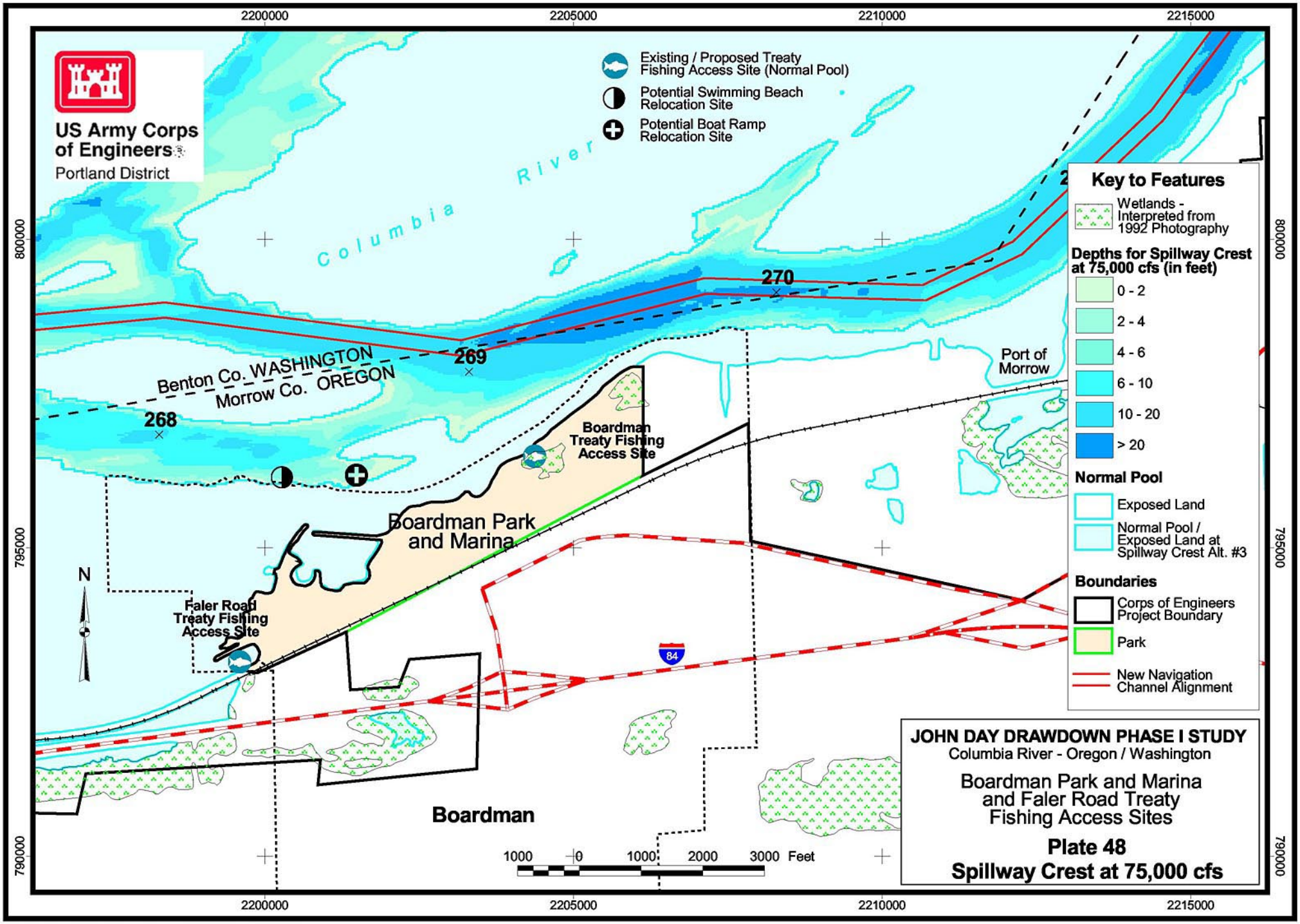
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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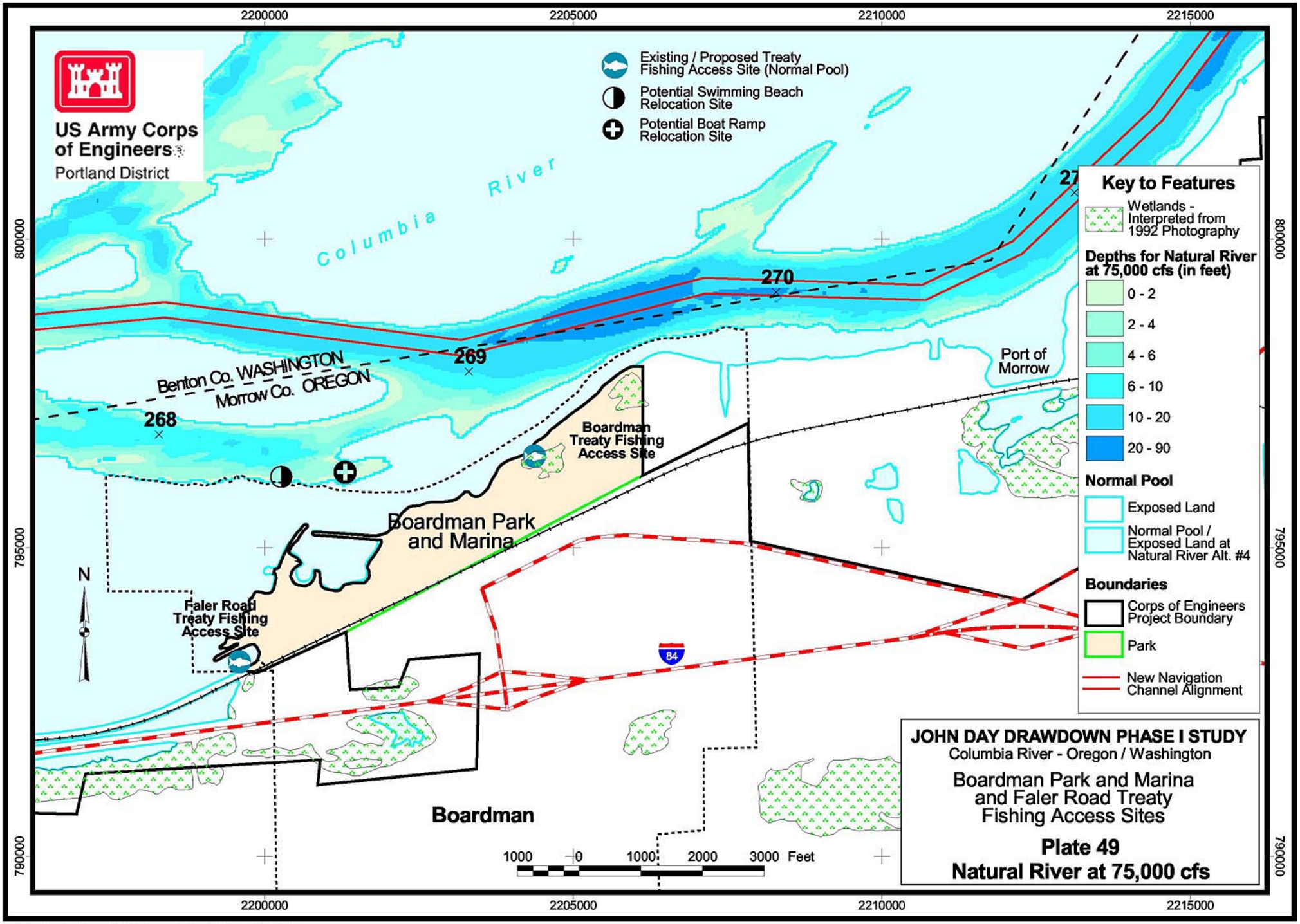
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland District



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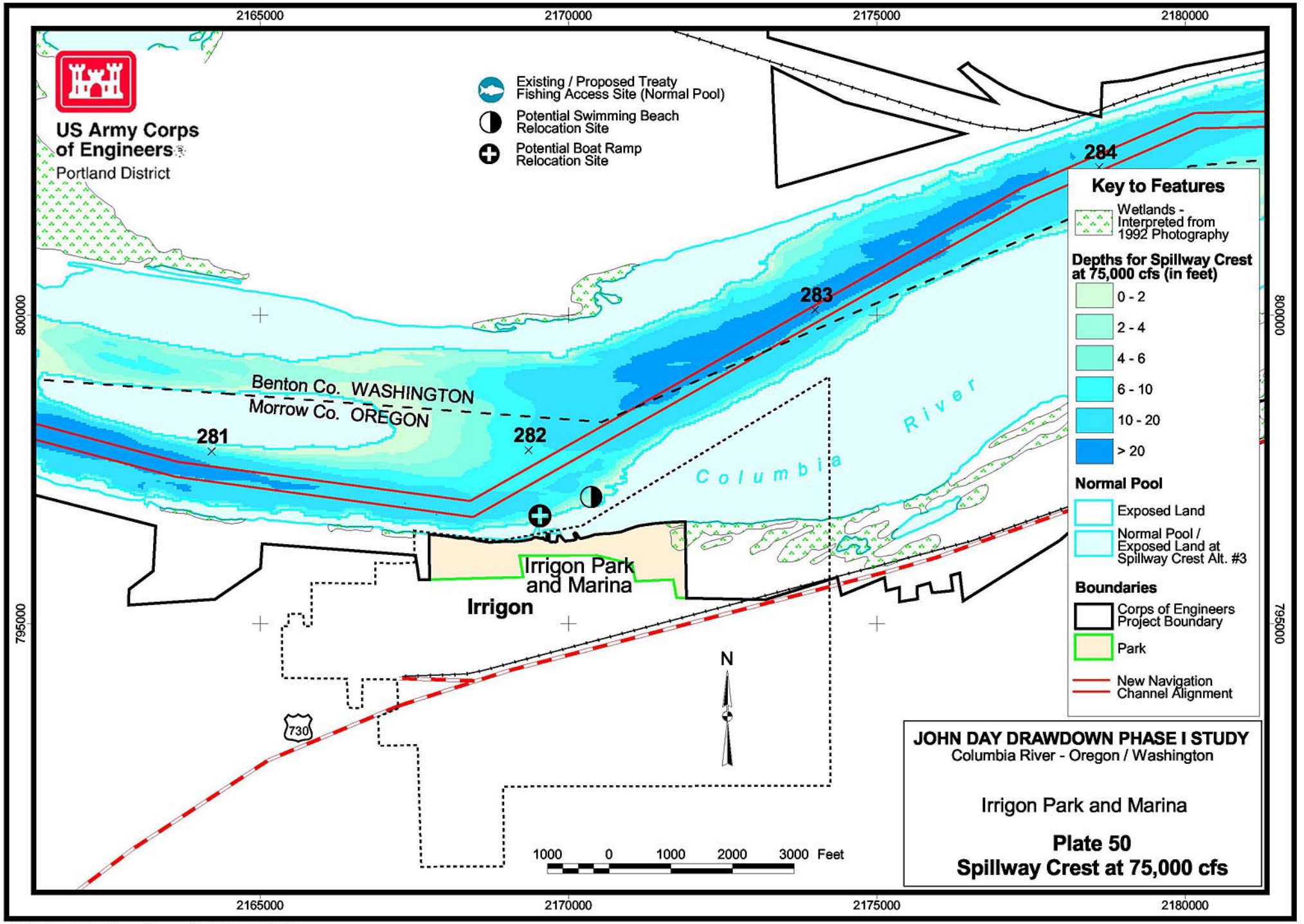
US Army Corps of Engineers, Portland District



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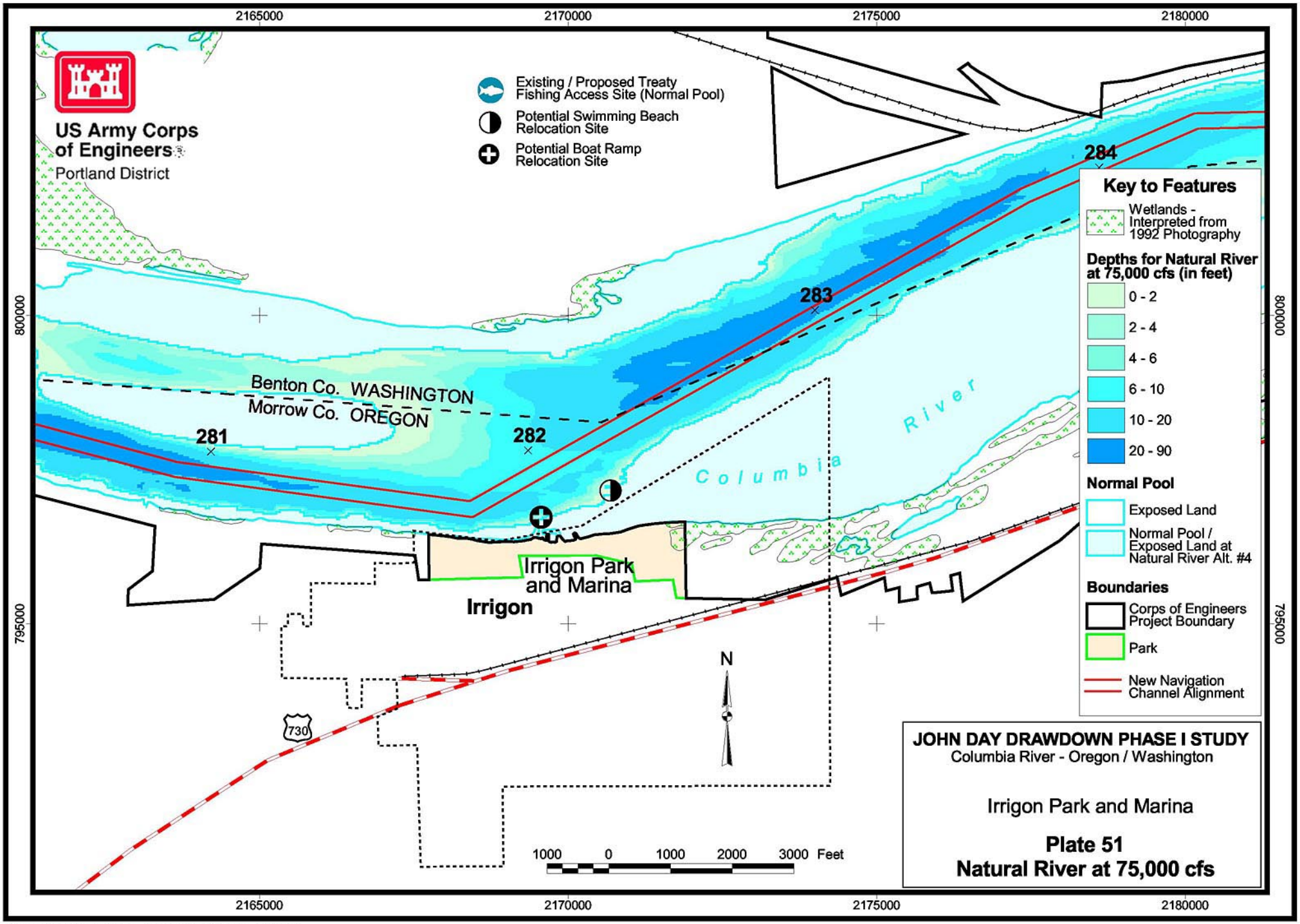
US Army Corps of Engineers, Portland District



Projection: State Plane, Oregon North Zone, NAD 27
Depths based on Corps of Engineers Hydrosurveys, 1994
Produced by GIS, Survey and Mapping Section
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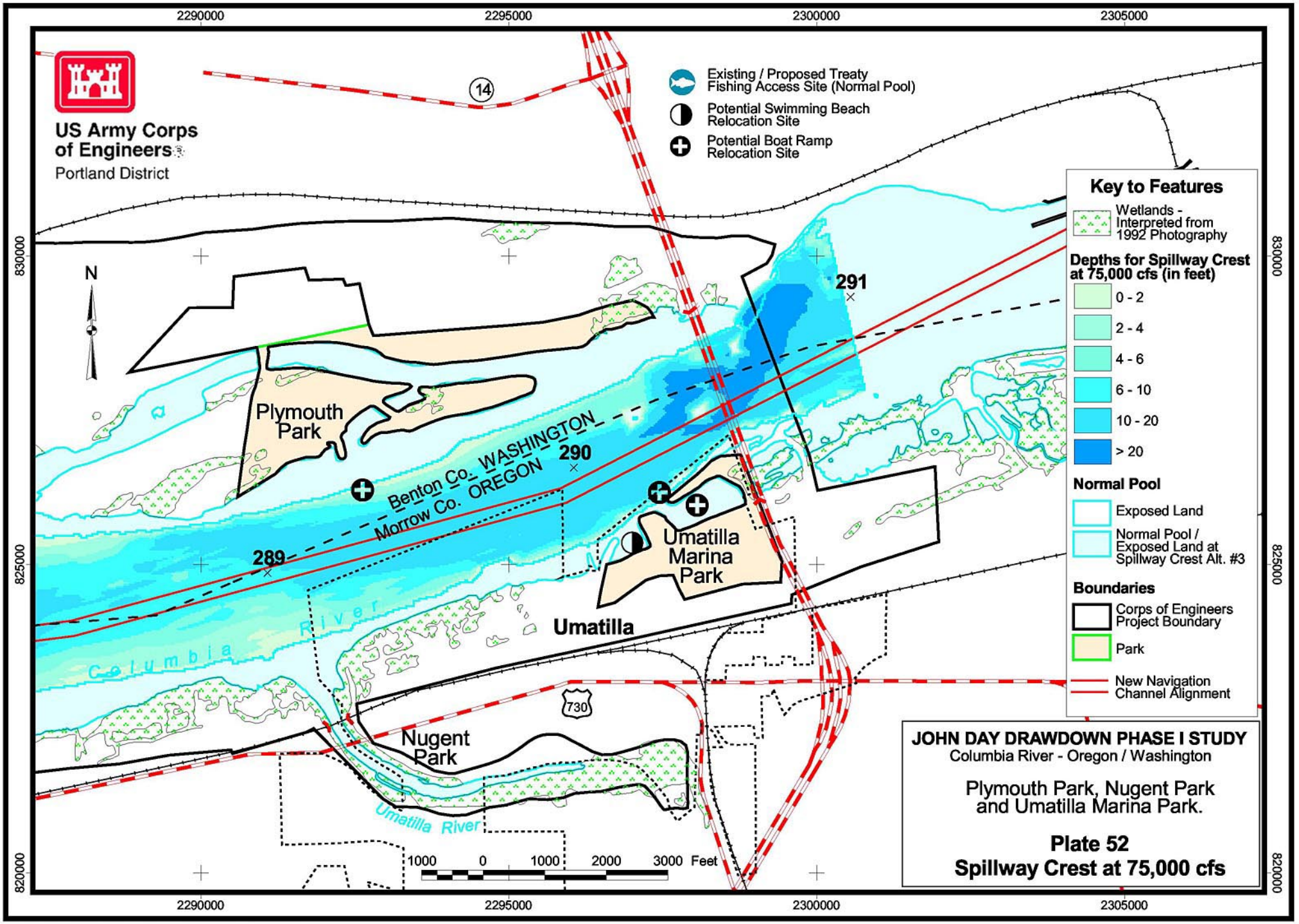

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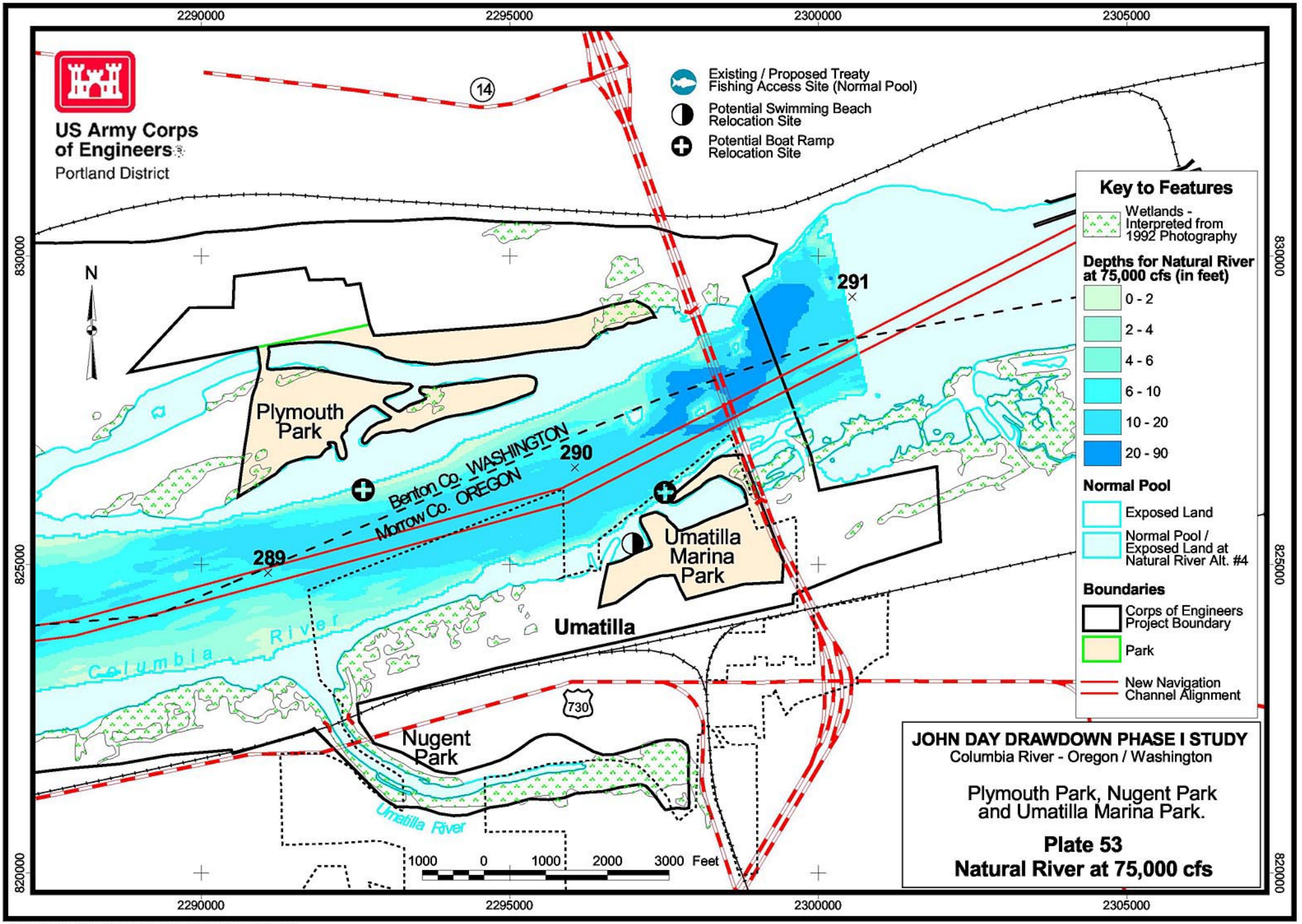

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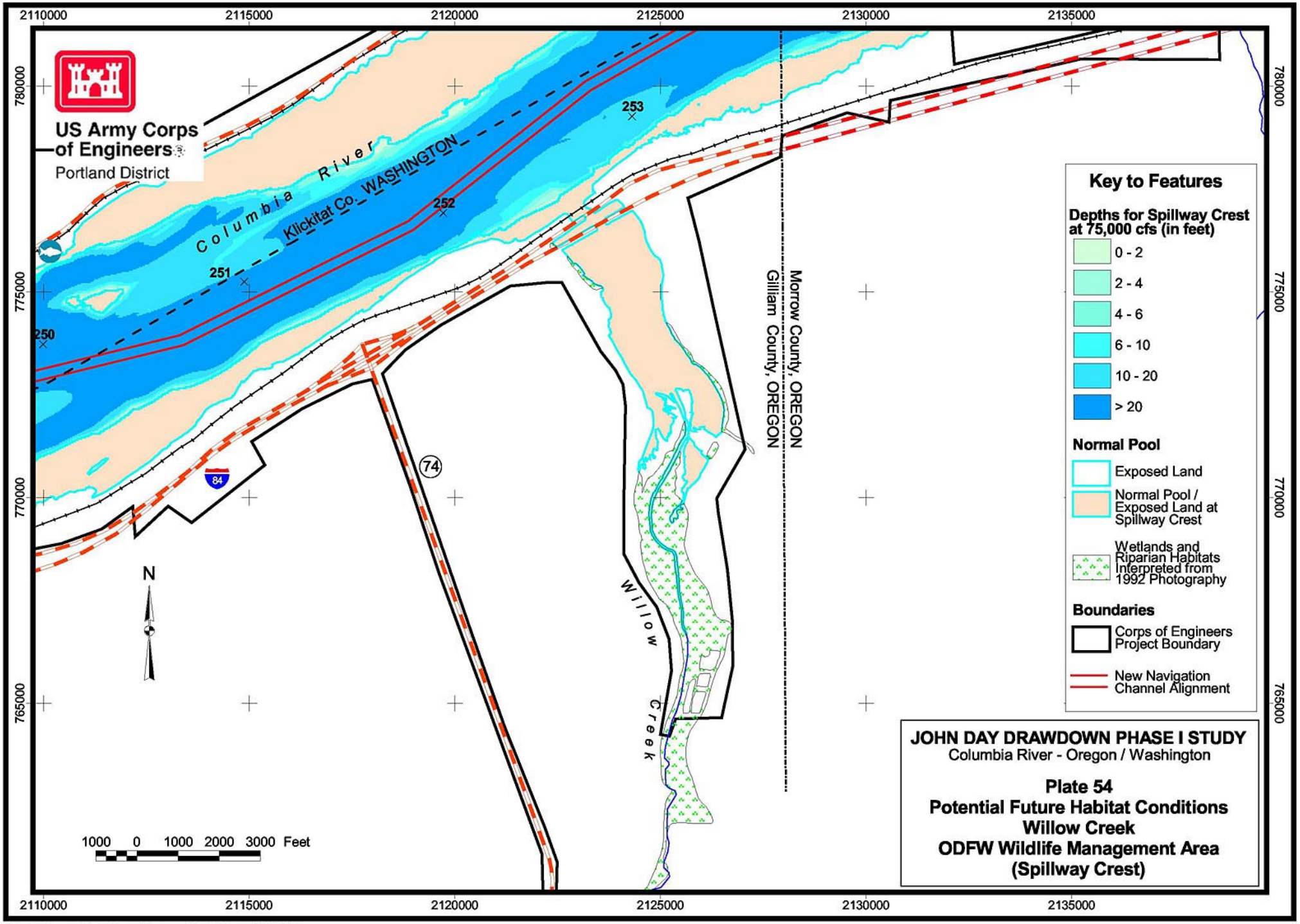

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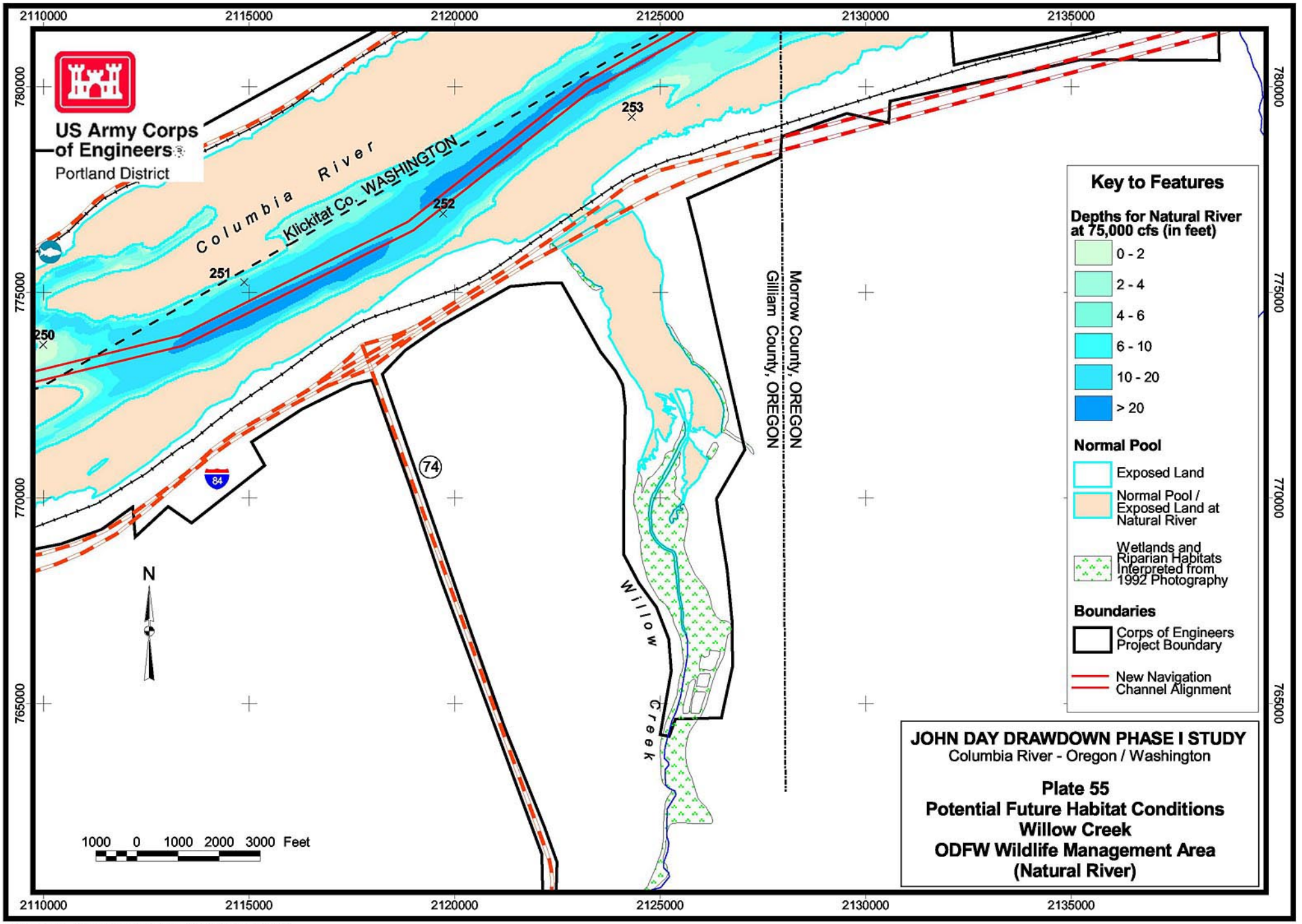

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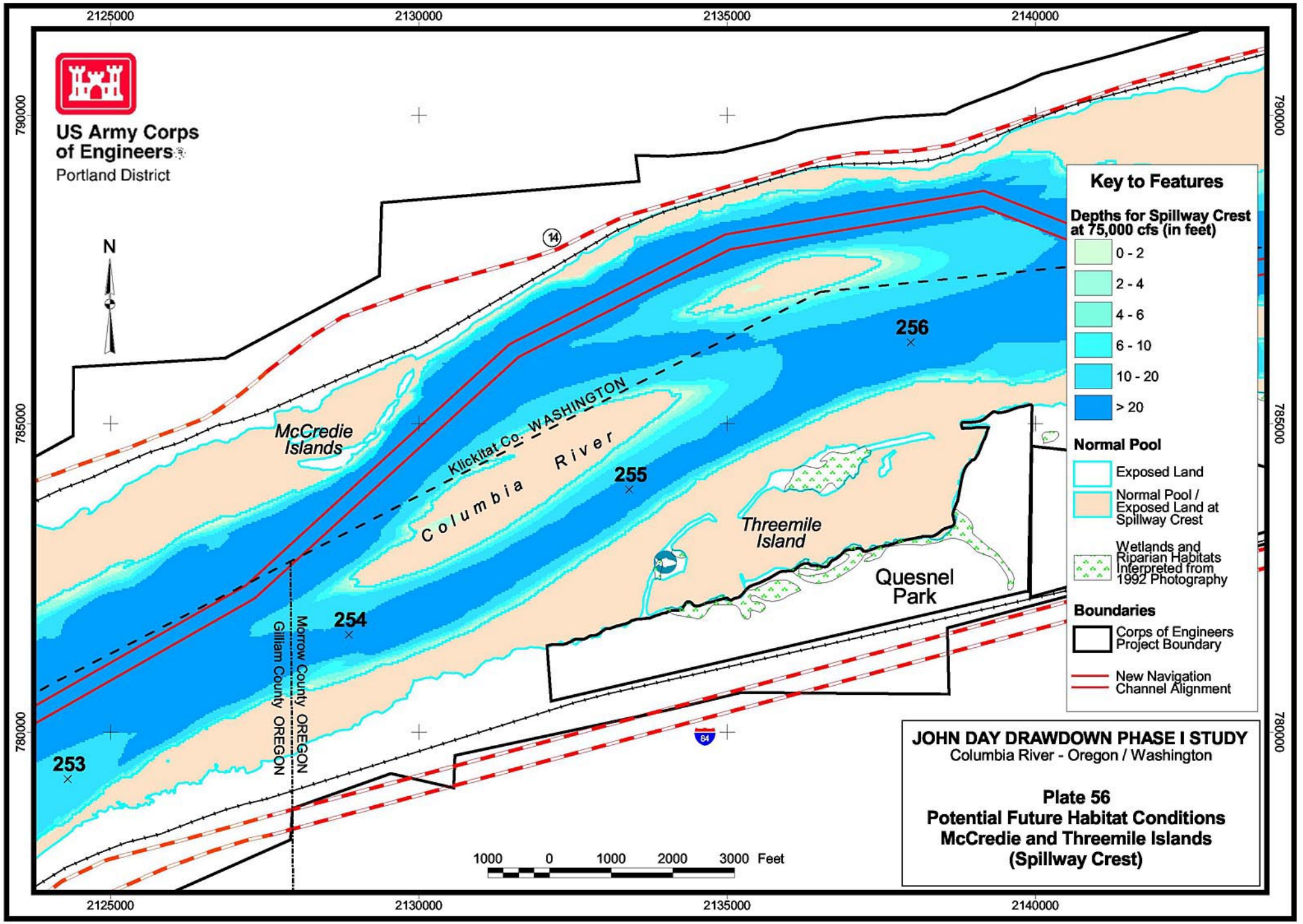

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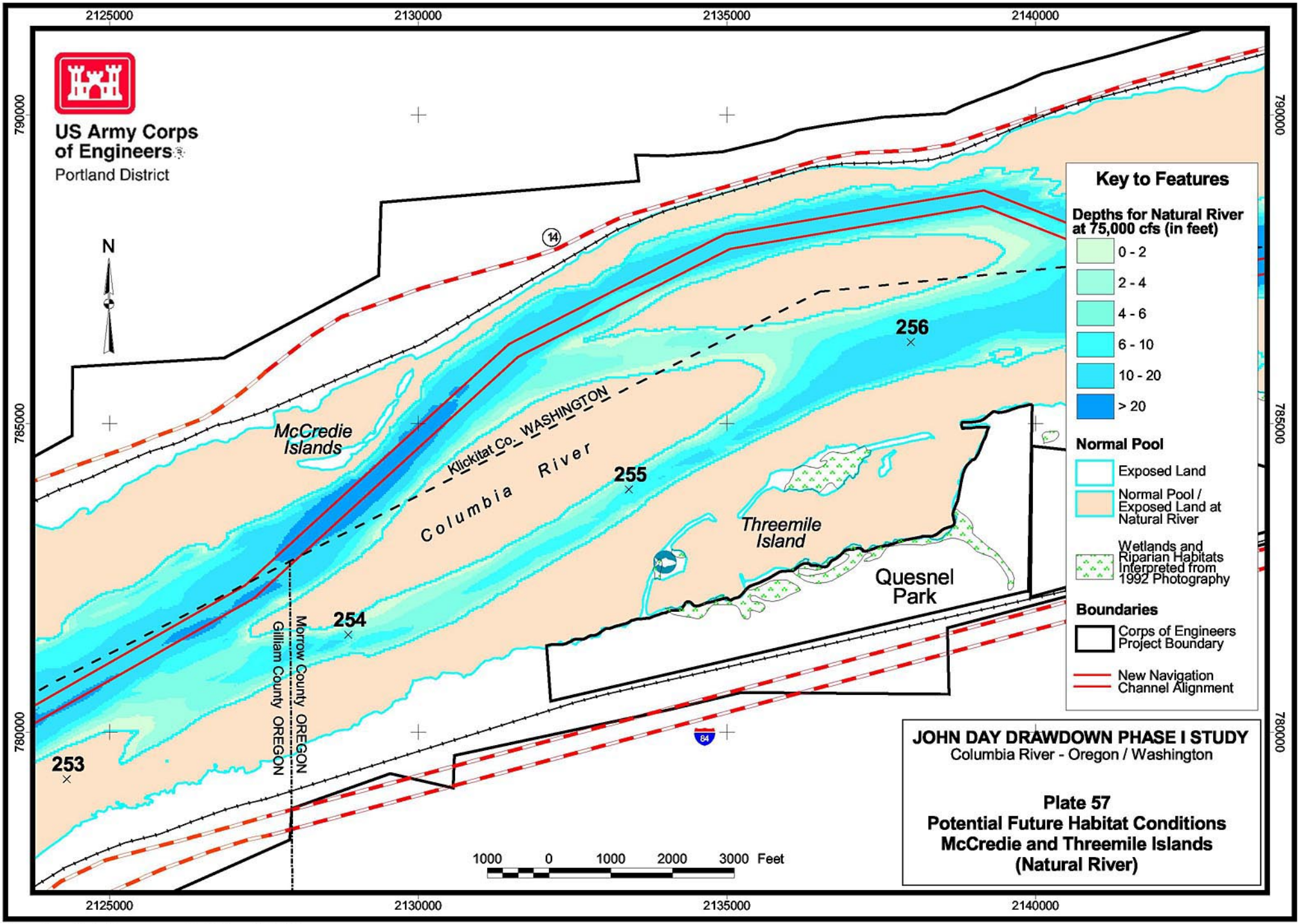

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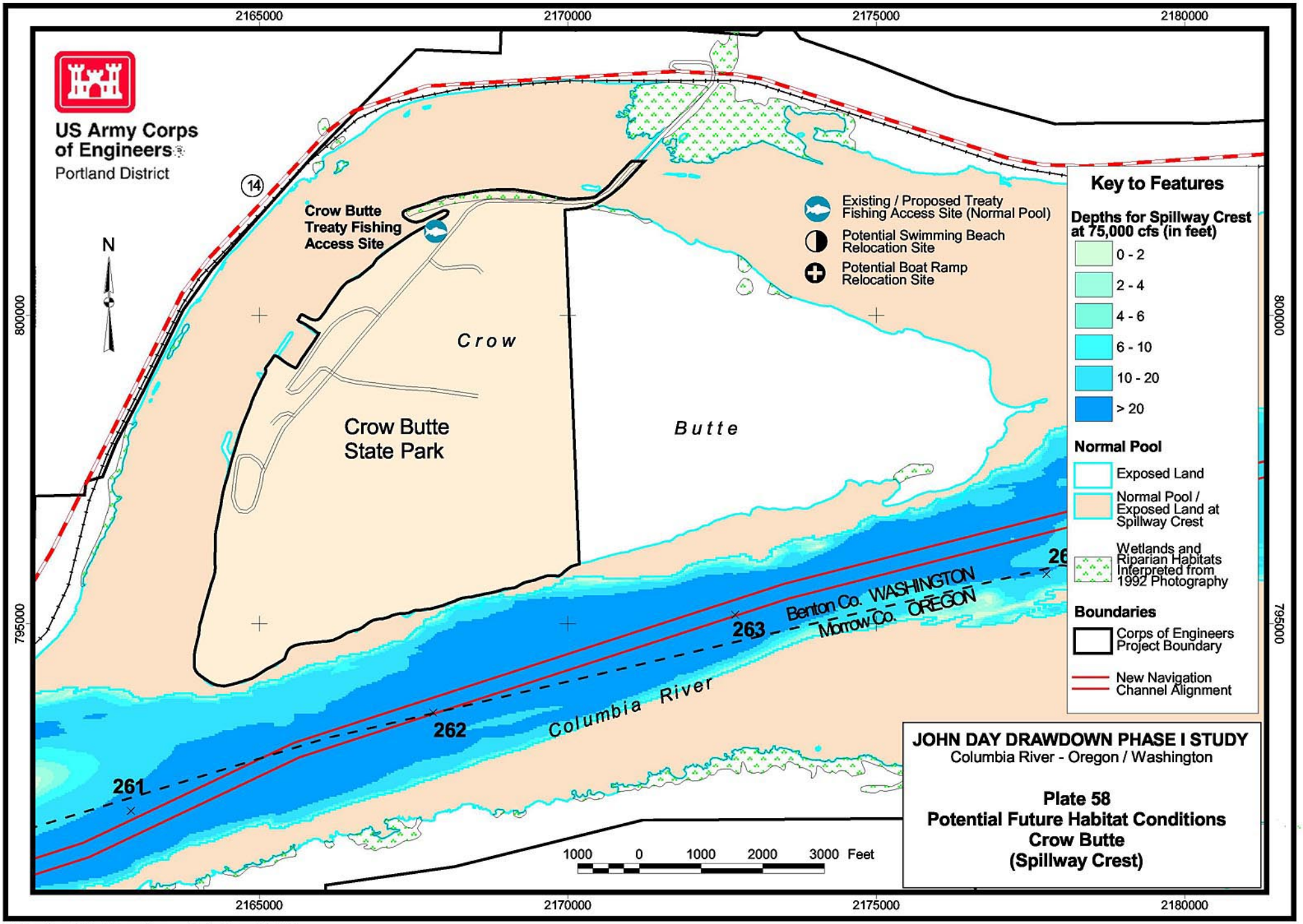

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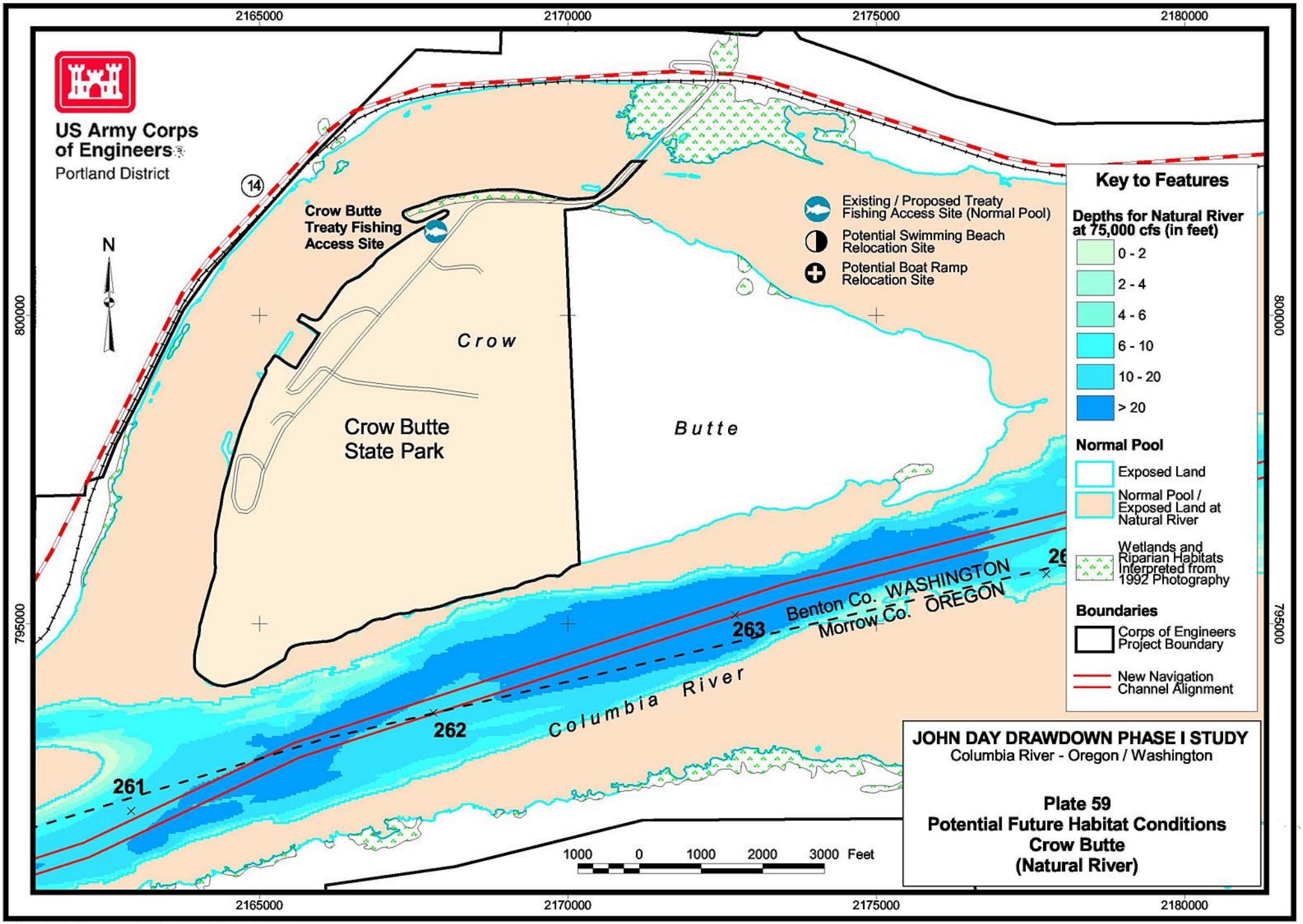

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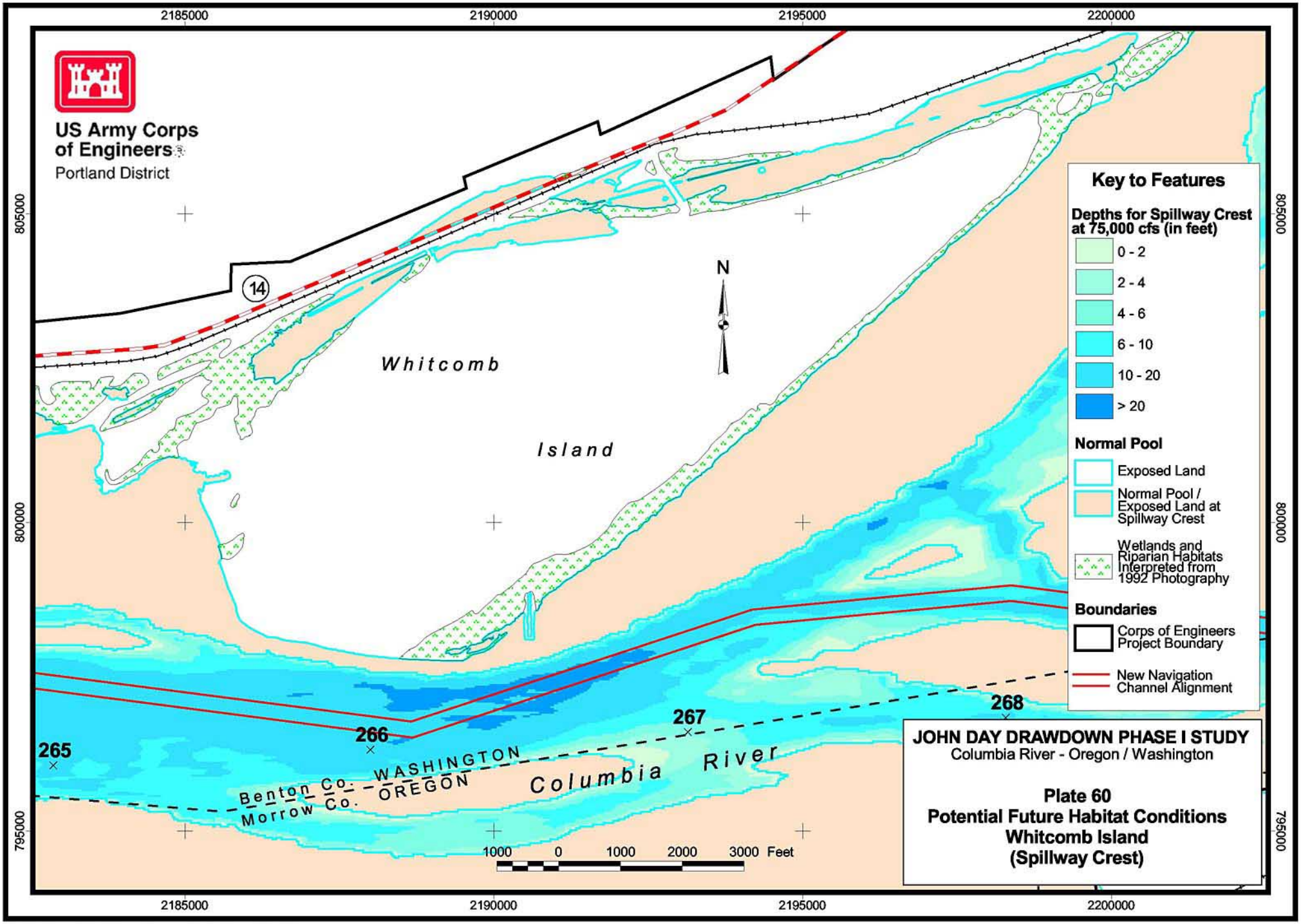

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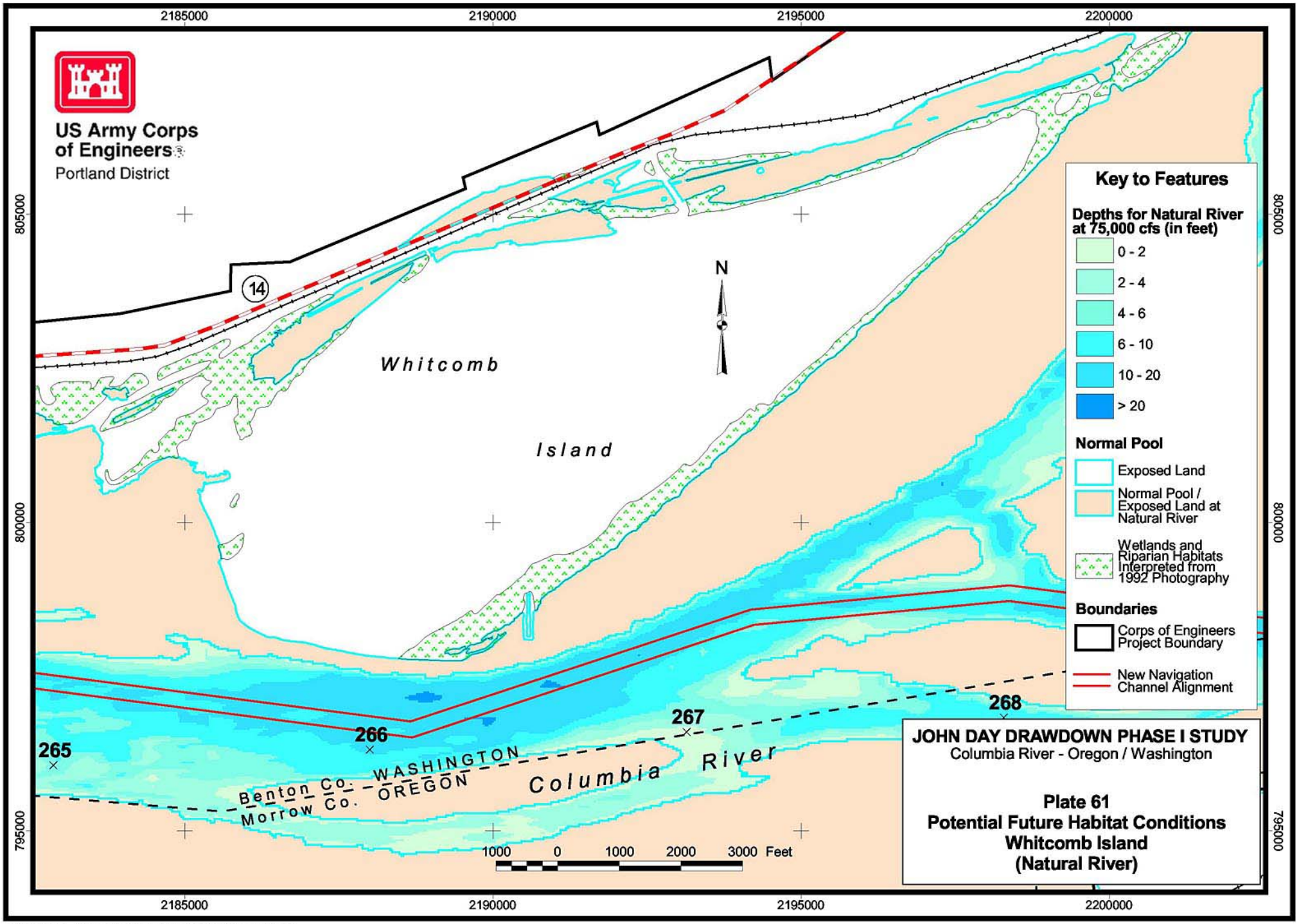

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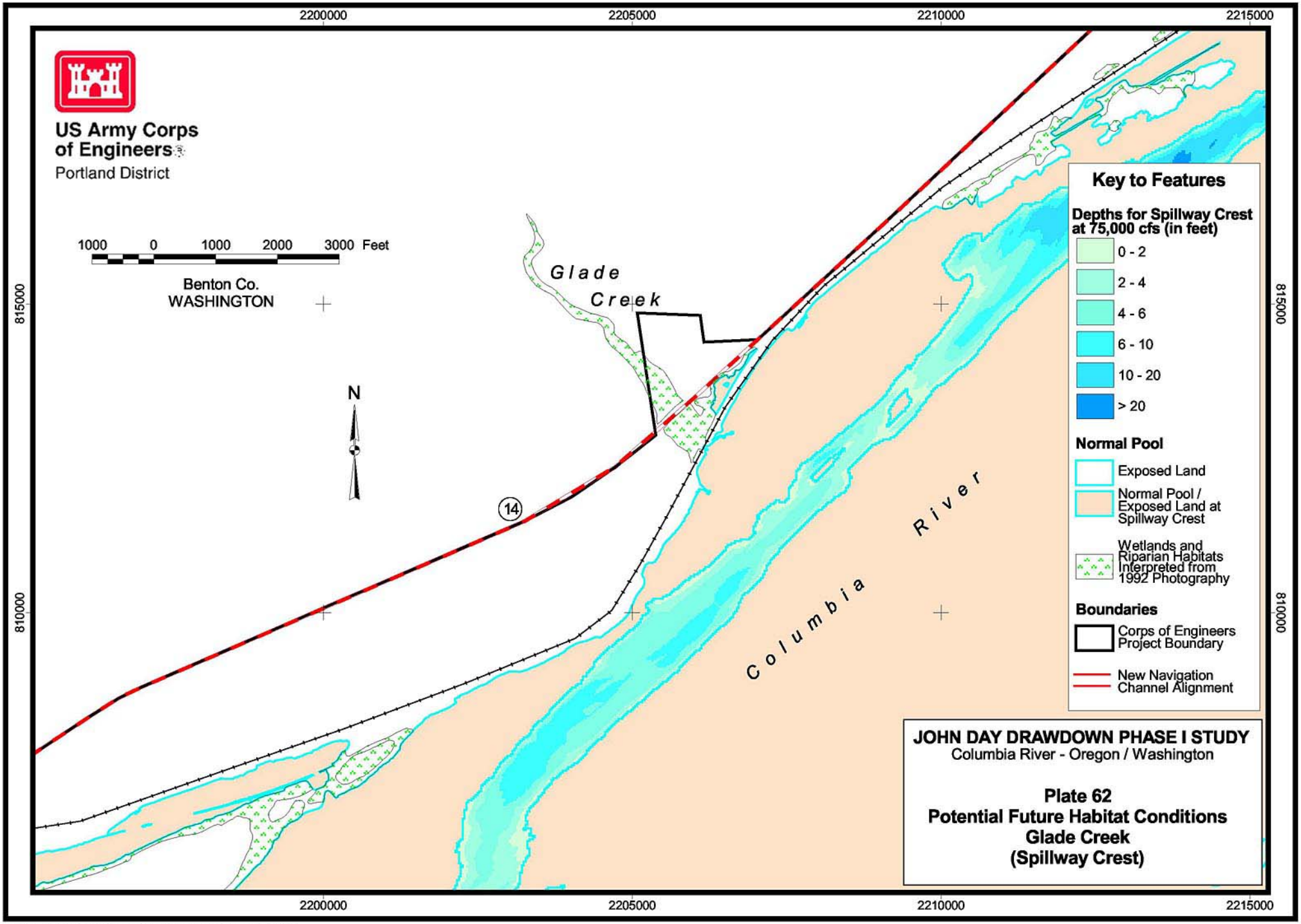

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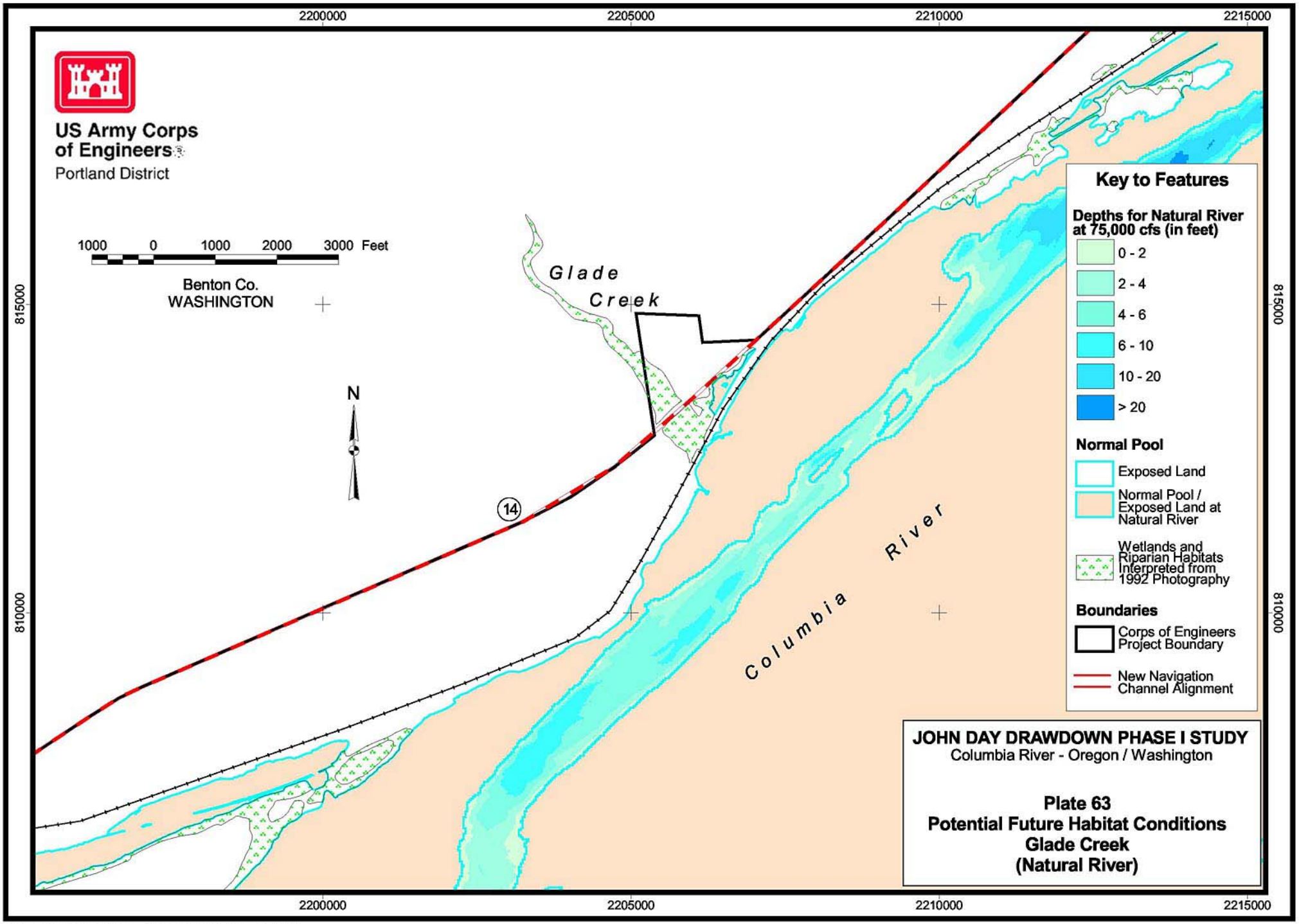

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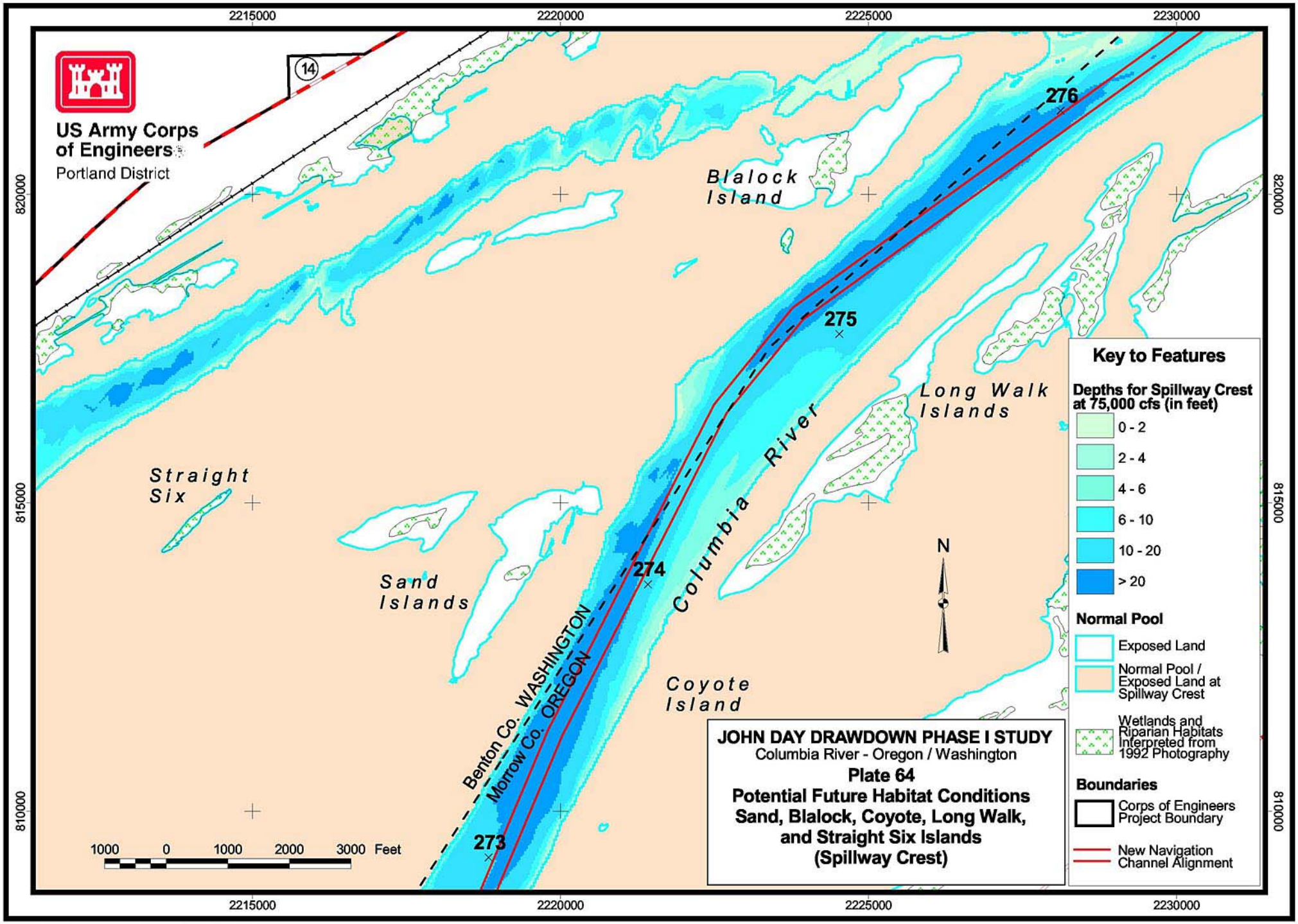

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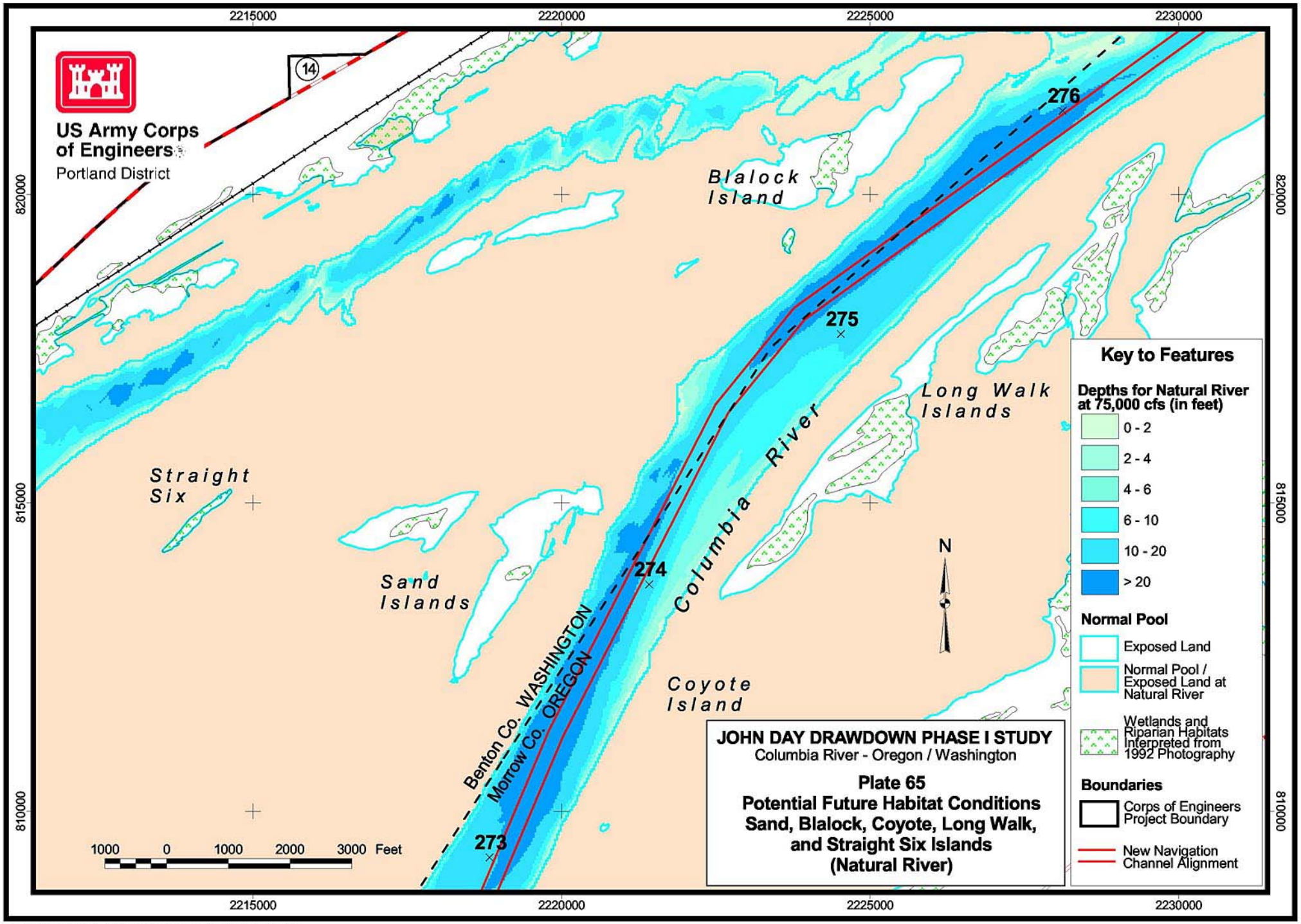

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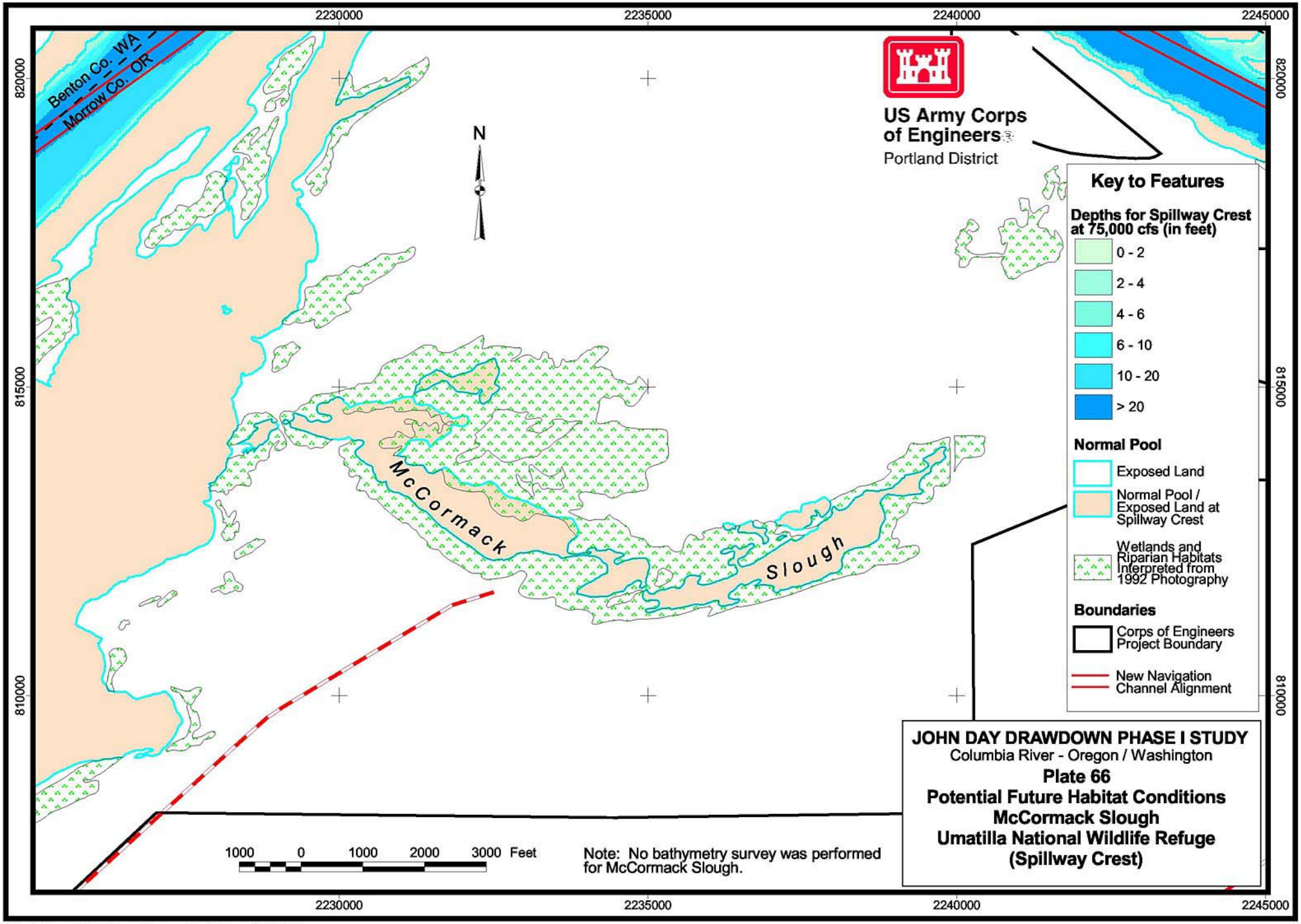

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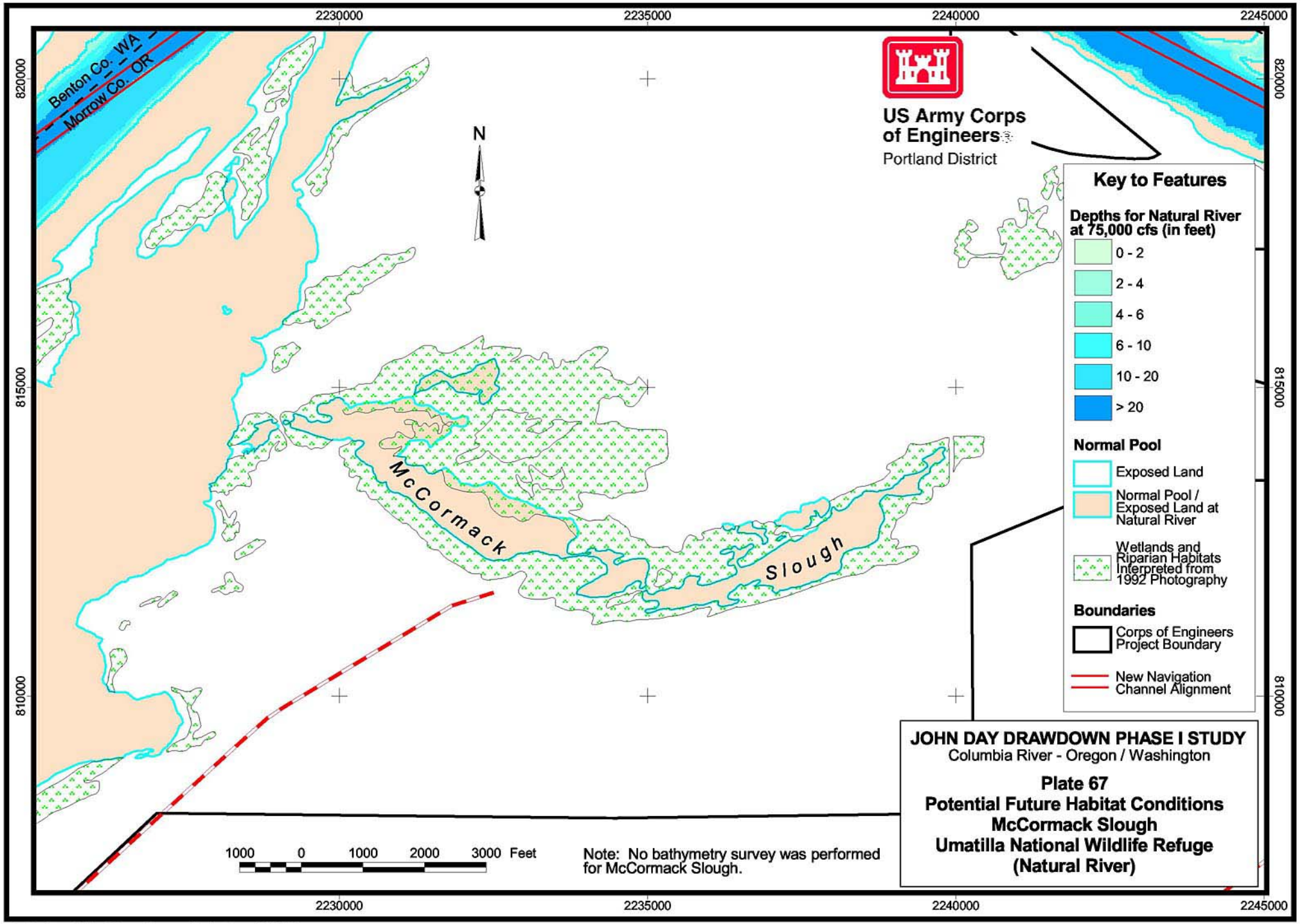

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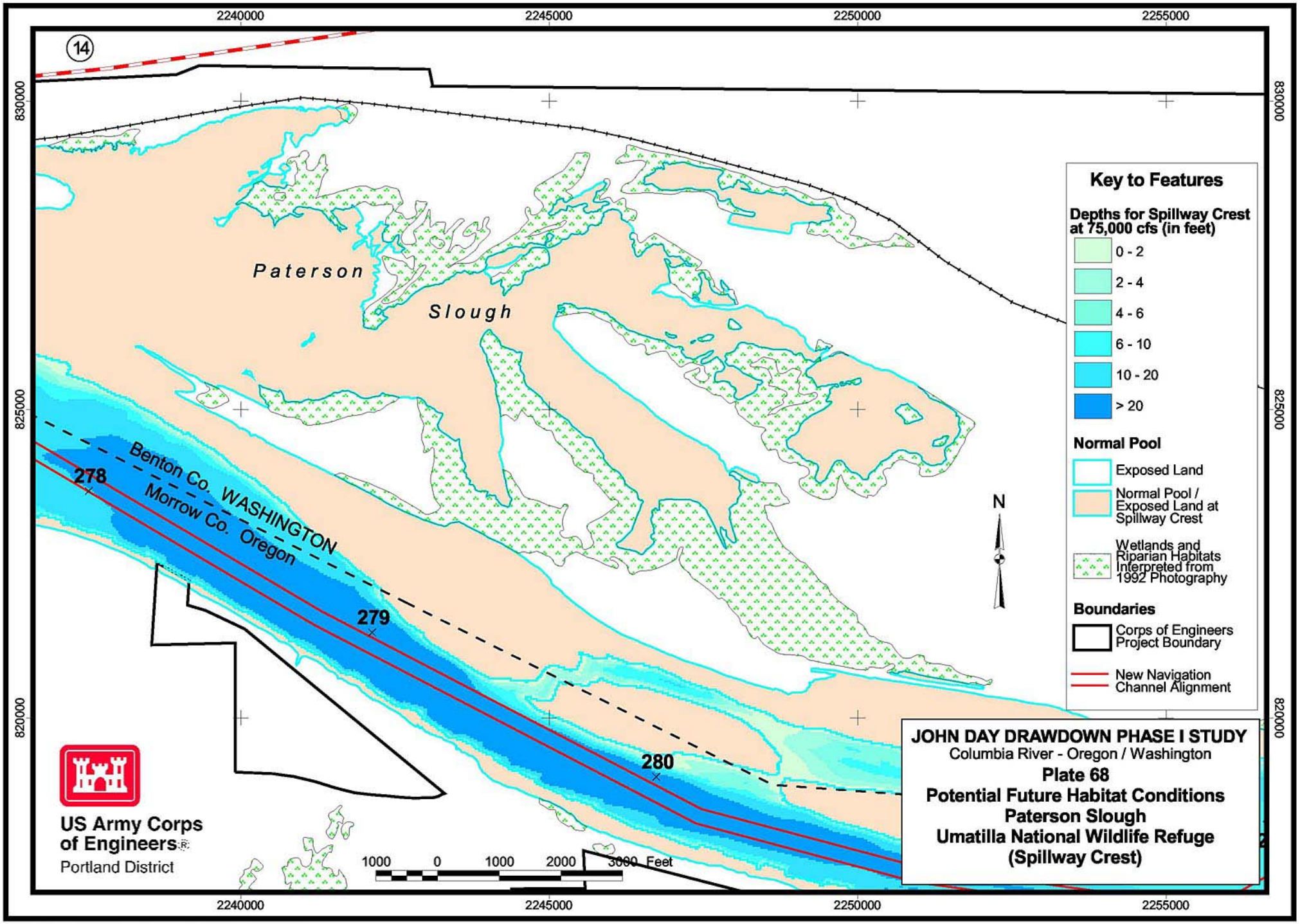

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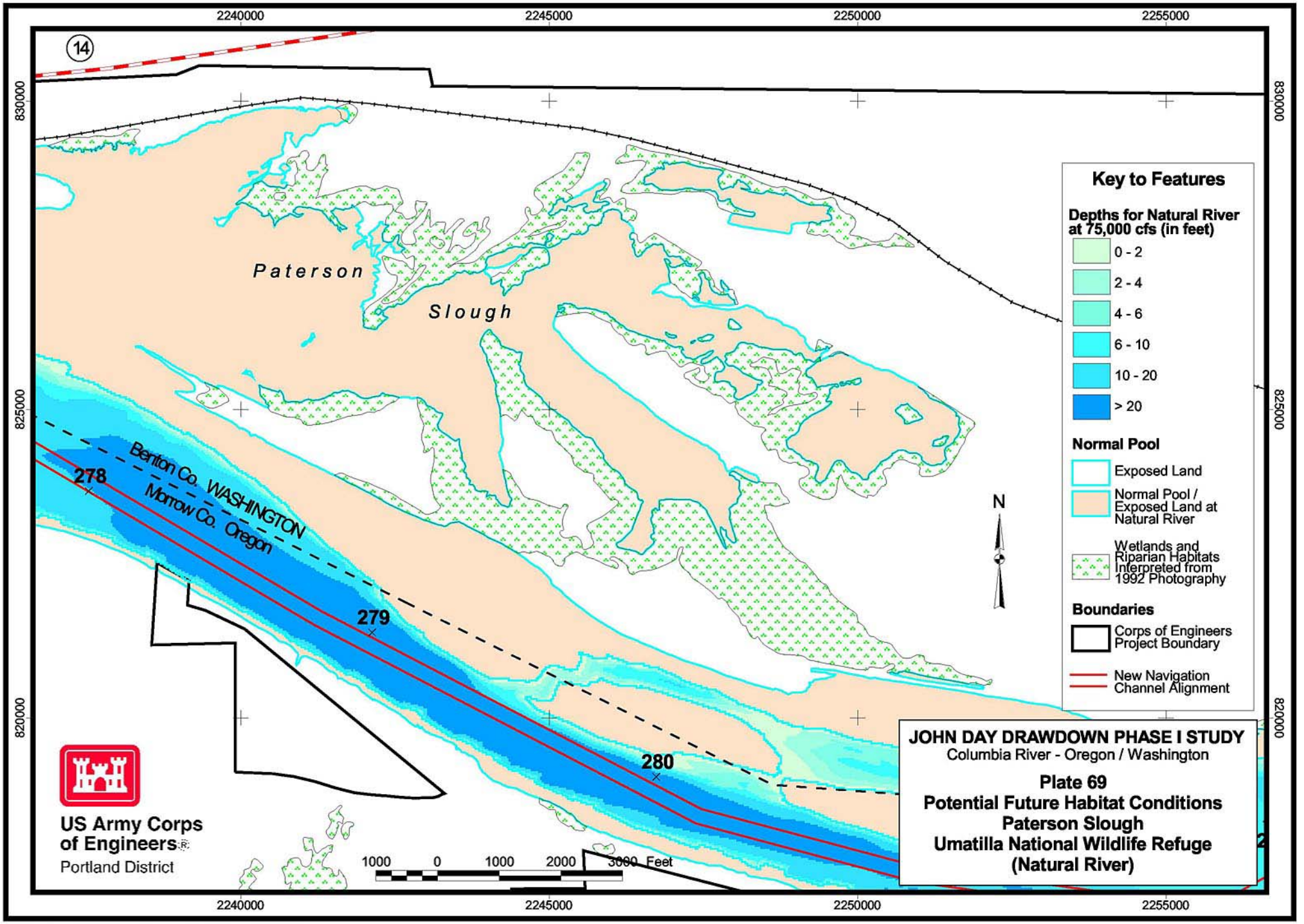

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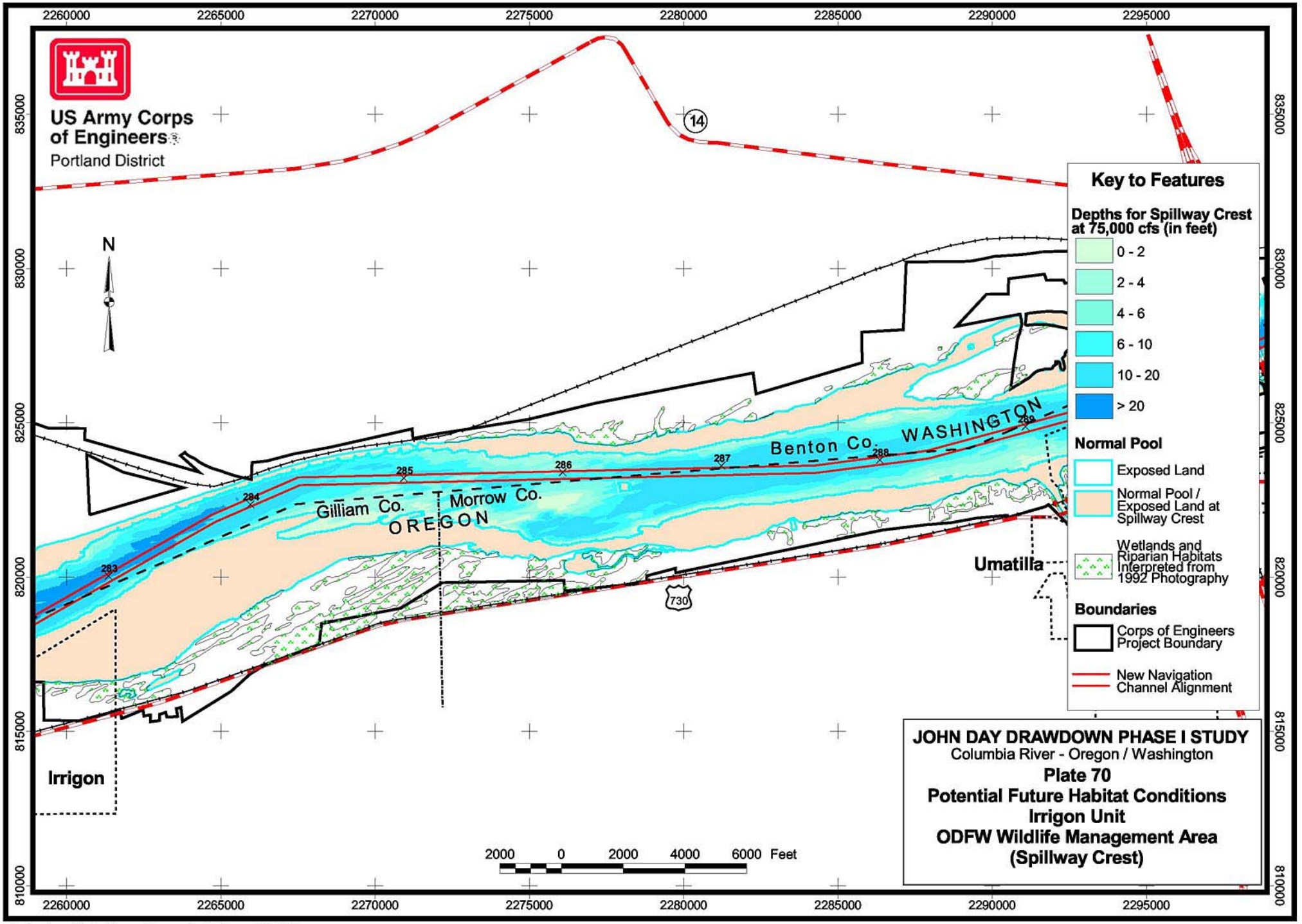

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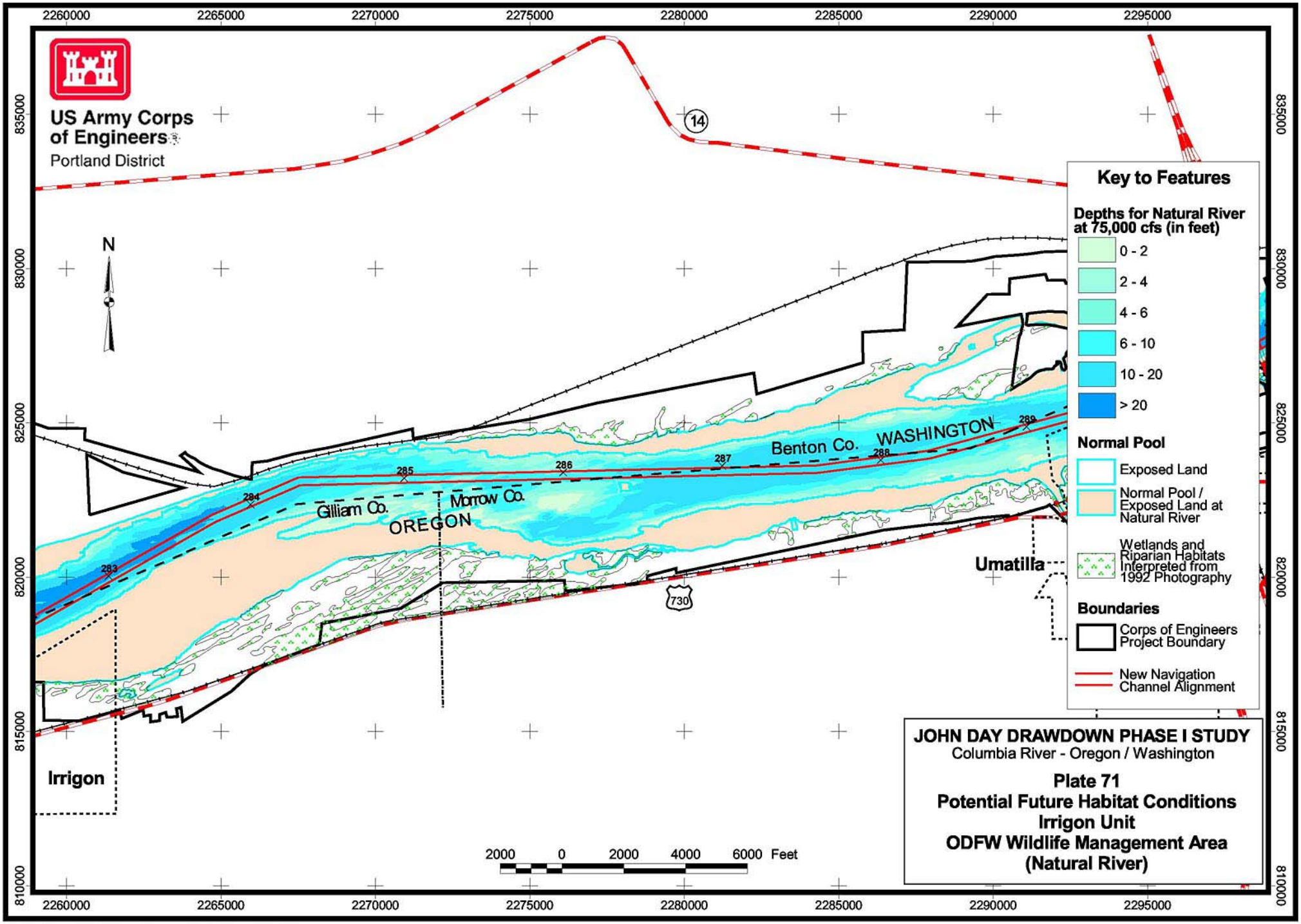

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